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The Determinants of Default Risk in Brazil

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THE DETERMINANTS OF DEFAULT RISK IN BRAZIL

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ABSTRACT: Based on the literature that investigated the macroeconomic determinants of dollar-denominated bond spreads and using data for Brazil, we initially formulated a general unrestricted model of the EMBI+ spreads and fundamentals. Employing an algorithm that performs automated model selection, the general model was simplified to a parsimonious and congruent specification. The findings reveal that macroeconomic fundamentals, such as current account deficit ratio to GDP, public deficit ratio to GDP and imports over foreign exchange reserves can explain a great part of the variation in EMBI+ spreads. The signs of the coefficients are as expected in all estimated equations. There is robust evidence of systematic contagion from changes in risk in Argentina and Mexico, whereas the Russian crisis is manifested through the effect of outliers. Finally, we also found other significant outliers associated with the financial crisis in 1999 and the turmoil during 2002, the latter due to the uncertainty regarding the outcome of the presidential elections.

SUMÁRIO: Baseados principalmente na literatura que investiga os determinantes macroeconômicos de títulos denominados em dólares e usando dados para o Brasil, nós inicialmente formulamos um modelo irrestrito geral contendo EMBI+ *spreads* e fundamentos econômicos. Usando um algorítimo que realiza seleção automática de modelos, o modelo geral foi simplificado para uma especificação econômica e congruente. Os resultados revelam que fundamentos macroeconômicos, como o décifit em conta corrente do Balanço-de-pagamentos e o déficit público, ambos como proporção do PIB, além das importações como proporção das reservas externas, podem explicar boa parte da variação dos *spreads*. Os sinais dos coeficientes são como o esperado em todas as equações estimadas. Existe robusta evidência de que houve contágio sistemático do prêmio de risco da Argentina e do México ao Brasil, enquanto a crise Russa se manifestou através do efeito de mudanças abruptas capturadas por *dummies*. Finalmente, também encontramos evidência de que a crise financeira de 1999 e de 2002, a última derivada da incerteza quanto ao resultado das eleições presidenciais, também afetaram o EMBI+ *spread*.

KEYWORDS: Default Risk, Spreads, Fundamentals, Automated Model Selection.
PALAVRAS-CHAVE: Risco, Fundamentos, Seleção Automática de Modelos.

JEL Classification Numbers: E43, F39, G19, C51.
Área 3 - Macroeconomia, Economia Monetária e Finanças

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1. Introduction

There is an incipient literature aiming to investigate the determinants of dollar-denominated bond spreads. Because there is no currency risk or uncertainty, spreads are often interpreted as a default risk premium. If spreads are risk, then they should vary according to the information content of economic fundamentals. As a matter of fact, the empirical results strongly support the correlation between macroeconomic variables and spreads. However, as the impact of particular fundamentals on risk is not theoretically defined, the sign of their associated parameters is still an empirical question. By proving a rigorous treatment of the modelling approach, one can estimate the impact of a change in fundamentals on risk with greater accuracy.

Our work complements the literature on the causes of dollar-denominated bond spreads in an important way. We investigate whether spreads can be explained by economic fundamentals using the most recent methodology of automated model selection. We run regressions of the Emerging Markets Bond Index Plus (EMBI+) spreads[2] of Brazil (in relation to the US) against a set of economic fundamentals using PcGets, the newly algorithm embedded in the econometric software PcGive. The algorithm mechanises and standardises a series of complex search processes. This tool seems to be the most relevant for our purposes because theory and empirical evidence provide some idea of the form of the general unrestricted model (GUM) of the risk premia, but the true data generating process (DGP) is unknown. Furthermore, the DGP can be recovered with an accuracy that one would expect if the specification was known *a priori*. Monte Carlo experiments show that this holds if the GUM contains all variables that matter for the DGP. Finally, the methodology employed outperform a simple general-to-specific approach as it pays special attention not only to the significance of the parameters but also to the diagnostic tests, in order to ensure that the model selected has a high explanatory power and the residuals are white-noise.

The tests are carried out for Brazil from 1995M5 until 2004M, due to data availability. The country chosen for our tests has been experiencing high *ex ante* and *ex post* real interest rates. One of the most alluded explanations for its high rates is default risk. It follows that if risk increases because fundamentals deteriorate, then real interest rates should vary accordingly. As implied by the Real Interest Rate Parity Hypothesis, arbitrage conditions in international financial markets would ensure that real interest rate differentials would only arise if market imperfections exist. For example, imperfect substitutability between bonds of Brazil and its North-American counterpart is likely to occur, explaining the differential. A high real interest rate in Brazil in comparison to the US implies, *ceteris paribus*, slower economic growth. Hence, there is a crucial motivation for this applied work. If we are able to identify the determinants of risk, then we can propose appropriate macroeconomic policies that can decrease *ex ante* real interest rates.

The rest of the paper is organised as follows. In the next section, we introduce the methodology of the tests, including an explanation about the automated process that is adopted. Following, we discuss the data and the results. The final section concludes.

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[2] Throughout the paper we refer to dollar-denominated bond spreads, alternatively, as bond spreads, spreads, default risk, risk, and EMBI+ spreads. Notice that all definitions can be considered as synonyms to a large extent.

