BRAZILIAN SOVEREIGN RISK, INTERNATIONAL CRISES AND FOREIGN PORTFOLIO INVESTMENT FLOWS

ENSAIO – FINANÇAS

Antônio André Cunha Callado
Doutor pela Universidade Federal da Paraíba
Professor Adjunto da Universidade Federal Rural de Pernambuco
E-mail: andrecallado@yahoo.com.br

Horst Dieter Moller
Doutor em Economia pela Universidade de Hamburgo
Professor Adjunto da Universidade Federal Rural de Pernambuco
E-mail: horst@hotlink.com.br

ABSTRACT

    The objective of this paper is to describe the behavior of Brazilian sovereign risk from 1995 to 2005 and evaluate the influence of international financial crises on the Brazilian sovereign risk in this period. The influence of international financial crises on the sovereign risk is analysed by econometric methods. The sovereign risk can econometrically be modelled ad hoc by regressing on explaining variables like the IBOVESPA, the short-term interest rate SELIC, the Brazilian international reserves, the exchange rate to the US$ and the foreign portfolio investment flows in equity and fixed income. The first four variables are used to construct an exchange market pressure index to identify and measure periods of international financial crises and model their influence on the sovereign risk. Another model explains changes in the sovereign risk by the exchange market pressure index and the foreign portfolio investment flows equity and does fairly well in a dynamic forecast for the dependent variable Brazilian sovereign risk. Monthly data were used with the Granger causality test to identify lead/lag relations. The results show that the market variables are determined simultaneously, while the SELIC rate reacts with a certain short lag, showing that monetary policy reacts to the financial crises more than anticipates them. The Granger causality test was used also for daily data with the same result.

Key words: *Sovereign Risk, International Capital Flows, Portfolio Investment.*

RISCO SOBERANO BRASILEIRO, CRISES INTERNACIONAIS E FLUXOS DE INVESTIMENTOS ESTRANGEIROS EM CARTEIRAS DE AÇÕES

RESUMO

    O objetivo deste artigo é descrever o comportamento do risco soberano brasileiro de 1995 a 2005, para avaliar a influência das crises financeiras internacionais sobre o risco soberano brasileiro nesse período. A influência das crises financeiras internacionais é analisada por métodos econométricos. O risco soberano pode ser modelado econometricamente mediante regressões com variáveis explicativas, tais como IBOVESPA, taxa de juros SELIC de curto prazo, reservas internacionais brasileiras, taxa de câmbio do Real em relação ao dólar americano e fluxos de investimentos estrangeiros para portfólios de ações e renda fixa. As primeiras quatro variáveis são usadas para a construção de um índice de pressão do mercado de câmbio que identifique e mensure períodos de crise financeira internacional e modele suas influências sobre o risco soberano. Outro modelo explica as mudanças no risco soberano em razão do índice de pressão do mercado de câmbio e dos fluxos de investimentos estrangeiros em portfólios de ações, obtendo bons resultados em

uma projeção dinâmica sobre a variável dependente risco soberano brasileiro. Dados mensais foram usados em um teste de causalidade de Granger para identificar relações defasadas. Os resultados mostraram que as variáveis de mercado são determinadas simultaneamente, enquanto a taxa de juros SELIC reage com certa defasagem curta, o que revela que políticas monetárias reagem mais às crises financeiras do que se antecipam a elas. O teste de causalidade de Granger foi usado para dados diários e obteve o mesmo resultado.

Palavras-chave: Risco, Fluxos Internacionais de Capitais, Carteira de Investimento.

EL RIESGO SOBERANO DE BRASIL, CRISIS INTERNACIONALES Y FLUJOS DE INVERSIÓN EXTRANJERA EN CARTERA

RESUMEN

El objetivo de este artículo es describir el comportamiento del riesgo soberano brasileño de 1995 a 2005 para evaluar la influencia de las crisis financieras internacionales sobre el riesgo soberano brasileño en este periodo. La influencia de las crisis financieras internacionales es analizada por métodos econométricos. El riesgo soberano puede ser modelado econometricamente a través de regresiones con variables explicativas, tales como, IBOVESPA, tasa de interés SELIC de corto plazo, reservas internacionales brasileñas, tasa de cambio del Real en relación al dólar americano y los flujos de inversiones extranjeras para carteras de acciones y renta fija. Las primeras cuatro variables son usadas para construir un índice de presión del mercado de cambio para identificar y mensurar períodos de crisis financiera internacional y modelar sus influencias sobre el riesgo soberano. Otro modelo explica las mudanzas en el riesgo soberano debido al índice de presión del mercado de cambio y a los flujos de inversiones extranjeras en carteras de acciones y obtuvo buenos resultados en una proyección dinámica sobre la variable dependiente riesgo soberano brasileño. Datos mensuales fueron usados en un test de casualidad de Granger para identificar relaciones rezagadas. Los resultados mostraron que las variables de mercado son determinadas simultáneamente, mientras la tasa de interés SELIC reacciona con algún retraso corto, mostrando que políticas monetarias reaccionan más a las crisis financieras que se antecipan a ellas. El test de casualidad de Granger ha sido usado para datos diarios y obtuvo el mismo resultado.

Palabras-clave: Riesgo, Flujos Internacionales de Capitales, Cartera de Inversiones.

1. INTRODUCTION

Sovereign risk, focusing on the probability of a government defaulting on debt, plays an important role in literature and in the assessment and administration of risk in international transactions, as can be seen in Frenkel, Karman and Scholtens (2004).

Sovereign risk is a specific concept of the broader term, country risk, measuring the economic and political stability of a country. In international transactions the assessment and administration of country risk is important for the strategies of international investment and the hedging of international positions by financial and non-financial corporations.

The use of econometric methods, which are backward looking but open the possibility to establish lead/lag relations for the variables, is also opening an horizon to create possible forward looking risk indicators, that are important for the assessment and administration of international risk by financial and non-financial corporations.

The objective of this paper is to describe the behavior of Brazilian sovereign risk from 1995 to 2005, evaluate the influence of international financial crises on the Brazilian sovereign risk in this period (Mexico 1994/95, Southeast Asia 1997, Russia 1998, Brazil 1998/99, Argentina 2001/2 and Brazil 2002/3), and estimate lead/lag relationships between the Brazilian sovereign risk, other financial and macroeconomic indicators and the foreign portfolio investment flows entering and leaving Brazil in the period.

2. BRAZILIAN SOVEREIGN RISK

Since the end of the eighties, the demand for information related to risk analysis has increased in the international financial market. Because of this demand for more precise information on risk assessment, some mechanisms for measuring, monitoring and risk assessment have been widely publicized. Several methodologies have been developed to serve this purpose along with the construction of indicators of the market related to certain types of risk.

Garcia and Didier (2001) define sovereign risk as a reflection of the economic and financial situation of a country, reflecting also the political stability and performance, historically, of fulfilling financial obligations.

About the relevance of sovereign credit risk, Cantor and Packer (1996) believe it is important not only that some of the largest issuers of securities in the international market are national governments, but also that these concepts of risk affect the credit risk of lending to borrowers of the same nationality.

Country risk can be measured in various ways. According to Scholtens (2004), country risk "is the risk that unforeseen events in a foreign country affect the value of international assets, investment projects and their cash flows. Traditionally, the theoretical analysis of country risk distinguished between the ability to pay and the willingness to pay.

The first assumes that if a debtor is able to meet his obligations, he will do so. The debtor will default only if he cannot fulfill his repayment obligations (interest, amortizations). Various macroeconomic solvency and liquidity indicators are used to measure the capacity to pay. However, willingness to pay also appears to play a role."

More specifically, sovereign risk focuses on the possibility of a default of a government on its debt. There are different forms of evaluating country risk and sovereign risk. Scholtens (2004) shows four approaches to assess country and sovereign risk: "the balanced-score card approach (BSC), the country risk rating, the secondary market analysis, and the option approach. Of course, in practice, all four approaches may be employed in some combination or another."

