An Empirical Model of the Brazilian Country Risk - An Extension of the Beta Country Risk Model

Joaquim P. Andrade [*]
Universidade de Brasília (UnB)
Departamento de Economia
jandrade@unb.br

Vladimir Kühl Teles [†]
Universidade de Brasília (UnB)
Departamento de Economia
vkteles@unb.br

21st April 2004

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[*]Universidade de Brasília Instituto de Ciências Humanas Departamento de Economia Campus Universitário Darcy Ribeiro - ICC Ala Norte Brasília-DF CEP:70910-900, Tel:(61) 307-2498 Fax: (61) 340-2311, e-mail: jandrade@unb.br

[†]Departamento de Economia, Universidade de Brasília (UnB), e-mail: vkteles@unb.br

1

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Abstract

This paper develops a statistical model to study the brazilian country risk using a country beta model in spirit of Harvey and Zhou (1993), Erb et. al. (1996a, 1996b) and Gangemi et. al. (2000). Specifically, we analyze the impact of macroeconomic variables using a time-varying parameter approach. An extension of the original model is applied in order to verify the parameters' stability in time. We find that monetary policy have a significant and stable impact on Brazil's country risk and international reserves have a significant impact only in fixed exchange rate period.

Key-Words:country beta, risk modeling.

1 Introduction

It is possible to define a financial crisis as a shift from a good equilibrium with low country risk to a bad equilibrium with high country risk (Razin e Sadka, 2001). The understanding of the fundamentals that limit the country risk and how it may be affected by the economic policy is of great importance to define sustainable monetary policies. Garcia and Brandão (2001) suggest that the country risk is one of the main factors that explain the high interest rates prevailing during the Real Plan.

Recently a discussion on the relationship between country risk and monetary policy was renewed due to the steady increase of the country risk despite the high interest rates. The present debate suggests that the relation between country risk and interest rate present two distinct effects depending on the fiscal fundamentals of the economy. A tight monetary policy may contribute to the reduction of the risk as long as it reduces private spending that contributes to price stability. When the fiscal fundamentals are weak and the sustainability of the public debt is fragile, a monetary policy of high interest rates may lead to higher country risk, see for instance Favero and Giavazzi 2003.

In this sense, the paper examines the relationship between the country risk and several macroeconomic variables, notably the short run interest rate. This relation is established through the methodology developed by Harvey and Zou (1993), Erb et.al. (1996a, 1996b) and Gangemi et. al. (2000). This framework, called as *Country Beta Market Model*, consists of an state econometric model, where the country risk is a time-varying parameter. This methodology is more appropriate than the use of the traditional indicators as public bonds due to the fact that the private foreign debt share on the total foreign debt is substantial. [1].

An important extension of the model is obtained through the use of the Kalman filter. This procedure allows the analysis of the change of the parameters through time, particularly the ones that followed the shift on the exchange rate regime of 1999 as well as the ones that happened during the foreign crises that hit the country during the period. The remaining of the paper is organized as follows: the next section presents the model to be estimated, the section three presents and analysis the results while the last section concentrates the final comments.

2 Modeling the Country Risk

The starting point for the construction of a country risk measure is to use the country beta model. In this sense, the Brazilian risk is considered as corresponding to the relationship between the returns of Brazilian equity market and the returns of the equity

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[1] The ratio of private foreign debt to the total foreign debt in 2002 was 43,57% according to IPEA-DATA

market of the rest of the world[2] The model is defined as follows:

$$R_{bra} = \alpha + \beta R_{ext} + e_t \tag{1}$$

where R_{bra} represents the return of domestic equities and R_{ext} the return of the equities of the rest of the world.

The parameter β is the basic measure of the Brazilian country risk, when β increases the country risk diminishes, since this indicates that the return of the domestic equities market increases in relation to the rest of the world equities market.