2. Methodology

The literature on the causes of default risk, measured as dollar-denominated bond spreads, is especially focused on emerging economies. The reason is that many of these countries experienced situations of default during the 1980s and 1990s. The seminal papers, in which we base the methodology below, are Edwards (1984) and Edwards (1985)[3]. For two bonds with returns in the same currency, spreads can be written as

$$x_t = i_t - i_t^* \quad (1)$$

where the parameter x_t represents the spread, i is the interest rate of the dollar-denominated bond of the domestic economy and i^* is the exogenously determined foreign interest rate that matures at time t. Authors [such as Svensson (1992) and Berk and Knot (2001)] have either found or modelled risk as an autoregressive process. Hence, one can rewrite equation (1) as

$$(1 - \sum_{i=1}^{p} a_i L^i) x_t = f + m_t \quad (2)$$

where L is the lag operator, p is the number of lags, f is an intercept term, a_i is the i^{th} autoregressive parameter, the disturbance term m_t is iid $N(0, s_m^2)$ and s_m^2 represents its variance. The stationarity of spreads is intuitive because if risk followed an unrestricted random walk, the non-Ponzi game condition would often be disrespected due, solely, to changes in interest rates.

The spread could stem from violations of the assumption of perfect markets, such as those underlying Covered Interest Parity (CIP)[4]. For instance, transaction costs and imperfect capital asset substitutability could explain differences in returns across countries. As transaction costs are supposed to be static and small in international financial markets and are possibly captured by the intercept term, a, many authors have interpreted the time-varying x_t as a risk premium. If the spread is a rational expectations risk premium, then it should respond to the variables that are theoretically supposed to affect it, such as macroeconomic fundamentals [Engel (1996)]. Following Edwards (1984) and Edwards (1985), we relate x_t to a set of n economic fundamentals:

$$x_t = f + \sum_{i=1}^{p} a_i x_{t-i} + \sum_{j=1}^{n} \sum_{i=1}^{p_j} b_{ji} F_{t-i}^{(j)} + m_t \quad (3)$$

[3] Other works include Edwards (1998), Cantor and Packer (1996), Eichengreen and Mody (1998), Kamin and Kleist (1999), Min (1998), Akora and Cerisola (2001), Beck (2001), Nogués and Grandes (2001), Fiess (2003), Ferruci (2003), Uribe and Yue (2003), Jahjah and Yue (2004) and Tillmann (2004).

[4] Note that the comparison with uncovered interest parity is unwarranted because there is no currency depreciation or risk. The spread cannot also be directly compared with CIP because the finding of foreign exchange rate premium can be associated with other inefficiencies in financial markets rather than a risk premium.

where $F^{(j)}$ is the j^{th} fundamental and b_{ji} are parameters. We formulated the GUM according to equation (3) assuming that spreads can be captured by an autoregressive distributed lag process. The problem with the estimation of (3) is to find the combination of fundamentals and lagged variables, in which the parameters are significant, the error term is white-noise, and both the explanatory power and the degrees of freedom are reasonable. Once the algorithm selects a model that passes all tests and is consistent with economic theory, one could identify the determinants of the time-varying risk.

2.1. Automated Selection - PcGets

As mentioned earlier, we use the automated selection procedure embedded in the algorithm of the econometric package PcGets. This is a general-to-specific modelling approach based on the theory of reduction [for a summary discussion of this theory see Krolzig and Hendry (2001) and Hendry and Krolzig (2003a)]. Designed to simplify dynamic and linear model regressions, the software automates the processes put forward by Hoover and Perez (1999). PcGets selects the relevant variables from those that compose a GUM, according to pre-specified diagnostic tests and significance levels, and delivers a terminal model that is encompassing.

Economic theory helps us to specify the variables in the GUM, to ensure that variables are orthogonalized, to perform appropriate data transformations, to calibrate the algorithm and, finally, to interpret the results. The importance of the specification is that the larger the number of regressors, the more likely irrelevant variables will be retained in the terminal selection because they determine the multiple search paths that deliver the contender models. On the other hand, the smaller the GUM, the higher is the chance that important variables will be omitted.[5]

The method was appropriate because it released us from manually testing a great number of models using a general to specific *t* or *F*-test. We were also able to use a standardised testing procedure for all countries and benefited from the rigour of the "theory of reduction". The procedure considers multiple path searches, which are tested until a dominant encompassing reduction is selected[6]. The objective is to find a congruent model, in order words, a model that is absent of mis-specification [PcGets (2005)].

The outcome depends on the choice of the GUM as well as on the calibration of the algorithm. The significance levels and the number of diagnostic tests are important because they are able to terminate search-paths. The tests were performed using the built in "liberal" strategy[7]. This strategy follows a search procedure for which the algorithm is already calibrated [see PcGets (2005)] and aims to keep the maximum number of variables that matter in the DGP. The performance of the liberal strategy depends on the number of irrelevant variables in the GUM [Hendry and Krolzig (2003b)]. We used the option "quick

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[5] The procedure is relatively new and there are few applications [see, for example, Krolzig and Hendry (2004)]. One applied work of PcGets to monetary problems is Sánchez-Fung (2005).