The characteristics of the terms and conditions of financial transactions carried out by foreign investors, through isions on the allocation of financial resources, have been isive in determining the magnitude and composition of capital flows to developing countries in the ade of nineties.

On the relevance of indicators of sovereign risk in this process, Adams, Mathieson and Schinasi (1999) show the great responsibility and impact that they have on both the cost of borrowing as well as on the desire expressed by institutional investors to keep certain assets in its possession.

Commenting on the characteristics associated with the debt-conversion of external debts of developing countries, Fabozzi (2000) states that the secondary market of these securities is highly liquid in the world, presenting large volumes of daily trading. According to Bhatt (1988), the financial innovations related to the process of securitization also create conditions for the emergence of secondary markets for a large number of financial instruments, such as bills, bonds and shares.

The securitization also contributed to the reintegration process of developing countries into international financial market, because of the boundary limits of operations and simplified procedures for attracting external resources. Barros and Mendes (1994) suggest several factors related to the expansion of credits securitization, which are:

- *Generalization of the culture of aversion to risk;*

- *Progress of information and communication technologies;*

- *Dissemination of international financial innovation;*

- *Growth of operations "out of balance";*

- *Increasing participation of so-called institutional investors.*

Pinheiro (2005) considers that securitization is a transaction that allows a renegotiation of debt, financial and trade, through the placement of long-term securities market with operational guarantees.

The secondary market of debt securities is regarded as a reference and an active orientation for the expectations of economic performance and is one of the parameters of the climate for capital flows in relation to a debtor country.

About the dynamics of this secondary market for securities, Assaf Neto (2008) says that in the globalized economy, negotiations with these titles are almost instant, linking the various financial markets. Among the various types of securities issued by Brazil in the renegotiation of external debt, the C-Bond is the best known and is highly liquid.

Technical information is regularly issued by financial institutions that operate globally on the secondary market of debt bonds, to investors with regard to economic analyses as well as their

expectations for the short and long term, including Brady Bonds in the calculations, where among the Brazilian securities traded, the C-Bonds are computed.

Commenting on the analysis of the market about the debt rescheduling of external debt as a source reference to the associated risk of a country, Fortuna (2005) says that fulfillment can be associated with the price in which the C-Bond is being negotiated in the secondary market. Dooley, Fernándes-Arias and Kletzer (1996) show that the value of foreign debt securities in the secondary market is a useful barometer for a country's credibility.

On the expectations of investors with the analysis of secondary markets bonds, Fortuna (2005) states that in relation to Brazil, the C-Bonds are monitored according to the prices for which they are being negotiated.

In this paper the assessment of sovereign risk is made by the secondary market analysis, using the information from the trade in assets of a country (Scholtens, 2004). More specifically, the Brazilian sovereign risk in this paper is evaluated as the spread of effective yields of Brazilian C-bonds in secondary markets over the effective yields of US Treasury securities, seen as "risk free" assets.

Further in the paper the spread of effective yields of Brazilian C-bonds over the effective yields of US Treasury securities is called C-bond spread. The C-bond, a highly liquid security emitted by the Federal Republic of Brazil in 1994 with maturity in 2014, is part of the JP Morgan Emerging Market Bond Index Plus (EMBI+) and of the index EMBI+ Brazil (Banco Central do Brasil, 2005) and is used in other papers referring to the Brazilian sovereign risk, such as Loureiro and Barbosa (2004) and Moreira and Rocha (2003).

Sovereign risk for emerging markets is normally rising in a currency and financial crisis, because the expectations of the actors on the international financial markets are changing negatively in a crisis, evaluating the probability of a default on the sovereign debt of the country, as rising.

With rising probability of default for sovereign debt, on the secondary markets the supply of the securities is rising (the supply curve shifts to the right), while the demand is falling (the demand curve shifts to the left), with prices of the securities

also falling. With falling prices, the effective yield of the securities is rising, consequentially leading to rising spreads of the sovereign securities over US Treasuries (higher sovereign risk), while the prices and yields of US Treasuries are supposedly constant.

The Graph 1 shows this behavior of the C-bond spread, the C-bond spread rising in the aftermath of the crisis of Mexico in 1995, in the Asian crisis in 1997, in the Russian and Brazilian crises in 1998/99, in the Argentine crisis in 2001, and in the most expressive rise during the Brazilian crisis in the election period 2002/03.

Graph 1: C-bond spread over US treasuries
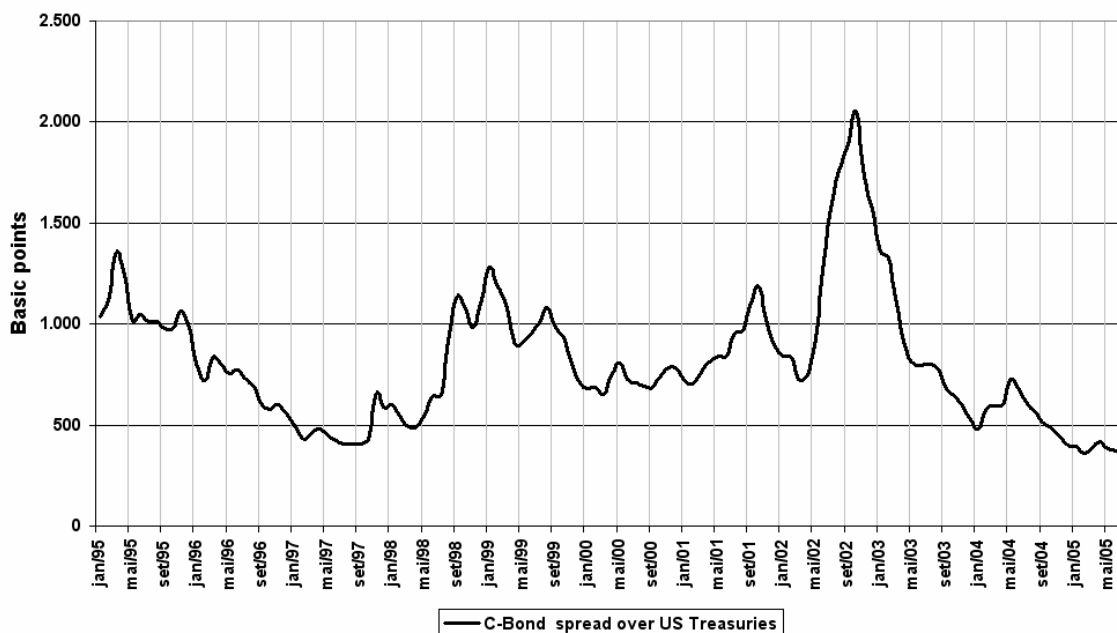
Source: IPEADATA.

As shown in Graph 1 in every financial crisis, the C-bond spread was significantly rising, showing contagion from crises in other countries and the loss of confidence of the international financial markets, and possibly anticipating the financial crisis.

Also considered was the influence of financial crises on the C-bond spread and on the foreign portfolio investment flows to and from Brazil. Some might wonder if there are any leading indicators for pressure situations in the exchange markets leading to a financial crisis. A leading indicator has importance for the assessment and administration of risk in international transactions, especially for foreign portfolio investments and also for national macroeconomic policies in periods of crisis.

3. INTERNATIONAL FINANCIAL CRISES SINCE THE REAL PLAN AND BRAZILIAN SOVEREIGN RISK

The period since 1990 has been characterized by deep financial and economic international crises, especially in emerging markets, following the liberalization of capital markets and the capital account in the aftermath of the Washington Consensus.

In Brazil the renegotiation of the external debt, the partial liberalization of capital markets and other markets, the opening of the country to the global markets, the privatization of public corporations, and the macroeconomic stabilization after the Real Plan led to expressive inflows of foreign capital in the period after the Real Plan success, however subject to high volatility in

periods of international crises, especially in the segment of foreign portfolio investment flows.