However, it becomes necessary to model the country risk, and, as a consequence the parameter β, as something variable through time instead of a constant. Treating the parameter as time-varying parameter is highly justifiable by the macroeconomic theory where the relationship between return to assets and macroeconomic variables are increasingly recognized by the literature. In this context, Fama and French (1989) and McQueen and Roley (1993), for example, present evidence that the expected returns of the assets depend on the behaviour of the macroeconomic variables within the economic cycle. Such results are reenforced by the evidence presented by Dumas (1994), Erb et. al. (1994, 1996a) and Diemonte et. al. (1996). Indeed, the assertion that the agents expect that the assets returns are constant during the periods of growth and of crises during the economic cycles reflects some degree of naivete.

Within this framework it is expected that the relation between the returns on domestic equities and the returns on the rest of the world equities be strongly related to the macroeconomic variables and consequently the parameter beta to change significantly as a response to shocks of macroeconomic variables. The appropriate question that appears in this debate is not about the endogeneity of the country risk, since this is well established, but which and how macroeconomic variables are capable of affecting significantly the country risk In this sense, the central aim of this paper is to build an econometric model to be used to evaluate the explanatory power of the macroeconomic variables on Brazilian country risk. Taking into account the variables that have been used to explain the country risk in other countries [e.g. Erb et al. (1996a); Bekaert et al. (1996); Abell e Krueger (1989); e Groenewold e Fraser (1997)], as in Brazil [e.g. Garcia e Brandão (2001)], the following set of variables as presented in Table 1, were chosen.

In this sense, the variable GOV would reflect the sensibility of Brazilian country risk to the fiscal fundamentals of the public sector. The agents consider that an increase of the public debt increases the risk related to the country. It was used the concept of primary deficit to avoid multicollinearity with the interest rate.

The consideration of the interest rate is due to the possible effect of the monetary policy on the country risk. The variable OIL is employed as a proxy for supply shocks, and the variable RES tries to model the effect of the external shocks and above all the pressures on the exchange rate.

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[2]In the model the IBOVESPA index was used as reflecting the return of domestic equities while the Dow Jones index was used as the return of the rest of the world equities

Table 1: List of the Explaining Variables

Variable	Symbol	Source
Foreign Reserves	RES	IPEA
Oil Price	OIL	EIA
Nominal Interest Rate (SELIC)	JUR	IPEA
Financial Borrowing Needs of the Public Sector(Primary Concept)	GOV	IPEA

Table 2: ARIMA Models for the Macroeconomic Series

	Macroeconomic Variables			
	RES	OIL	JUR	GOV
Constant	10.6947	7.3782	0.6103	-2976.34
AR(1)	0.9629	0.9511	0.9785	0.1758
AR(2)				0.1907
AR(5)				0.1868
AR(12)				0.2708
MA(1)	0.1905	-0.2460		

All variables are monthly, from January 1991 to December 2002, and JUR, RES and OIL, are taken as logs.

In an efficient market, only non anticipated shocks of the variables are expected to affect the returns. Being that the case, the econometric model should consider only the non anticipated components of the related series. To white the series Box and Jenkins procedure was applied and an univariate ARIMA process for each macroeconomic series was obtained. The nature of the ARIMA process of each series was modeled by the analysis of its degree of integration, through the analysis of auto-correlation and partial auto-correlations. The results of theses estimations are depicted in Table 2.

The series obtained after the filtering correspond to white noises. In this sense the series correspond to the unanticipated components, i.e. represent unexpected shocks. Such series are the correct ones from the theoretical framework as explained above and present the advantage of being stationary and avoiding spurious regression.

The equation to be estimated to evaluate the effects of the shocks of the macroeconomic variables on the country risk is the following:

$$\beta_t = b_0 + b_1 RES_t + b_2 GOV_t + b_3 OIL_t + b_4 JUR_t + u_t \tag{2}$$

where all the variables are defined by their unanticipated components according to the above analysis.