[6] Dominance happens when a model nests all contending explanations as special cases and encompassing requires a simple model to explain a more general one within which it is nested [Hendry and Krolzig (2003a)].

[7] We also tested a modified version without mis-specification tests for conditional volatility or autoregressive conditional heteroscedasticity (ARCH) effects. The justification is that heterocedasticity would influence efficiency but the OLS estimator would still be linear and unbiased, if the model passed other diagnostic tests. However, the liberal strategy without ARCH effects delivers the same terminal selections as the pre-calibrated liberal strategy, meaning that volatility is not a binding constraint.

modelling”, in which the program automatically selects the lag length and then checks the congruence of the resulting GUM. The pre-programmed selection was set with outlier correction. The size of the marginal outlier is defined according to the area under the normal distribution that gives the probability of a “rare event”. In the liberal strategy it is set to be 2.56, which gives a probability of 1%.

3. Data

Our selection of data was influenced by the theory aimed to understand the causes of the debt crisis during the 1980s and the currency crises in the 1990s [see for example, Krugman, (1979), Sachs (1985) and Kaminsky and Reinhart (2000)] in addition to the aforementioned literature on the causes of spreads. A plot of the complete series is presented in Figure 1 and descriptive statistics in Table 1.

Brazil has been experiencing very high *ex ante* and *ex post* real interest rates. A common explanation is the existence of a default risk premium – since Brazil defaulted in 1982 and again in 1987. A higher real interest rate with respect to other economies imply, keeping everything else constant, slower economic growth. As previously stated our work can reveal the determinants of risk in Brazil and shed some light on the appropriate macroeconomic policies that are able to decrease real interest rates.

The data was obtained from ipeadata of IPEA (the Institute of Applied Economic Research of Brazil), IFS (International Financial Statistics) of the IMF and JPMorgan. Monthly observations span from 1995M3 to 2004M9, which correspond to the most recent data available. Following the literature, we divided the variables into categories: a) liquidity and solvency b) macroeconomic factors c) international shocks and d) contagion or dummy variables. For the first category we used the current account deficit to GDP ratio, the public deficit to GDP ratio and the ratio of imports to foreign exchange reserves. For the macroeconomic factors we employed the growth of industrial production, because monthly data on GDP is not available. Terms of trade and an estimated measure of exchange rate misalignment were used to capture international shocks. Both the level and the variance of dollar-bond spreads are used to test for contagion.

An increase in the current account deficit to GDP ratio would raise risk. The ratio of imports to foreign exchange reserves is important if the country had experienced current account problems and limited access to capital markets. An increase in the ratio is expected to enlarge risk as more foreign currency is needed to pay for imports. The ratio of export to import prices was employed as a measure of terms of trade. The rationale is that if export prices increase relative to import prices, then there is more revenue accruing from international trade and one would expect a decrease in both the country and currency risk. However, if export prices increase the economy is less competitive and, hence, exports will be harder to sell. The final effect depends upon the export and import elasticities of demand and is an empirical issue.

We calculated exchange rate misalignment by subtracting the log of the real exchange rate series by its detrended value, which was estimated using the HP filter [as in Jahjah and Yue (2004)]. The real effective exchange rate, calculated using wholesale prices of Brazil and its major trading partners, was obtained from IPEA. A high positive value means that the exchange rate is highly depreciated which improves the competitiveness of a country but at the same time raises concerns about inflation. The sign of the coefficient depends on the perceived impact of the increase on competitiveness and inflation, which is also an empirical question.

The public deficit to GDP ratio is an indicative measure of the health of the public accounts. For this variable, we used the first difference of the total public debt to GDP ratio, which is also available at IPEA's website. A positive value corresponds to a deficit on the public accounts therefore an increase in the ratio should increase risk. The growth rate of industrial production provides a quantitative measure of the state of the real economy. If systematic increases are perceived by agents as changes in the potential output or in the ability of the economy to generate income and to pay for its bonds at maturity time, the sign of the parameter would be negative.

On the monetary side, we used the growth of M1. This aggregate can reflect the degree of credibility and the quality of the monetary policy implemented by the Central Bank. The expected sign of the parameter is supposed to be positive. Jahjah and Yue (1994), for instance, claim that inflation indicates a higher probability of a Balance-of-Payments crisis and thus a larger probability of default. Other authors, such as Cantor and Parker (1996), suggest that high inflation points out to structural problems in government finances, and public dissatisfaction with price increases may raise political instability.

We had to use separated data on current account deficit and GDP in order to build a small part (from 1995M3 to 1995M12) of the current account deficit to GDP ratio series, because data for this period was not available at IPEA. The ratio of imports to foreign exchange reserves was constructed using data from the IFS as well as the terms of trade and the growth of industrial production. Notice in Figure 1 that the ratio import/reserves is calculated as the monthly imports divided by the total reserves. Daily statistics of the EMBI+ from 1995M3 to 2004M9 were provided by JPMorgan for Argentina, Brazil, Mexico and Asia. We divided the EMBI+ by 1000 in order to obtain percentages and then calculated the monthly average. We also constructed a series of the volatility of the spread, by taking the monthly variance of the EMBI+ using daily data. This artifice was used to account for conditional volatility, as PcGets is not designed to reduce general models with the mean and variance estimated at the same time. The plot of these series can be seen in Figure 2. Data on the EMBI+ variance of Argentina, Mexico and Asia were used to capture contagion[8] from the financial crises. We have also used the level of the EMBI+ as a measure for contagion.