Frenkel, Karman and Scholtens (2004) classify the types of financial crises according to IMF taxonomy:

- *Currency crisis: when there is a significant devaluation of a currency with loss of reserves and/or significant rise in interest rates in an attempt to defend the currency, caused by a speculative attack on the currency or a sudden unexpected event.*

- *Banking crisis: when potential or actual bank failure or a bank run causes a major part of national banking system to suspend internal*

service of their liabilities, a situation which is typically accompanied by bank insolvencies.

- *Foreign debt for country crisis: when a country is not able or willing to service its foreign debt, whether public or private. Sovereign risk, as a special case, centering on the repayment perspectives of public debt.*

After the crisis of the European Monetary System in 1992/93, several financial and economic crises occurred in emerging countries and in 2007/08 a crisis occurred in the United States of America which is not included in the econometric modeling. Table 1 shows financial and exchange rate crises after 1994.

Table 1: Financial and Exchange Rate Crises after 1994

Year	Origin	Causes	Effects
1994	Mexico	Overvalued currency, credit bubble, political crisis, confidence crisis, speculative attacks on the national currency	Devaluation, contagion to Latin America, banking crisis and deep recession
1997	Southeast Asia	Credit and investment bubble, hard peg to the US$, fragile banking regulation, confidence crisis, speculative attacks on the national currency	Devaluation, contagion to the world, banking crisis and deep recession
1998	Russia	Unsustainable internal economic policies, fall in commodity prices, confidence crises and speculative attacks on the national currency	Devaluation, contagion to Brazil, default on part of the external and internal debt, banking crisis and deep recession
1998/99	Brazil	Overvalued currency with crawling peg to the US$, high fiscal deficit and high deficit in the current account, rising public debt, confidence crises, capital flight and speculative attacks on the national currency	Devaluation in January 1999 and change to a flexible exchange-rate system, economic problems in Argentina.
2001	Argentina	Hard peg to the US$, currency board, economic recession, also as a consequence of the devaluation of the real, high dollarization of debt, flight to the US$	Devaluation, default on external debt, deep recession, political and social problems
2002/03	Brazil	Confidence crisis in the election period, capital flight, rising public debt	Depreciation of the real, credit crunch in the international financial markets for Brazil, restrictive monetary and fiscal policies, rease in growth
2007/08	United States of America	Expansionary monetary policy 2001 to 2004, bubble in the real estate sector and crack of the bubble beginning in 2006, sub prime crises, securitizised debt sold to banks in other countries, bankruptcy of financial institutions, credit crunch and crisis of confidence, recession	Fragility of the international financial system, banking crises in other countries, strong recession in the industrialized countries, credit crunch influences Brazil, fall of commodity prices

Source: The authors.

The Mexican crisis in 1994/95 had negative influences in other South American countries. In 1997 the financial crisis beginning in Thailand spread to Indonesia, Malaysia and South Korea with contagion to other emerging countries.

The Russian crisis with the partial default on part of the internal public debt, beginning in August of 1998, reached Brazil in September leading to massive outflows of capital, expressive loss of international reserves, expressive rise in the short term interest rate SELIC, and a US$ 41.5 billion rescue packet from the IMF, the World Bank and the international financial community to stabilize the Brazilian economy and to defend the crawling peg of the R$ to the US$, with a yearly nominal devaluation of 7.5% between 1995 and January 1999 (Aschinger, 2001, p. 106). In January 1999, after new speculative attacks, the Brazilian government and the Brazilian central bank floated the Real to avoid more losses of international reserves.

In the aftermath of the crisis in Argentina in 2001 with default on the external public debt in ember, in Brazil the second half of the year 2002 and the beginning of 2003 were characterized by an expressive depreciation of the Real and a massive rise in the spread of Brazilian C-bonds over US Treasuries, an often used measure of Brazilian sovereign risk.

The turbulences on the exchange market were consequences of a crisis of confidence in the election process of 2002 and the uncertainty over the government policies of the new President Luiz Inácio "Lula" da Silva in 2003. With the new government pursuing stabilizing macroeconomic policies, the Real was appreciating again and the sovereign risk was expressively lining.

The latest financial crisis began after the collapse of the US sub-prime mortgage market and turned into a world wide financial collapse. This crisis showed that the great complexity of several modern financial products and instruments has become a weakness of the global financial system. But this crisis has not been included in the data for the econometric models

4. INFLUENCE OF INTERNATIONAL CRISES ON FINANCIAL AND MACROECONOMIC VARIABLES

The financial crises since the Mexican crisis in 1994 left impressive scars on the economies of the affected countries reflecting deep recessions with rising unemployment and poverty. In Indonesia and Argentina the gross domestic product lined more than ten percent in the aftermath of the crises. The main objective of the paper is to analyze the financial and macroeconomic variables, which could serve as leading indicators for financial crises in an early warning context for the assessment and administration of risk.

As shown in Graph 1, the C-bond spread rises in all cases of a financial crisis in the period studied, rising to the highest point of 2335 basic points in the Brazilian crisis of 2002 during the election period, on the 27th of September of 2002. So, the sovereign risk measured by the C-bond spread should be a variable considered in the context of establishing relations and leading indicators for the occurrence of financial crises.

In the literature, following Sy (2004), Kräussel (2004) and Frenkel and Fendel (2004), an exchange market pressure index (EMPI) or an index of speculative market pressure is used to identify currency crises. The variables, that in different combinations enter these indexes, are changes in the exchange rate, the short term interest rates, the international reserves and the stock market index. The Graph 2 shows the standardized variables, the IBOVESPA (the main stock market index of Brazil), the short term interest rate SELIC, the Brazilian international reserves and the exchange rate to the US$.

Graph 2: Standardized Variables of an Exchange Market Pressure Index (EMPI)
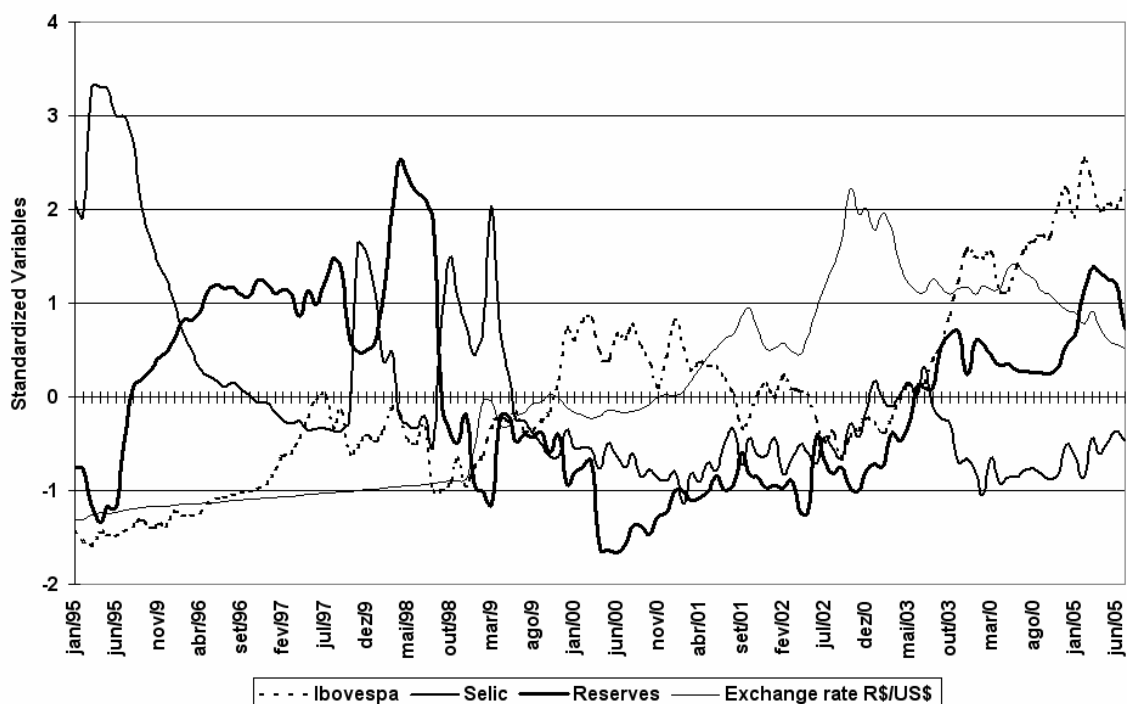
Source: Basic data: IPEADATA.