The direct estimation of this model, however, is not possible by the non existence of time series for β. However, it is possible to substitute the above equation in equation (1), specifying the beta country model with a time varying parameter to be estimated

Table 3: "Beta Country Risk Model" for the Brazilian Country Risk

	Models		
Variables	(1)	(2)	(3)
Constant	0.0127	0.0095	0.0128
R_{ext}	0.2038	0.1699	0.2057
$RES * R_{ext}$	-0.7101	8.3226*	-0.5523
$GOV * R_{ext}$	-3.16E-06		-3.88E-06
$OIL * R_{ext}$	0.0364	-0.3744	0.016
$JUR * R_{ext}$	-0.1747	6.4539*	
$Adjusted\ R^2$	-0.03	0.07	-0.02
$D-W\ Test$	2.01	2.07	2.01
$F\ Test$	0.11	3.89	0.13

(*) is for statistical significance of at least 1%

by,

$$R_{bra} = \alpha + (b_0 + b_1 RES_t + b_2 GOV_t + b_3 OIL_t + b_4 JUR_t)R_{ext} \qquad (3)$$

or,

$$R_{bra} = \alpha + b_0 R_{ext} + b_1 RES_t R_{ext} + b_2 GOV_t R_{ext} + b_3 OIL_t R_{ext} + b_4 JUR_t R_{ext} \quad (4)$$

This equation can be estimated with observable variables only. The results obtained of the equation (4) permits to compute the parameters of equation (2) and therefore a series for the country risk. In order to overcome the Lucas critique we assumed that the coefficients of the estimated parameters and its significance, can vary through time. As a consequence, the model was re- estimated using the Kalman Filter to analyse the changes of the coefficients of the macroeconomic variables through time.

3   Results

The analysis was conceived for the period 1991:01 a 2002:12, using monthly data. The sources of the data follow the specification of the last section. The results estimated from the model are depicted in Table 3.

In this sense the model is estimated under three alternative specifications. One includes all the variables, and the other two the variables JUR and GOV, each one at a time. These alternatives can be justified for the possible interdependence between the variable of fiscal policy and the variable of monetary policy in the same model. The improvement of the statistical significance of the coefficients estimated with the exclusion of the variable GOV from the model, and the non statistical significance of this

variable in the other models suggest that it should not be considered in the model. This is justified since the variable GOV not only was not statistically significant but also it led to some inefficiency reducing the t statistics of the other variables. It becomes convenient, to expand the model to examine the stability of the coefficients through time. The preoccupation was to observe the size of the impact and the significance of the macroeconomic variables through time. For that matter it was applied the Kalman filter estimation procedure. The path of the coefficients are presented in Figure 1

In this sense, since the variable JUR correspond to first differences of the nominal interest rate, the effect of the level of such variable falls strongly from the Real Plan on as long as the inflation rate fell down. This does not mean that the monetary policy became less important since then, but that the coefficient adjusted itself to the change of the level in the interest rate. On the other hand, the magnitude of the effects of the level of reserves on the country risk is less stable through the period. Notably, the effects of this variable became extremely small since the adoption of the floating exchange rate regime. This suggests that the significance of this variable is related to the exchange rate regime.

Figure 2 presents the change of the estimated coefficients for the period that follows 1995. Such restriction is meant to focus the analysis in the period where the Brazilian economy presented some stability. The behaviour of the coefficient of the variable nominal interest rate reveals that the effect of the monetary policy was kept relatively stable in relation to the results on the country risk. It is notorious that the sign of the coefficients are positive suggesting that the unanticipated increase of the interest rate acted efficiently to reduce the country risk. [3]

Another relevant result of the present experiment is the evidence that the unanticipated shocks in interest rate affected the country risk during the period of fixed exchange rate. This suggests a relative active role of monetary policy in this period contrasting with the view of Garcia e Brandão (2001).

The variable foreign reserves presented the expected effect with a negative relation with the country risk. A fall in the reserves lead to an expectation of exchange rate devaluation.

The behaviour of the coefficient of foreign reserves on country risk presented a notorious lack of stability particularly during the real plan that goes until 1999 comparing to the period that follows.