Other variables, such as the level of public and foreign debt were not included in the GUM because their first difference is supposed to be equal to the public deficit and the current account deficit, respectively. The exclusion of these variables also relieved us from concerns about the order of integration as deficits are theoretically expected to be I(0). Other possible series that could be included are either captured by the variables that we had already chosen or because they would raise concerns about correlation and simultaneity between the explanatory variables. Finally, we have to explain that, with the exception of those variables that were seasonally adjusted in the IFS database, the other seasonally adjusted variables were created using seasonal dummies.

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8 According to information on the website of the World Bank, the broad definition of contagion is the cross-country transmission of shocks or the spillover effects which can take place both during both tranquil and crises periods. The restrictive definition is the transmission of shocks beyond any fundamental link among the countries, usually explained by herding behaviour.

4. Results

We ran a regression of the EMBI+ on the fundamentals. The GUM generally comprises spreads as the dependent variable and a number of approximately seven fundamentals and up to seven contagion variables as possible regressors. The first GUM includes the variance of the EMBI+ for Argentina, Mexico and Asia in addition to the fundamentals. Table 1 shows that the ratio of imports of reserves, public deficit and the variances of the Asian and the Mexican EMBI+ enter the final selection. The algorithm retrieves a model with a reasonable amount of dynamics due, perhaps, to the high frequency of the data. The terminal selection is not congruent as the residuals pass all but the heteroscedasticity tests. The dummy that was created is associated with the Russian crisis, possibly because the change in risk perception associated with this event was not captured by the variance of other measures of the EMBI+ spread. The signs of the static long run equation, solved using the estimated coefficients from the final selection, are as expected. The exception is the variance of the EMBI+ of Asia. The latter result might be an indication that variance is able to measure agents attitude to risk, such as in Markowitz (1952), up to a limited extent. For example, Granger (2002) has explained that the behaviour of investors in different tails of the distribution of returns is not uniform. The reason is that agents diversify in order to avoid large losses but not large gains. Higher variability of gains regarding Mexican or Argentinean bonds may have induced diversification towards safer bonds. However, the same might not be true for Asian bonds. The portfolio decision would depend on the macroeconomic circumstances regarding both groups of countries. Therefore, an increase in the volatility of Asian spreads can cause agents to buy Brazilian bonds, increasing their prices and thus decreasing returns (and the spreads). Finally, it must be said that the problem of heteroscedasticity can be due to the existence of outliers that, due to several financial crisis, were not infrequent during the nineties[9].

We used the monthly average of the EMBI+ in the place of the variance in the second GUM (see Table 3). The algorithm retrieves a model that, as in the previous test regression, includes imports over reserves and the public deficit to GDP ratio. It additionally selects the ratio of the current account deficit to GDP, which is shown to have a stronger impact on risk in comparison to the other variables. The default risk of Brazil, EMBI+, can be explained by its own variance (the higher the variability of returns the higher is the risk) and also by the EMBI+ of Argentina and Mexico. This means that the larger the risk in these countries, the bigger is the Brazilian EMBI+ spread. The static long run equation shows that, within fundamentals, the current account has the strongest impact on the EMBI+. The model is not absent of mis-specification as there is a problem of conditional volatility in the residuals.

We then decided to run an even more general model, including all the contagion variables (both the level and the variance of EMBI+) together with the US inflation, which would supposedly measure other risk factors that are not captured by the EMBI+. We also modified the algorithm in PcGets in order to exclude contemporaneous relationships between EMBI+ spreads and the regressors, as it might take some time for risk to change in response to variations in fundamentals, and because we also avoided problems of

[9] We dealt with the heteroscedasticity problem by changing the size of the marginal outlier. Generally, when this is done, more dummies are included in the final selection. We report results concerning this different calibration in Table 5, using the more general model that we could formulate.

simultaneity[10]. Table 4 presents the findings showing a positive relationship between the EMBI+ spread and the EMBI+ of Argentina and Mexico, the current account deficit to GDP ratio, the public deficit to GDP ratio and, finally, its own variance. Notice that these results are robust to the inclusion of other variables and the calibration of PcGets. Two of the dummies that were created capture the effects of the Russian crisis and the Brazilian financial crisis, the one that culminated with the free float of the domestic currency in January, 1999. However, the terminal model still does not pass heteroscedasticity tests.

The problem of heteroscedasticity was eliminated by re-estimating GUM 3 using a different calibration for the algorithm. As explained earlier, the previous findings were obtained using the pre-programmed "liberal strategy". In Table 5, we show the findings using the liberal strategy modified for a different size of the marginal outlier, 1.5 standard deviations, thus allowing for a higher probability of modelling a "rare event". The objective of this calibration is to account for other changes in the mood of international agents that are not captured by the spreads, the variance of the EMBI+ and the previous dummies. By allowing the algorithm to retrieve more dummies, heteroscedasticy problems are ameliorated. Results presented in Table 5 show that, in addition to the same variables previously selected, two new dummies were created. One still reflects the effects of the financial crisis in the beginning of 1999, due to the high volatility of the exchange rate, and the other is associated with the financial turmoil regarding the uncertain outcome of the presidential elections in which a leftwing candidate was the favourite. Observe that this last model is absent of mis-specification. Finally, also notice the high R^2 of all of the above estimations. This is due to the ability of PcGets to search for the congruent model that has high explanatory power among a set of numerous possibilities. The final selections discussed above did not include any of the other fundamentals because models including those variables could not outperform the ones that we have presented.