All variables are highly volatile. All variables show expressive changes in the periods of international financial crises, with the exception of the exchange rate in the period of a crawling peg exchange rate system. In the crawling peg exchange rate system, prevailing between 1995 and January 1999 in Brazil, the nominal exchange rate to the dollar was devaluating in a predicable manner but not sufficiently to prevent a revaluation of the Real exchange rate, because the residual inflation in Brazil after the successful Real Plan was still higher than the inflation rate in the United States and other commercial partners. The over valued exchange rate was one of the causes of the crisis in 1998/99.

In the case of a crawling peg the central bank is confronting the outflows of capital in a crisis by sharply raising the short term interest rate and the central bank is obliged to sell international reserves to defend the crawling peg. In this exchange rate system the short term interest rate should be raised by the central bank, while the international reserves should fall. There was sharp rise in the short term interest rate SELIC and a sharp fall in international reserves in the 1998/99 crisis.

After floating of the real, the exchange rate becomes more volatile, the exchange market pressure was directly accommodated by depreciations in the nominal exchange rate. In the dirty floating system after January 1999, the international reserves are less volatile and the short term interest rate is used with minor expression in attempts to reduce the depreciation of the nominal exchange rate but the variables still show some volatility and reflexes in the crises of this period.

The stock market also shows reactions to the financial crises, because in these crises the possibility of devaluations (crawling peg system) or, in the case of a floating exchange rate, the possibility of a sharp depreciation of the exchange rate leads to the possible capital losses. The possibility of capital losses leads to the selling of stocks and a drop in the stock market index (IBOVESPA), sometimes in anticipation of the crises.

Financial crises with the chance of abandoning the crawling peg and a possible sharp devaluation, or, in the case of a floating exchange rate, the possibility of a sharp depreciation, lead to reactions

of foreign and national financial investors. In a crisis there should be a change in the direction of the flows and the possibility of liquid outflows.

Obviously the movements of the C-bond spread on the secondary markets and foreign portfolio investment flows have no real connections, but there are connections through reactions on similar expectations in the international financial markets, especially in the case of international financial crises.

The Graph 3 shows the flows of foreign portfolio investment in the period, for equity and fixed income. Especially the series of foreign portfolio investments in equity shows high volatility, and, among other factors, sharp changes in the flows, in the case of financial crises. The series of foreign portfolio investments in fixed income shows less volatility and expressive changes in flows only in the Asian crisis and the Brazilian crisis of 1998/99.

Graph 3: Foreign Portfolio Investments in Equity and Fixed Income
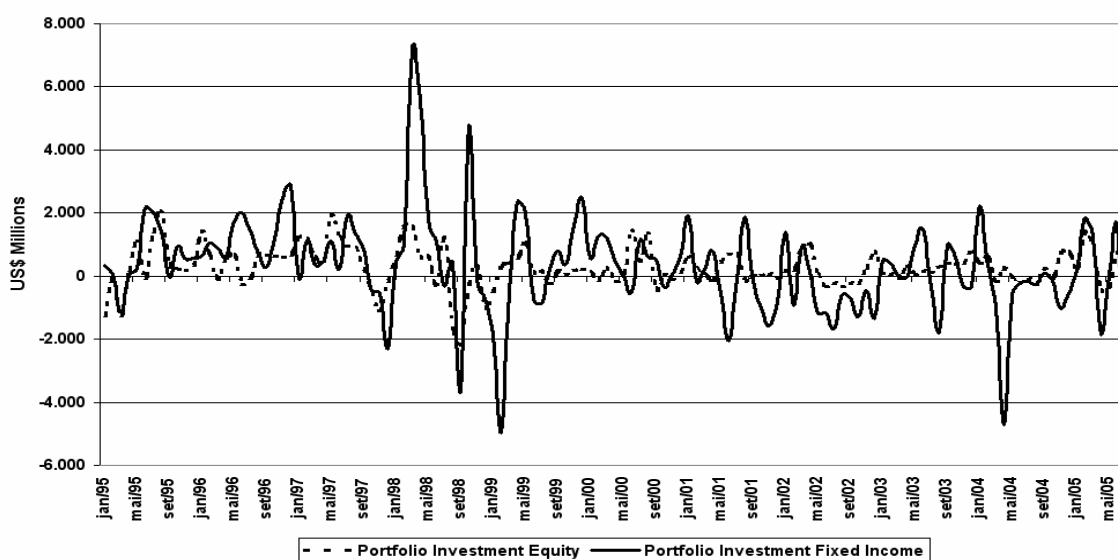
Source: Banco Central do Brasil.

5. METHODOLOGICAL PERSPECTIVES

In this paper the relation between the international financial crises and financial and macroeconomic variables was analyzed in the period from January 1995 to July 2005, emphasizing the variables: C-bond spread, stock market index IBOVESPA, short term interest rate SELIC, international reserves of Brazil, exchange rate R$/US$ and foreign portfolio capital flows in the segments of equity and fixed income. The monthly values of the variables were obtained from the Brazil's Central Bank and IPEADATA.

For the more refined analysis of the identification of a leading indicator for the financial crises, daily values are used from the same institutions;

obviously the availability of daily variables is more restricted.

In the discussion found in literature and in Scholtens (2004), there are other variables and ratios to assess the external vulnerability of a country influencing the possibility of a financial crisis, some of which were considered in the part on the econometric analysis of this paper.

First, a qualitative econometric approach was made with dummy variables to analyze the influence of the international financial crises on the C-bond spread and the foreign portfolio investment flows in equity and fixed income, where the dummy variables reflect the periods of financial crises.

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 k_t + \beta_3 u_t + \beta_4 w_t + \beta_5 z_t + e_t$$

(1)

Where,

t – Time index

y – Dependent variable (C-bond spread, foreign portfolio investment flows)

x – Mexican crisis 1994/95 (dummy)

k – Asian crisis 1997 (dummy)

u – Russian and Brazilian crises 1998/99 (dummy)

w – Argentine crisis 2001 (dummy)

z – Brazilian crisis election period 2002/03 (dummy)

βi – parameters

e – stochastic error.

For the levels of the C-bond spread, the coefficients of the dummies should be positive showing that the C-bond spread in times of crises is greater than the mean of the remainder of the period. For the first differences of the C-bond spread, the coefficients should be positive showing an increasing C-bond spread in times of crises. For the levels of the capital flows, the coefficient should be negative showing a lining level of the capital flows, it should also be more negative than the (positive) coefficient for the rest of the period (the intersection), because in times of crises the positive liquid inflow of capital should reverse to a negative liquid outflow of capital as a result of the crisis.

Changing from a qualitative econometric analysis with binary variables as independent variables to a quantitative approach, it was necessary to consider directly variables, which express the financial stress for a country in the period of a financial crisis, to model the C-bond spread with econometric methods. In Sy (2004), Kräussel (2004) and Frenkel and Fendel (2004) the changes in the exchange rate, short term interest rates, international reserves and the stock market index are used as variables to construct an exchange market pressure index (EMPI) or an index of speculative market pressure to identify the financial and currency crises. The variables participate in different combinations for the construction of the index.

In the ad hoc approach, an econometric model is defined with levels of the variables in the following form: C-bond spread as dependent variable, and the levels for the exchange rate R$/US$, the foreign portfolio investment flows in equity, the IBOVESPA stock market index, the international reserves of Brazil and the short term interest rate SELIC as independent variables, also including a constant:

C-bond spread = β1 + β2X2 + β3X3 + β4X4 + β5X5 + β6X6 + ε

(2)

Where

βi – parameters

Xi – independent variables (as explained above)

ε – stochastic error.