This result is expected as long as the effect of abrupt falls in the reserves are associated with the lack of sustainability of the exchange rate regime, increasing the country risk. It is possible to understand that the relative size of the effect of the reserves on the country risk is related to the lack of credibility of the fixed exchange rate regime. It is noteworthy the period that goes from Russian crises,starting in 1998, to January 1999. In this critical period it is possible to note that the significance of the coefficient

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[3]It is important to note that the interest rate can have an unstabilizing effect on the sustainability of the public sector and as such induce an increase in the country risk. The evidence presented in this paper can be considered a favorable result to the traditional role of liquidity tightening of the monetary policy

Figure 1:

A. Coefficient Changes Through Time
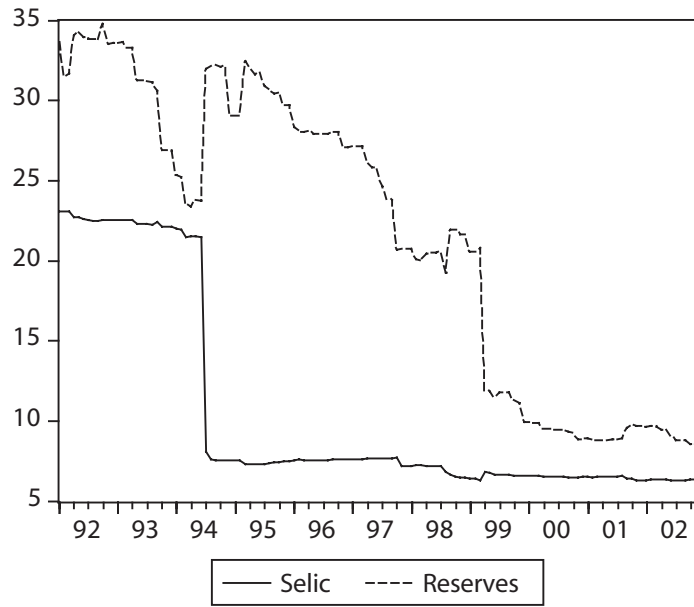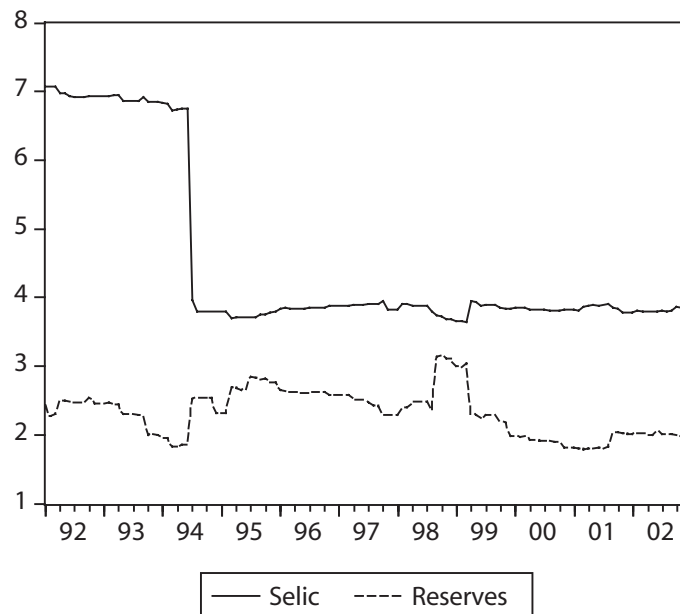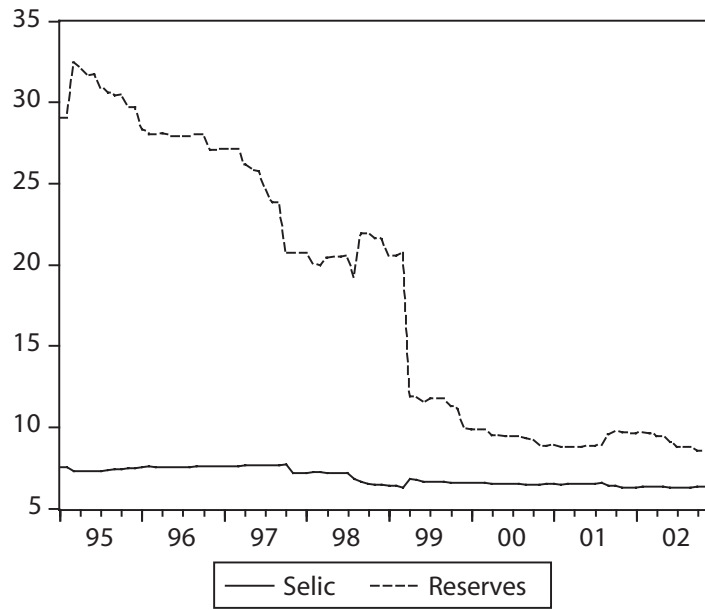