5. Conclusion

We ran regressions of dollar-denominated bond spreads against a set of economic fundamentals drawing insights from papers that investigated the determinants of dollar-denominated bond spreads and from the literature that analysed the debt crises in the 1980s and the financial crisis in the 1990s. Our results, using an automated model selection criterion, show that spreads can be explained by economic fundamentals. The models retrieved have a high explanatory power, meaning that a great part of the variation in risk is due to changes in particular macroeconomic variables. From a list of approximately seven fundamentals and six contagion variables, we found that the time-varying risk is strongly correlated to the current account deficit ratio to GDP and also to the ratio of the public deficit to GDP. Imports over reserves, a measure of liquidity and solvency problems, also explain risk in a consistent way. There is evidence of systematic contagion from variations of the Argentinean and Mexican risk (EMBI+ spreads). Some of the financial crises in Brazil and elsewhere are manifested through outliers and affect EMBI+ spreads significantly. The variance of the EMBI+ of Brazil, used to account for conditional volatility, also impacts the spread.

A possible extension for our work is the application of the same methodology above to other countries. The idea would be to verify whether the evidence still points out to both

[10] The use of lags as instruments does not properly take simultaneity (between risk and fundamentals) into account because there is too much loss of dynamics.

the current account and the public deficit to GDP ratios as the main variables belonging to the DGP of EMBI+ spreads. The difficulty might lie in the availability of monthly data.

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Figure 1. EMBI+ and Fundamentals of Brazil