Regression models with variables in levels with deterministic or stochastic trends can lead to erroneous interpretations. A first sign of possible problems is a very low Durbin-Watson in an otherwise significantly estimated model. Regressions in levels could result in spurious regressions, when the variables in the model are not stationary.

To test the stationarity of the variables, the Dickey-Fuller test of (1979) is utilized. It tests the null hypothesis of a deterministic or stochastic trend in the data against the hypothesis of a stationary time series. If the Dickey-Fuller test for some variables does not show significant results, the regression results could be spurious. In this case a test of a model with first differences could be used to test the significance of the relations between the variables used in the model in levels. But, the model in first differences shows only the short term influences between the variables, excluding possible long term relations. Another possibility is to test for the possibility of co-integrating relations between the variables in levels.

To simplify the model by constructing an exchange market pressure index (EMPI) to identify financial and currency crises in a quantitative manner, following Sy (2004), Kräussel (2004) and Frenkel and Fendel (2004), different indexes were constructed:

$$EMPI_t = \sum_{i=1}^{k} w_i X_{i,t}$$

Where,

EMPIt   exchange market pressure index at period t

wi   weight of variable i

Xi,t   Value of the variable i included in the index at period t.

The variables, which could be included, are changes in the exchange rate, short term interest rates, international reserves, the stock market index and the foreign portfolio investment flow in equity.

With the exchange market pressure index (EMPI) and the foreign portfolio investment flow as independent variables and the first differences in the C-bond spread as dependent variable, a simplified model was constructed, which is equivalent to modeling the C-bond spread as a random walk with systematic influences of the EMPI and the foreign portfolio investment flows:

(C-bond spreadt - C-bond spreadt-1) = β0 + β1EMPIt + β2(For. Inv. flows) + εt

C-bond spreadt = β0 + C-bond spreadt-1 + β1EMPIt + β2(For. Inv. flows) + εt

(3)

To identify leading and lagging variables, which is obviously important for the assessment of early warning variables in an international crisis and equally important for the administration of risk in international transactions, the Granger causality test (Granger, 1969) is used to identify the precedence (Granger Causality) of one variable to another. The Granger causality test is used for monthly data and also for available daily data of the variables in discussion, because the analysis of daily data is more important for understanding the rapid propagation of international financial and currency crises.

6. ESTIMATION OF THE ECONOMETRIC MODELS

6.1. Influence of international crises on the C-bond spread and foreign portfolio investment flows

The basic hypothesis is that the international financial and currency crises have impacts on the C-bond spreads and the foreign portfolio investment flows through the negative changes in the expectations of the actors in the international financial markets.

In an international crisis the C-bond spread is rising, while the foreign portfolio investment flows are reasing with the possibility of liquid outflows of foreign capital. In the econometric models the dependent variable is the C-bond spread (or alternatively, changes in the C-bond spread) and the independent variables are dummies characterizing the international financial crises. The estimated econometric models are for the dependent variables of foreign portfolio investments in equity and fixed income (levels only).

The dummies of the financial crises assume a value of 1 in the period of the crisis and a value of 0 otherwise. The Mexican crisis (DUMMEX 1995:1 – 1995:4), the Asian crisis (DUMASIA 1997:9-1998:1), The Russian crisis and the Brazilian crisis (DUMRBR 1998:9-1999:2), the crisis in Argentina (DUMARG 2001:7 – 2001:12), the Brazilian crisis in the election period (DUMEL 2002:6 – 2003:1). The results are shown in Tables 2 and 3.

Table 2: C-BOND SPREAD and international financial and currency crises

Dependent Variable: C-BOND SPREAD				Dependent Variable: First differences C-BOND SPREAD			
Sample(adjusted): 1995:01 2005:06							
Variable	Coefficient	t-Statistic	Prob.	Variable	Coefficient	t-Statistic	Prob.
DUMMEX	468.9279	4.568672	0.0000	DUMMEX	86.59389	1.399341	0.1643
DUMASIA	-181.6505	-1.969144	0.0512	DUMASIA	57.26605	1.182926	0.2392
DUMRBR	412.2063	4.871561	0.0000	DUMRBR	56.85546	1.280279	0.2029
DUMARG	327.6833	3.192554	0.0018	DUMARG	25.92954	0.583885	0.5604
DUMEL	943.3664	12.75282	0.0000	DUMEL	73.06485	1.881631	0.0623
C	718.1355	35.50414	0.0000	C	-18.31842	-1.709085	0.0900
R-squared	0.633815	Mean d. v.	815.7415	R-squared	0.059467	Mean d. v.	-5.299699
Adjusted R-squared	0.618558	S.D d. var.	325.8597	Adjusted R-squared	0.019949	S.D. d. var	106.6316
Durbin-Watson stat	0.556927	Prob (F-statistic)	0.000000	Durbin-Watson stat	1.302266	Prob (F-statistic)	0.193427

Source: : Basic Data: IPEADATA.

The coefficients of the binary variables for the financial crises show the differences of the C-bond spread in times of crises compared to the mean of the rest of the period (718 basic points). A positive sign means that the level of the C-bond spread in the times of crises is above the mean level.

All variables show a significantly positive level above the mean, with the exception of the coefficient of the Asian crisis, which shows a negative sign, because the level of the C-bond spread before the crisis was very low. But the second part of the table shows that even in the Asian crises, the C-bond spread was rising (positive sign), as is the case for all other crises.

The second column shows positive changes of the C-bond spread in the periods of all financial crises, including the Asian crisis. This corroborates the hypothesis that the C-bond spread rises in periods of financial crises, with levels of the spread well above the level in normal times (with exception of the Asian crisis).

The results of Table 3 corroborate the hypothesis that the foreign portfolio investment flows are reasing in periods of financial crises, showing liquid outflows in the segment of equity and fixed income in all crises with exception of the crisis in Argentina of 2001, the mean level of the foreign portfolio investments equity is reasing, but still showing inflows (424 less 326).

The reasing inflows, but not liquid outflows, in the Argentine crisis show, that the Argentine crisis did not have a strong contagion in relation to the Brazilian economy. That is true in the Argentine crisis also for other variables, because the Brazilian economy in 2001 was more negatively influenced by the energy crisis in that year than by the Argentine crisis.

Table 3: Foreign portfolio investment flows and international financial crises

Dependent Variable: Foreign portfolio investment equity				Dependent Variable: Foreign portfolio investment fixed income			
Sample(adjusted): 1995:01 2005:06							
Variable	Coefficient	t-Statistic	Prob.	Variable	Coefficient	t-Statistic	Prob.
DUMMEX	-1029.228	-3.408370	0.0009	DUMMEX	-797.7813	-1.049156	0.2962
DUMASIA	-607.2040	-2.237100	0.0271	DUMASIA	-1008.313	-1.475255	0.1428
DUMRBR	-980.6407	-3.938517	0.0001	DUMRBR	-1696.832	-2.706343	0.0078
DUMARG	-326.7434	-1.312289	0.1919	DUMARG	-915.1153	-1.459553	0.1470
DUMEL	-451.2631	-2.072745	0.0403	DUMEL	-1450.895	-2.646508	0.0092
C	424.8770	7.070158	0.0000	C	614.3973	4.060096	0.0001
R-squared	0.212934	Mean d. v.	277.1997	R-squared	0.121201	Mean d. v.	332.5597

Adjusted R-squared	0.180139	S.D d. var.	653.6571	Adjusted R-squared	0.084584	S.D. d. var	1557.721
Durbin-Watson stat	1.493540	Prob (F-statistic)	0.000022	Durbin-Watson stat	1.426588	Prob (F-statistic)	0.007772

Source: Basic Data: Banco Central do Brasil.

The variables representing the exchange market pressure, the exchange rate R$/US$, the IBOVESPA stock market index, the international reserves of Brazil and the short term interest rate SELIC also show significant changes in periods of international financial crises, corroborating the hypotheses mentioned above (the exchange rate, obviously, is rising significantly only in the periods of crises after the floating of the Real in January 1999; while the international reserves are falling, with the exception of the Asian crisis, and the SELIC rate shows no significant change in the crisis of Argentina and the Brazilian crisis of 2002/03, corroborating the theoretical insight that in a floating exchange rate system, monetary policy is more independent).