B. T Statistic Changes Through Time

Figure 2:

A. Coefficient Changes Through Time

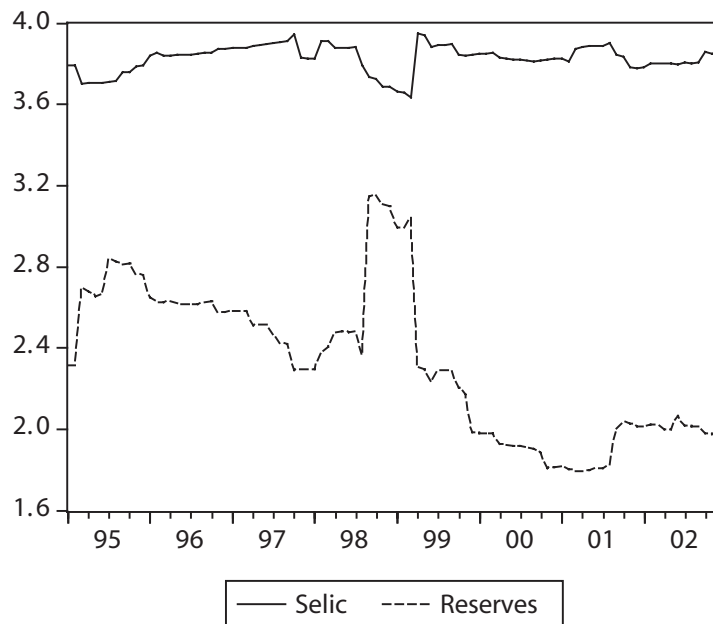B. Statistic t Changes Trough Time

Figure 3:

A. Statistic t Changes Through Time

Selic - model without reserves   ----- Selic - model with reserves

B. Statistic t Changes Through Time

reserves - model with selic

----- reserves - model without selic

10
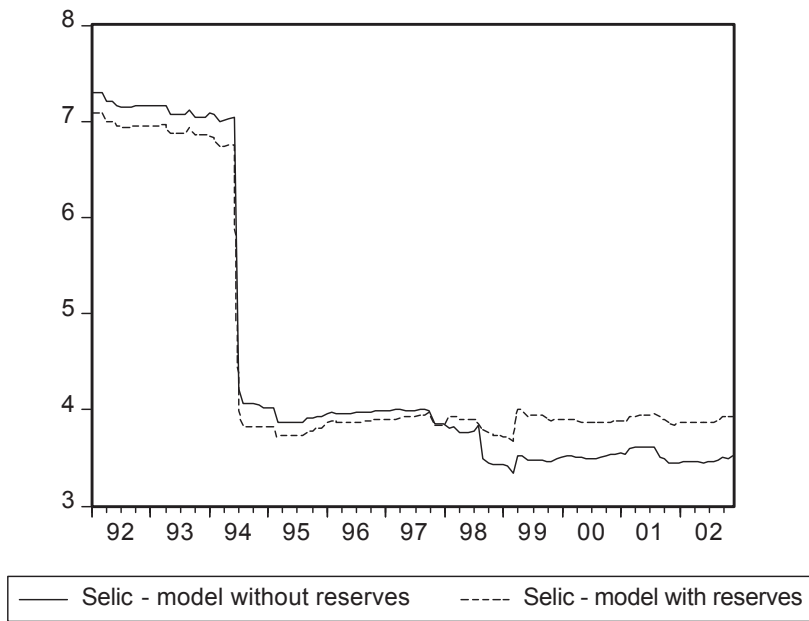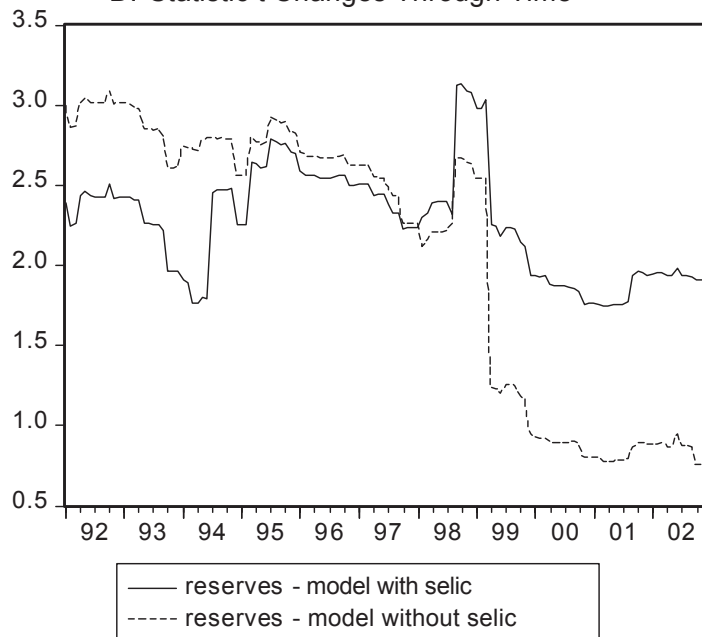
of foreign reserves is magnified. It suggests that, right after the crises, a small shock on the country risk is magnified. In the same period, there was a significant fall of the interest rate to explain country risk. Such analysis suggests that the efficacy of the monetary policy was reduced after the Russian crises while the pressures on the exchange rate were amplified. On these grounds it is possible to classify the Russian crises as a credibility crises of the fixed exchange rate regime. Such results make it clear that the interest rate, as the maintaining factor of the fixed exchange rate regime, has lost its power, what explain an excessive rise of the interest rate to obtain the same results obtained before the crises. The costs to maintain the fixed exchange rate are magnified turning the regime not sustainable.

The inclusion of the variable foreign reserves with the interest rate is justifiable as long as they are non unticipated, having been modeled as white noises. To check for a possible multicollinearity effect between these variable two models were estimated where the variables were introduced alternatively. The only relevant change comes from the foreign reserves that looses its significance in the period that follows 1999 as shown in Figure 3. The empirical model applied in the paper suggests that the macroeconomic variables are capable of affecting the country risk. Particularly a policy of tightening money may be consistent with the reduction of the country risk.

4   Conclusions

The main objective of this paper was the estimation of an empirical model of Brazilian country risk for the period 1990-2002. For that matter the methodology of Harvey e Zhou (1993), Erb et. al. (1996a, 1996b) and Gangemi et. al. (2000) denominated *Country Beta Market Model*, was applied. This methodology consists of a construction of an state space econometric model where the country risk is a time varying parameter.

The results of the econometric estimation of the model suggest that the monetary policy, represented by the selic interest rate, was important throughout the whole period. The monetary policy kept its traditional role of reducing the risk through a rise in the interest rate contrasting with Favero e Giavazzi (2003). The mechanism behind this effect is supposedly the efficacy of the interest rate on price stabilization. The assumption is that the credibility of the government is enhanced by a correct stabilization policy, thus reducing the country risk.

The foreign shock, defined by the fall of the foreign reserves had an independent influence on the country risk during the period of the Real Plan when there was a managed exchange rate regime. The results suggest that the influence of the foreign reserves shocks was offset by the interest rate policy of the period. This becomes evident by the results obtained by the models that consider each variable at a time.

It is notorious the stability of the coefficients independently of the changes in specification of the model during the period of fixed exchange rate. The importance of the reserves disappear during the period of floating exchange rate. These results make sense as long as the floating exchange rate regime smooth the exchange rate path com-

paring to the period of fixed exchange rate and at the same time there is more efficacy of monetary policy with floating exchange rate.

The paper concludes that the monetary policy has been efficacious to control the country risk, being a tool capable of promoting stability even during periods with plenty of adverse shocks.

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