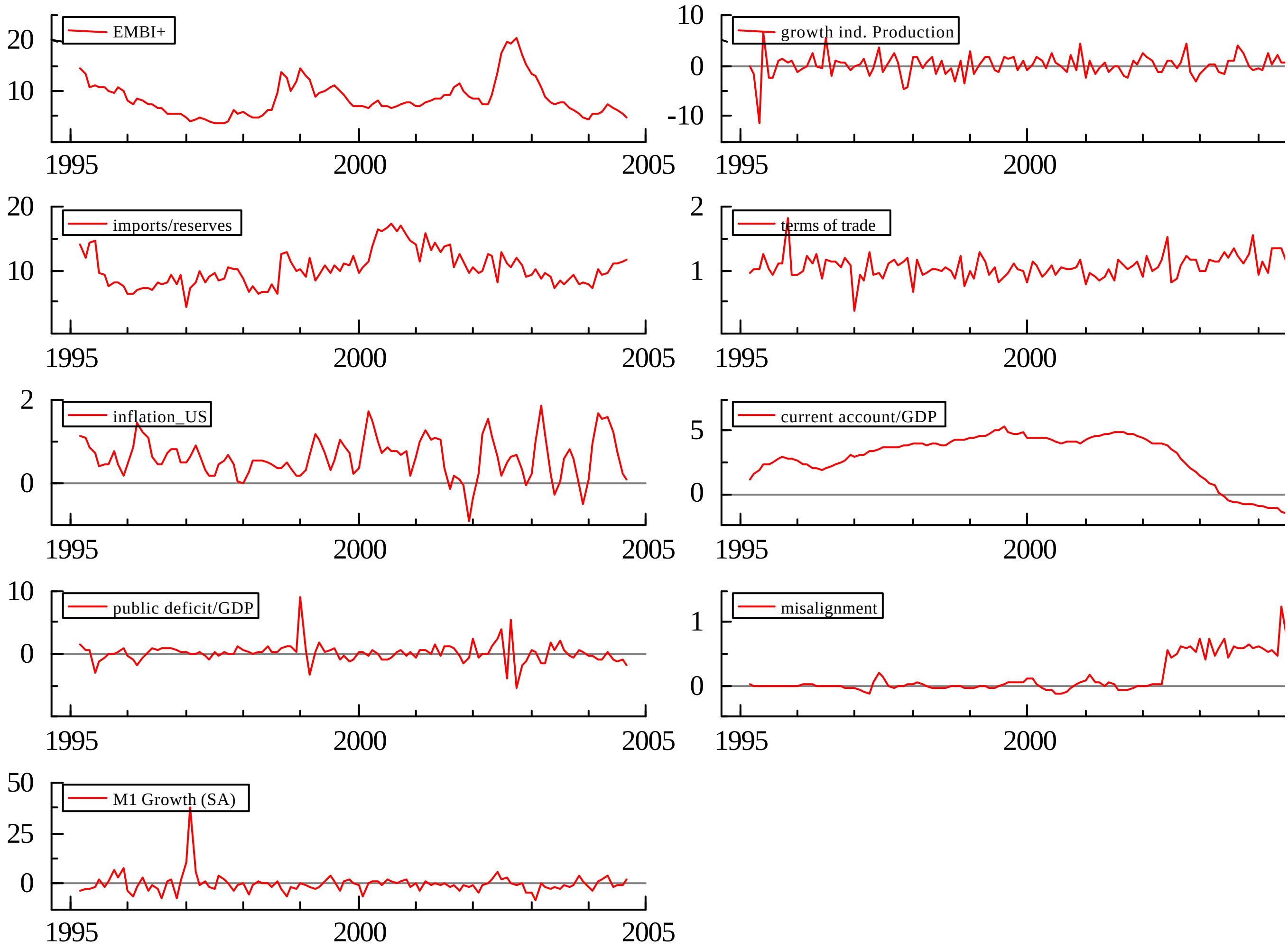

Figure 2. Monthly EMBI+ and its variance

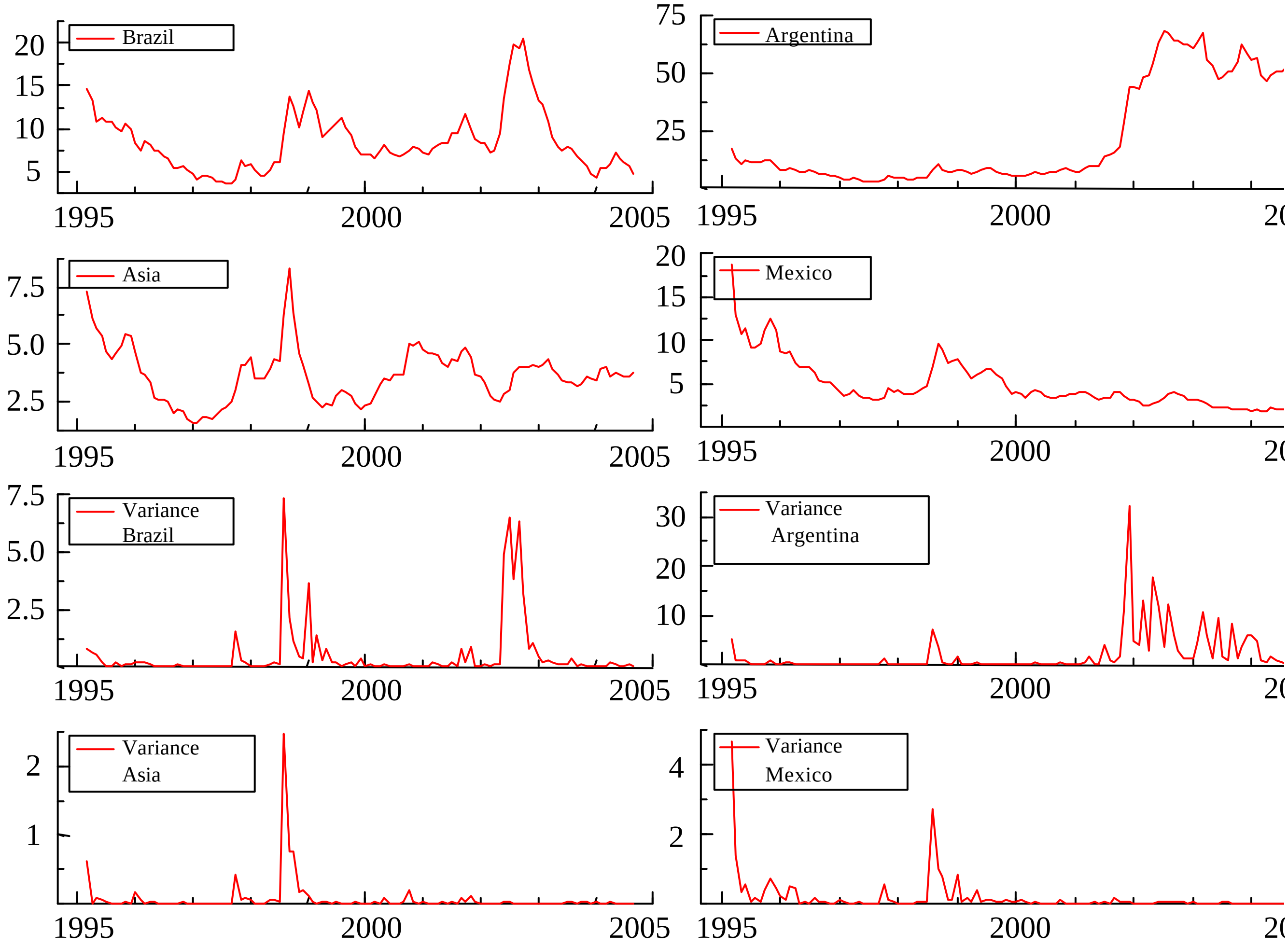

Table 1. Descriptive Statistics

Sample period from 1995M5 until 2004M9, n=115

	Mean	**Std Error**	**Minimum**	**Maximum**
Growth of industrial production	0.2	2.2	-11.2	6.8
Imports/reserves	10.2	2.7	4.3	17.3
M1	1.8	5.9	-7.2	39.6
Terms of trade	1.1	0.2	0.4	1.8
Exchange rate changes	3.9	12.9	-18.0	71.9
Current account/GDP	0.2	0.3	-0.1	1.2
Public deficit/GDP	2.9	1.9	-1.7	5.3
Misalignment	-0.2	10.1	-43.2	62.2
Argentina - EMBI+	0.1	0.3	0.0	2.7
Asia - EMBI+	21.9	22.3	2.9	68.3
Brazil - EMBI+	3.6	1.1	1.6	8.3
Mexico - EMBI+	8.4	3.4	3.7	20.4
Argentina - Variance of EMBI+	0.2	1.5	-5.2	8.9
Asia - Variance of EMBI+	2.1	4.3	0.0	32.1
Brazil - Variance of EMBI+	0.1	0.3	0.0	2.5
Mexico - Variance of EMBI+	0.5	1.3	0.0	7.3