6.2. Model relating the levels of the relevant macroeconomic variables

To explain the dependent variable, C-bond spread, by the main macroeconomic variables, the exchange rate R$/US$ (EXRATE), the foreign portfolio investment flows equity (EQUITY), the IBOVESPA stock market index (IBOVESPA), the international reserves of Brazil (RESERVES) and the short term interest rate (SELIC), an ad hoc econometric model is estimated to assess the compatibility of the results with macroeconomic theory. The results are shown in Table 4.

The regression shows an expressive adjustment with an adjusted R2 of 0.81. The coefficients are significant on the level of significance of at least 0.05 and show the theoretically expected signs.

The sign of the exchange rate is positive, showing a positive relation of the exchange rate with the C-bond spread. In periods of financial crises the exchange rate and the C-bond spread are rising (at least theoretically in a floating exchange rate system).

The sign of the foreign portfolio investment flow equity is negative, showing a negative relation of the foreign investment flow with the C-bond spread. In periods of financial crises, theoretically, the foreign investment flows should fall, while the C-bond spread rises, a negative correlation.

The sign of the Brazilian stock market index IBOVESPA is negative, showing a negative relation between the IBOVESPA and the C-bond spread. In periods of financial crises the stock market index should fall (expectations of capital losses), while the C-bond spread should rise.

Table 4: Model explaining levels of the C-bond spread

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dependent Variable: C-BOND SPREAD
EXRATE	294.5300	22.45377	13.11717	0.0000
EQUITY	-0.058062	0.020097	-2.889108	0.0046
IBOVESPA	-0.045785	0.003165	-14.46602	0.0000
RESERVES	-0.007975	0.001275	-6.253143	0.0000
SELIC	56.78967	23.87480	2.378645	0.0189
C	1104.330	109.3137	10.10239	0.0000
R-squared	0.819547	Mean dependent var		812.0829
Adjusted R-squared	0.812091	S.D. dependent var		327.1723
Durbin-Watson stat	0.365394	Prob (F-statistic)		0.000000

Dependent Variable: C-BOND SPREAD
Sample(adjusted): 1995:01 2005:07

Source: Basic Data: IPEADATA, Banco Central do Brasil.

The sign of the international reserves is negative, showing a negative relation between the international reserves and the C-bond spread. In periods of financial crises the central bank has to defend the crawling peg (in a crawling peg exchange rate system) or tends to contain the rising of the exchange rate (in a dirty floating exchange rate system) by selling dollars (reasing the international reserves), while the C-bond spread is rising.

The sign of the short term interest rate SELIC is positive, showing a positive relation between the SELIC and the C-bond spread. In periods of financial crises the central bank tends to contain the outflow of capital by raising the short term interest rate, to contain the outflow of capital and make speculative attacks more costly for the speculators, while the C-bond spread is rising.

The estimated regression equation therefore seems reasonable, but there is a serious shortcoming, an extremely low Durbin-Watson statistic of 0.365. The Durbin-Watson statistic for testing first order autocorrelation of the residuals is seen, in contemporary econometric methodology, as a signal for a possible spurious regression, resulting from a regressing non-stationary time series or as a signal of a misspecification of the model.

The stationarity of the time series can be tested by the augmented Dickey-Fuller test ADF (1979). The results for the levels of the time series and the first differences are given in Table 5.

Table 5: ADF (Dickey-Fuller) test statistic (lag = 4) significant, at least at the 0.1 level

Variable	Included	Level		First Differences	
C-bond spread	Trend and intercept	-2.819134	no	-5.118529	0.01
Foreign Inv. equity	Intercept	-5.021766	0.01	-6.798909	0.01
Exchange rate R$/US$	Trend and intercept	-2.183353	no	-4.103469	0.01
IBOVESPA	Trend and intercept	-1.945208	no	-5.463611	0.01
Reserves	Trend and intercept	-2.750218	no	-5.360997	0.01
SELIC	Trend and intercept	-3.807792	0.05	-5.355575	0.01

Source: Basic Data: IPEADATA, Banco Central do Brasil.

Table 5 shows all the variables are not stationary in levels, with exception of the variable foreign portfolio investment flow equity and of the variable short term interest rate SELIC, while all the variables in first differences are stationary. So the results of the model in Table 3 with the variables in levels could be spurious.

But an estimation of the same model in first differences representing the short term changes of the variables shows significant results for the parameters of the model (with exception of the international reserves) with signs corroborated by theory, with exception of the variable of the short term interest rate SELIC. So there could be a co-integration between some variables in levels and an error correction model could be constructed, but this is not explored in this paper.

6.3. Model including an exchange market pressure index (EMPI) as independent variable

But the explanation in this paper simplifies the explaining variables in the model by introducing an exchange market pressure index (EMPI) to measure financial and currency crises in a quantitative manner, following Sy (2004), Kräussel (2004) and Frenkel and Fendel (2004),

$$EMPI_t = \sum_{i=1}^{k} w_i X_{i,t}$$

Where,

EMPIt — exchange market pressure index at period t

wi — weight of variable i

Xi,t — Value of the variable i included in the index at period t.

Different specifications of the exchange market pressure index (EMPI) were tested introducing in the model, changes (standardized) in the exchange rate, short term interest rates, international reserves and the stock market index, with equal weights, with the exception of the exchange rate *which was a double weight because of the importance of the exchange rate in an index which shows the exchange market pressure. The Graph 4 shows the EMPI and the changes (standardized) of the C-bond spread.*

Graph 4: C-bond spread change and Exchange market pressure index
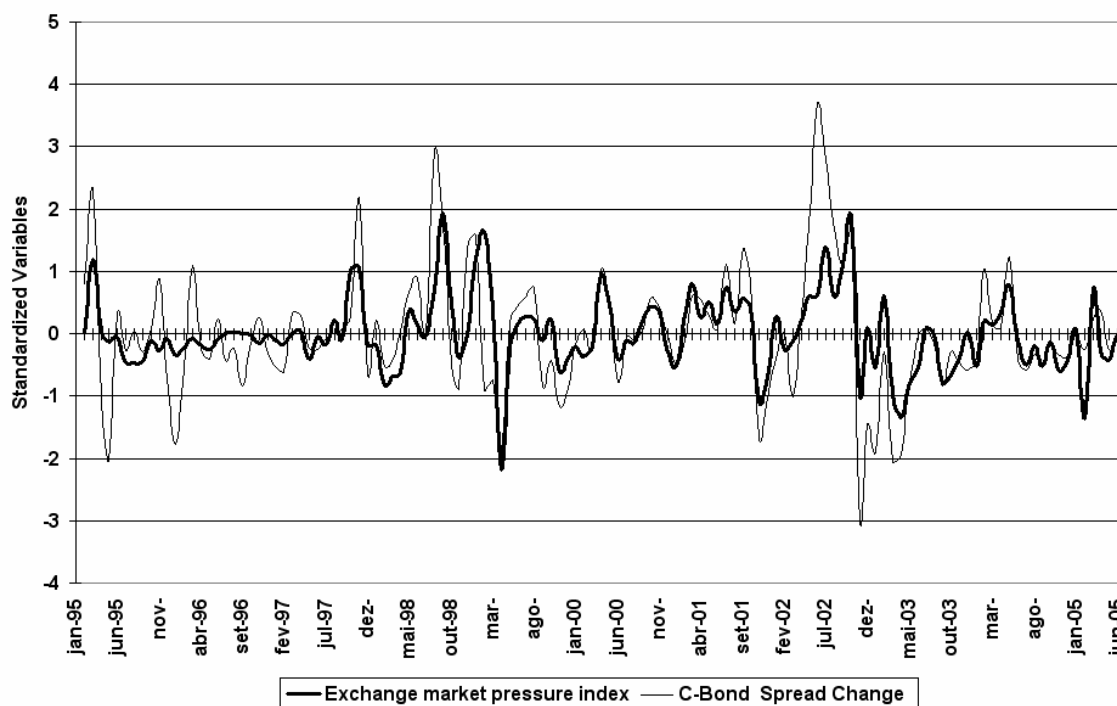
Sources: Basic data: IPEADATA, Banco Central do Brasil.