Table 2. Modelling EMBI+ of Brazil (GUM 1)

Period from 1995M5 to 2004M9; n= 113
GUM: growth industrial production (seasonally adjusted from the IFS), imports/reserves, M1 seasonally adjusted, terms of trade, current account/GDP, misalignment (HP filter), public deficit/GDP, variance of EMBI+ (Argentina, Asia, Brazil and Mexico).

	Coefficient	Std.Error	t-value	t-prob
EMBI+ Brazil lag(1)	1.03744	0.07942	13.063	0.0000
EMBI+ Brazil lag(1)	-0.21288	0.06998	-3.042	0.0030
Imports/Reserves	0.10434	0.01640	6.361	0.0000
Public deficit/GDP lag(1)	0.16424	0.04484	3.663	0.0004
Public deficit/GDP lag(2)	-0.11331	0.04496	-2.521	0.0133
Variance EMBI+ Brazil	0.58678	0.08243	7.119	0.0000
Variance EMBI+ Mexico	2.65420	0.53670	4.945	0.0000
Variance EMBI+ Mexico lag(1)	-0.94349	0.40958	-2.304	0.0233
Variance EMBI+ Asia	-3.10261	0.66212	-4.686	0.0000
Variance EMBI+ Asia lag(1)	1.97403	0.49859	3.959	0.0001
Variance EMBI+ Asia lag(1)	-1.02780	0.30152	-3.409	0.0009
I1998:12	3.61495	0.74924	4.825	0.0000

R^2 0.964
$Radj^2$ 0.960

Diagnostic Tests

	value	Prob
Chow(2000:1) F(57, 44)	1.1547	0.3120
Chow(2003:10) F(12, 89)	1.0701	0.3947
Normality $c^2(2)$	3.0578	0.2168
AR(1-4) F(4, 97)	0.9902	0.4167
ARCH(1-4) F(4, 105)	0.7494	0.5606
Hetero $c^2(23)$	39.4038	0.0179

Static long-run equation

	Coefficient	Std.Error	t-value	t-prob
Imports/Reserves	0.59471	0.04282	13.887	0.0000
Public deficit/GDP	0.29026	0.39191	0.741	0.4606
Variance EMBI+ Brazil	3.34456	0.41838	7.994	0.0000
Variance EMBI+ Mexico	9.75077	2.96706	3.286	0.0014
Variance EMBI+ Asia	-12.29097	3.98335	-3.086	0.0026
I1998:12	20.60468	5.07923	4.057	0.0001

Table 3. Modelling EMBI+ of Brazil (GUM 2)

Period from 1995M5 to 2004M9; Observations=113
GUM: growth industrial production (seasonally adjusted from the IFS), imports/reserves, M1 seasonally adjusted, terms of trade, current account/GDP, misalignment (HP filter), public deficit/GDP, variance of EMBI+ of Brazil and EMBI+ of Argentina, Asia and Mexico.

	Coefficient	Std.Error	t-value	t-prob
EMBI+ Brazil lag(1)	0.87930	0.06345	13.858	0.0000
EMBI+ Brazil lag(1)	-0.16851	0.05721	-2.945	0.0040
Constant	-1.21154	0.40356	-3.002	0.0034
Imports/Reserves lag(1)	0.09341	0.02546	3.670	0.0004
Current account/GDP lag(1)	0.23200	0.06822	3.401	0.0010
Public deficit/GDP lag(1)	0.15658	0.04183	3.744	0.0003
Variance EMBI+ Brazil	0.39453	0.06325	6.237	0.0000
EMBI+ Argentina	0.01782	0.01378	1.293	0.1990
EMBI+ Argentina lag(1)	0.01510	0.01611	0.937	0.3508
EMBI+ Mexico	0.90253	0.10456	8.632	0.0000
EMBI+ Mexico lag(1)	-0.66873	0.10593	-6.313	0.0000

R^2 0.968
$Radj^2$ 0.965

Diagnostic Tests

	value	prob
Chow(2000:1) F(57, 45)	1.3922	0.1258
Chow(2003:10) F(12, 90)	0.9576	0.4948
Normality $c^2(2)$	0.4458	0.8002
AR(1-4) F(4, 98)	0.7974	0.5297
Hetero $c^2(20)$	38.3928	0.0079