The EMPI and the changes of the C-bond spread (standardized) show positive correlation, the EMPI underestimating the changes in the Brazilian crisis of the election period, probably because of the strong political character of the crisis.

The model in first differences of the C-bond spread is shown here equivalently as a random walk model with systematic influence of the independent variables EMPI and foreign portfolio investment flow equity (equation 3), with results shown in Table 6.

The model shows an expressive adjustment (R2 adjusted = 0.946), the coefficients have the signs corroborated by theory and, with exception of the *constant, are significant on the level of significance 0.01. But the Durbin-Watson is relatively small, showing first order autocorrelation or a possible misspecification of the model, but in the case of a lagged dependent variable between the independent variables, the Durbin-Watson test is no longer appropriate.*

The sign of the exchange market pressure index is positive, showing a positive relation of the exchange market pressure index with the C-bond spread. In periods of financial crises the exchange market pressure index and the C-bond spread are rising.

Table 6: Model random walk C-bond spread

| Dependent Variable: CBONDSPREAD				
Sample(adjusted): 1995:02 2005:07				
CBONDSPREAD=C(1)+ CBONDSPREAD(-1) + C(2)*EMPI+C(3)*Foreign Investment flow equity				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	4.181016	7.658697	0.545917	0.5861
C(2)	102.6009	12.58035	8.155646	0.0000
C(3)	-0.032312	0.011895	-2.716438	0.0075
R-squared	0.946798	Mean dependent var		810.3072
Adjusted R-squared	0.945933	S.D. dependent var		327.8634
Log likelihood	-723.3309	Durbin-Watson stat		1.265917
The lagged dependent variable C-bond spread (-1) doesn't appear among the independent variables because its coefficient is a priori equal to 1 (random walk)				

Source: Basic Data: IPEADATA, Banco Central do Brasil.

The sign of the foreign portfolio investment flow equity is negative, showing a negative relation of the foreign investment flow with the C-bond spread. In periods of financial crises theoretically the foreign investment flow should fall, while the C-bond spread rises, a negative correlation.

Graph 5 shows the forecasts with the model in Table 5, showing that the dynamic forecast (using for the lagged dependent variable, values calculated (forecasted) by the model, while the static forecast uses the actual values of the dependent variable) seriously underestimating the rise in the C-bond spread in the Russian and Brazilian crises in 1998/99 and in the Brazilian crisis of the election period in 2002/03.

Graph 5: C-bond spread actual values, dynamic and static forecasts
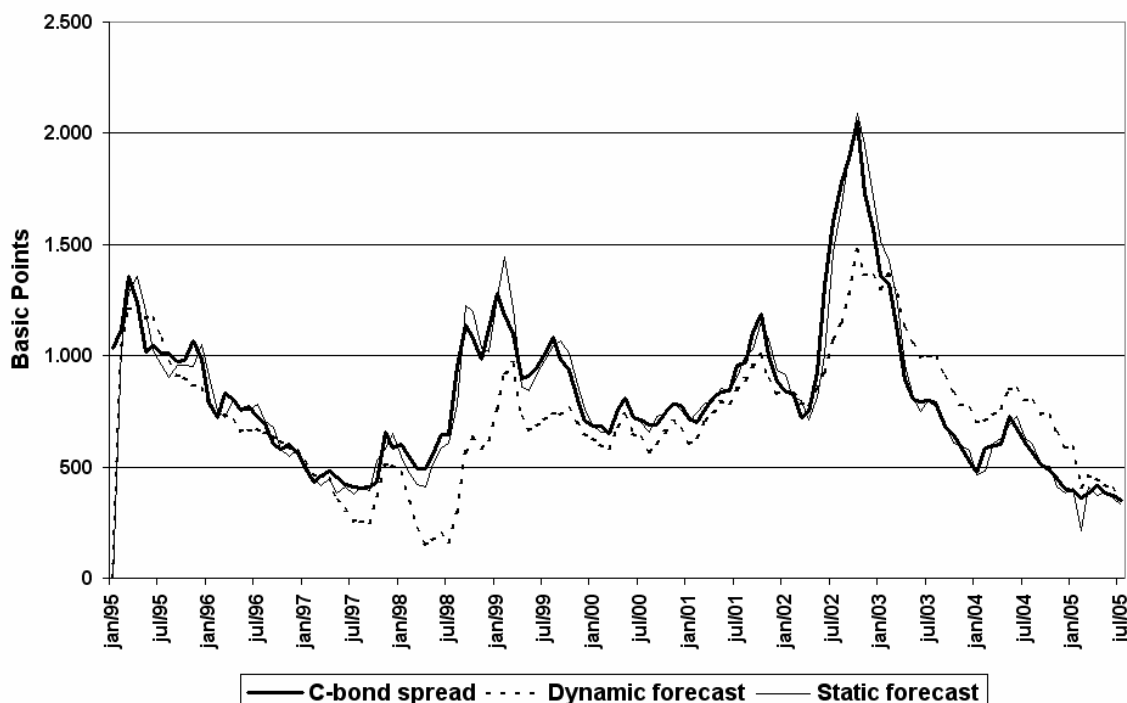
Sources: Basic Data: IPEADATA, Banco Central do Brasil.

To identify leading lag relations between the monthly variables analyzed, the Granger causality test is used; the results are shown in Table 7.

On a significance level of 0.05 the C-bond spread precedes (Granger causality) the variables EMPI and foreign portfolio investment flow equity, it could be a leading indicator for an international financial crisis.

Table 7: Pair wise Granger Causality Tests

Sample: 1995:01 2005:12 Lags: 4			
Null Hypothesis:	Obs	F-Statistic	Probability
EMPI does not Granger Cause CBONDSPREAD	122	1.65001	0.16664
CBONDSPREAD does not Granger Cause EMPI		5.47533	0.00046
EQUITY does not Granger Cause CBONDSPREAD	123	1.70789	0.15307
CBONDSPREAD does not Granger Cause EQUITY		2.55115	0.04289
EQUITY does not Granger Cause EMPI	122	1.62330	0.17324
EMPI does not Granger Cause EQUITY		2.19642	0.07384
EQUITY Foreign portfolio investment flows			

Source: Own calculations.

So the above models could be reformulated with the C-bond spread as one independent variable to explain changes in the other variables. But to establish lead lag structures between the variables, the available daily data must be analyzed, as shown in the next paragraph, because the propagation of international crises is in days, not in months.

7. ANALYSIS OF DAILY DATA

Daily data were available for the variables, the C-bond spread, the exchange rate R$/US$, the stock market index IBOVESPA and the short term interest rate SELIC. As Table 8 shows there are correlations with the expected signs between the variables.

Table 8: Correlations of the daily variables

	CBONDSPREAD	EXCHANGERATE	IBOVESPA	SELIC
CBONDSPREAD	1.000000	0.244098	-0.482310	0.272119
EXCHANGERATEE	0.244098	1.000000	0.623000	-0.539253
IBOVESPA	-0.482310	0.623000	1.000000	-0.658011
SELIC	0.272119	-0.539253	-0.658011	1.000000

Source: Basic data: IPEADATA, Banco Central do Brasil.

The Graph 6 shows that in the periods of crises, the daily variables also develop as expected and described above, for the monthly variables.