Static long-run equation

	Coefficient	Std.Error	t-value	t-prob
Constant	-4.18918	1.22444	-3.421	0.0009
Imports/Reserves	0.32299	0.08625	3.745	0.0003
Current account/GDP	0.80219	0.18207	4.406	0.0000
Public deficit/GDP	0.54140	0.16325	3.316	0.0013
Variance EMBI+ Brazil	1.36417	0.27005	5.052	0.0000
EMBI+ Argentina	0.11383	0.01747	6.516	0.0000
EMBI+ Mexico	0.80842	0.10717	7.543	0.0000

Table 4. Modelling EMBI+ of Brazil (GUM 3)

Period from 1995M5 to 2004M9; Observations=114
GUM: growth industrial production (seasonally adjusted from the IFS), imports/reserves, M1 seasonally adjusted, terms of trade, current account/GDP, misalignment (HP filter), public deficit/GDP, inflation US, variance of EMBI+ of Argentina, Asia, Brazil and Mexico and EMBI+ of Argentina, Asia and Mexico. Estimated without contemporaneous variables.

	Coefficient	Std.Error	t-value	t-prob
EMBI+ Brazil lag(1)	0.71171	0.04660	15.272	0.0000
Public deficit/GDP lag(1)	0.21460	0.05766	3.722	0.0003
Current account/GDP lag(1)	0.28123	0.05319	5.287	0.0000
Inflation_US lag(1)	0.43641	0.15504	2.815	0.0000
Variance EMBI+ Brazil lag(1)	0.56986	0.07838	7.270	0.0002
EMBI+ Argentina lag(1)	0.02460	0.00647	3.803	0.0335
EMBI+ Mexico lag(1)	0.08495	0.03942	2.155	0.0058
I1998:8	3.33036	0.80537	4.135	0.0001
DI1999:1	3.48093	0.61387	5.670	0.0000
I2002:6	3.49005	0.82555	4.228	0.0001

R^2 0.950
$Radj^2$ 0.947

Diagnostic Tests

	value	prob
Chow(2000:1) F(57, 47)	0.7583	0.8413
Chow(2003:10) F(12, 92)	0.6614	0.7837
Normality $c^2(2)$	1.3175	0.5175
AR(1-4) F(4, 100)	1.4208	0.2326
ARCH (1-4) F(4,106)	1.6156	0.1757

Static long-run equation

	Coefficient	Std.Error	t-value	t-prob
Public deficit/GDP	0.74438	0.25264	2.946	0.0040
Current account/GDP	0.97552	0.12614	7.733	0.0000
Inflation_US	1.51380	0.60242	2.513	0.0135
Variance EMBI+ Brazil	1.97668	0.29295	6.747	0.0000
EMBI+ Argentina	0.08532	0.01251	6.818	0.0000
EMBI+ Mexico	0.29467	0.10292	2.863	0.0051
I1998:8	11.55211	3.41171	3.386	0.0010
DI1999:1	12.07437	2.95647	4.084	0.0001
I2002:6	12.10600	3.62831	3.337	0.0012

Table 5. Modelling EMBI+ of Brazil (GUM 3) using a larger size for the marginal outlier

Period from 1995M5 to 2004M9; Observations=114
GUM (3) estimated without contemporaneous variables. Size of the Marginal Outlier= 1.5 standard deviations.

	Coefficient	Std.Error	t-value	t-prob
EMBI+ Brazil lag(1)	0.70988	0.04175	17.004	0.0000
Current account/GDP lag(1)	0.26750	0.04751	5.630	0.0000
Public deficit/GDP lag(1)	0.18152	0.05246	3.460	0.0008
Inflation_US lag(1)	0.45662	0.14006	3.260	0.0015
Variance EMBI+ Brazil lag(1)	0.60783	0.07053	8.618	0.0000
EMBI+ Argentina lag(1)	0.02395	0.00578	4.144	0.0001
EMBI+ Mexico lag(1)	0.09387	0.03532	2.658	0.0091
I1998:8	3.37217	0.71840	4.694	0.0000
DI1998:11	-2.10800	0.50469	-4.177	0.0001
DI1999:1	3.40035	0.54850	6.199	0.0000
DI1999:4	-1.28591	0.51616	-2.491	0.0144
I2001:9	1.84137	0.73299	2.512	0.0136
I2002:6	3.59812	0.73678	4.884	0.0000

R^2 0.962
$Radj^2$ 0.957

Diagnostic Tests

	value	prob
Chow(2000:1) F(57,44)	0.9665	0.5524
Chow(2003:10) F(12,89)	0.8002	0.6492
Normality c^2 (2)	1.6615	0.4357
AR (1-4) F(4, 97)	1.6479	0.1685
ARCH (4-4) F(1, 109)	3.1954	0.0766
Hetero F(23, 90)	1.4539	0.1089

Static long-run equation (Without the Effect of the Dummies)

	Coefficient	Std.Error	t-value	t-prob
Current account/GDP	0.92202	0.11222	8.216	0.0000
Public deficit/GDP	0.62567	0.21665	2.888	0.0047
Inflation_US	1.57391	0.54093	2.910	0.0045
Variance EMBI+ Brazil	2.09511	0.27176	7.710	0.0000
EMBI+ Argentina	0.08255	0.01129	7.314	0.0000
EMBI+ Mexico	0.32356	0.08917	3.629	0.0004