Graph 6: C-bond spread, exchange rate, SELIC, IBOVESPA, daily standardized values
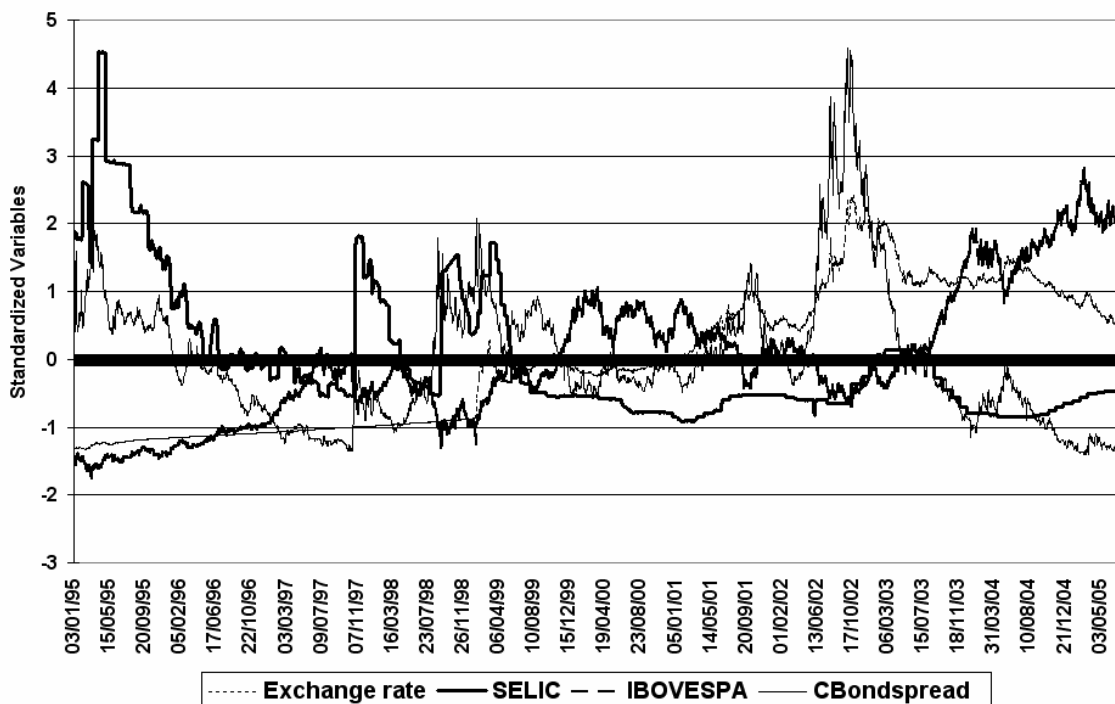
Source: Basic Data: IPEADATA, Banco Central do Brasil.

While the variables describing signals of the markets for the exchange market pressure (C-bond spread for the secondary external debt market, IBOVESPA for the Brazilian stock market and the exchange rate for the exchange market) seem to be changing simultaneously, there seems to be a slight lag in the short term interest rate SELIC. There seems to be a slight lag of the monetary policy variable in relation to the market signal variables, because the monetary policy is reacting with a certain lag to changes in the variables showing the market signals. The Granger causality test in Table 9 shows the same results.

Table 9: Pair wise Granger Causality Tests

Sample: 1/02/1995 7/29/2005			
Lags: 3			
Null Hypothesis:	Obs	F-Statistic	Probability
EXCHANGERATES does not Granger Cause CBONDSPREADS	2582	0.95700	0.41211
CBONDSPREADS does not Granger Cause EXCHANGERATES		66.1572	0.00000
IBOVESPAS does not Granger Cause CBONDSPREADS	2582	7.57923	4.8E-05
CBONDSPREADS does not Granger Cause IBOVESPAS		2.13230	0.09409
SELIC does not Granger Cause CBONDSPREADS	2582	1.21251	0.30359
CBONDSPREADS does not Granger Cause SELIC		9.27252	4.3E-06
IBOVESPAS does not Granger Cause EXCHANGERATES	2582	24.7761	8.4E-16
EXCHANGERATES does not Granger Cause IBOVESPAS		1.19112	0.31160
SELIC does not Granger Cause EXCHANGERATES	2582	0.74561	0.52483
EXCHANGERATES does not Granger Cause SELIC		0.57547	0.63113
SELIC does not Granger Cause IBOVESPAS	2582	1.24938	0.29021
IBOVESPAS does not Granger Cause SELIC		5.25507	0.00129

Source: Basic data: IPEADATA, Banco Central do Brasil.

While the market variables (with exception of the exchange rate, probably caused by the inclusion of the period of a crawling peg, because the Granger causality test shows simultaneity for the period of a floating exchange rate also for the exchange rate) are determined simultaneously, the SELIC rate does not Granger cause the market variables, while these do Granger cause the SELIC rate. So the market variables precede the SELIC rate, while this reacts with a certain short lag.

8. CONCLUSIONS

The paper analyzed the Brazilian sovereign risk, measured by the C-bond spread over US treasuries, and related variables, like the exchange rate R$/US$, the international reserves of Brazil, the short term interest rate SELIC, the Brazilian stock market index IBOVESPA and the foreign portfolio investment flow equity, and their behavior influenced by international financial and currency crises. An econometric analysis showed that all these variables are strongly influenced by the international financial crises after 1995.

The deregulation of its capital market (allowing greater flexibility and mobility to foreign capital),

the process of economic stabilization triggered by the Real Plan and the stabilization of domestic prices, as well as increasing credibility of the Brazilian economy in the external market over the ade, all influences that were demonstrated by the recent sovereign rating classification published by the most important credit rating agencies.

Another important factor for the Brazilian economy was the conclusion of negotiations for the conversion of its foreign debt in 1994, initiated by the signing of Brazil Bond Exchange Agreement on September 22nd, 1988. The important role of domestic price stabilization observed after implementation of the Real Plan in June 1994 should also be mentioned. Two major factors are pointed out as responsible for the improvement of Brazilian's sovereign ratings, changes in its macroeconomic environment and legal treatment of international capital.

Direct investments and portfolio investments have been the important factors in the flow of investment to Brazil and have been some important determinants for increasing development. The entry of private capital that does not generate debt flows within the various Brazilian companies, has helped in the process of technological

renovation and contributed to the implementation of policies for adjustment.

Within the amount of direct investments, changes in the internal scenario of the Brazilian economy, particularly after the process of economic stabilization triggered by the Real Plan in 1994, stimulated both the transfer of funds outside the headquarters of many multinational companies as well as the repatriation of capital belonging to Brazilians who were abroad. Direct investments were also responsible for other benefits such as the adoption of new technologies that have been very useful in the process of renewal and modernization of various aspects of Brazilian economic infrastructure. The repatriation of capital to the Brazilian economy has also been significant.

The results pointed out in this paper suggest that the credibility of a country with respect to the international investors plays an important role in the ision about the definition of portfolios.

Significant influences over the C-bond spread were found (both positive and negative). Real/US Dollar exchange rate and short term interest rate SELIC showed positive relations with C-Bond spreads. On the other hand, international reserves of Brazil, the stock market index IBOVESPA and the foreign portfolio investment flow equity had negative relations, as corroborated by economic theory.

To identify the international financial crises and their influences on the C-bond spread by an exchange market pressure index, according to the literature, an index was constructed, and an econometric model was formulated which showed significant influences of the exchange market pressure index (EMPI) and the foreign portfolio investment flow equity on the C-bond spread, presuming a random walk model for the C-bond spread.

Dynamic forecasts by the model show an expressive sub-estimation of the C-bond spread level in the Brazilian crises of 1998/99 and 2002/03, making another specification of the model necessary in future research, for example, using Markov-Switching models.

On a monthly basis it seems that the C-bond spread is a leading variable, but in the light of the rapid propagation of the international financial crises, an analysis of daily data was necessary. The

analysis of the daily variables showed that the market variables (C-bond spread for the secondary external debt market, IBOVESPA for the Brazilian stock market and the exchange rate for the exchange market) are determined simultaneously (the exchange rate only in the period of a floating exchange rate), while the SELIC rate reacts with a certain short lag. This is corroborated by the theory that monetary policy reacts to the financial crises more than it anticipates them.

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