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Country Risk, Macroeconomic Fundamentals and Uncertainty in Latin American Economies

Abstract

This paper analyzes the relation between the country risk and its macroeconomic determinants for Argentina, Brazil, Mexico and Venezuela, during the 1998-2013 period, using a Markov-switching SUR model estimated by Bayesian techniques. Two independent regimes for each country were identified. The first one, associated with periods of stability and favorable international conditions, in which the variables under consideration behave as reported in the literature. On the other hand, the second regime temporarily coincides with periods of high domestic and international uncertainty. Our findings suggest that the changes in the analyzed relation depend on the origin of the uncertainty. If the uncertainty's source is associated with external shocks, such as international crises, the financial markets volatility gains relevance, while the solvency and liquidity variables are less relevant; if the causes of uncertainty are domestic, the latter are the key variables to explain the sovereign risk.

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1. INTRODUCTION

The impact of macroeconomic fundamentals on sovereign default risk has been studied in the traditional literature (Sachs, 1985; Edwards, 1986; González-Rozada, 2006; Uribe and Yue, 2006; Hilscher and Nosbusch, 2010) through linear models. Interest has grown recently in exploring nonlinear relations between sovereign default risk, its macro determinants and global variables, in different types of economies.

In advanced economies, discussion on the high levels reached by sovereign debt and the sustainability of fiscal policy, have demonstrated the importance of a nonlinear relation between debt size and borrowing costs, as well as the nonlinearities caused by uncertainty regarding the type of economic policy coordination designed to address the deterioration in fiscal accounts. Troy et al. (2010) studied the consequences of rising public debt in developed countries in an environment with a fiscal limit, concluding that uncertainty regarding the way economic policies are combined generates a nonlinear relation between debt and inflation. Huixin (2012) presents a study on the interactions between sovereign risk premia and fiscal policy under conditions of fiscal limit in developed countries, finding a nonlinear relation between sovereign risk premia and the level of public debt in line with the empirical evidence. Greenlaw (2013) analyzed the tipping points of sovereign debt markets for 20 advanced countries during the period 2000-2011. The authors find evidence of nonlinearities in the relation between borrowing rates on sovereign debt and its proportion on GDP of the economies studied. These authors point out that sovereign interest rates rise much more quickly when debt levels are high.

In emerging economies, linear models have encountered some difficulties in explaining the evolution of country risk over the last two decades in terms of their macroeconomic fundamentals and global variables due to factors such as political or economic uncertainty, contagion effects, among others. Acosta, Barráez and Urbina (2014) proposed a Markov regime switching model (Hamilton, 1989) to study the case of Venezuela. These authors suggest that in the process of forming expectations regarding a country's capacity to pay its debts, agents will not weigh the different macroeconomic determinants constantly over time. They identified two temporary regimes in which the linear relation between the fundamentals and sovereign default risk clearly varies regarding the temporal regime. These regimes temporarily coincide with periods of high and low economic uncertainty.

A number of the research papers mentioned above point to uncertainty as one possible cause of the nonlinear relation between sovereign debt and fundamentals. This empirical work studies the break in the linear relation between sovereign default risk and its determinants (macroeconomic fundamentals and global variables) for Argentina, Brazil, Mexico and Venezuela during the 1998-2013 period. To this end, we focus on exploring how uncertainty influences this break, according to the event that generates it, whether it is domestic (corresponds to specific events in each economy) or external (linked to international type events).

For this purpose, a Markov switching regime model is implemented, which unlike that the one presented by Acosta, Barráez and Urbina (2014), has a Seemingly Unrelated Regression (SUR) structure estimated with Bayesian simulation techniques (Kim and Nelson, 1999). The proposed model allows temporary states or regimes to be specified for each country, while carrying out the estimatation jointly, this enables to exploit the correlation that might exist between the shocks to the sovereign default risk in each country.

This paper verified the presence of nonlinearities between sovereign default risk and its determinants, and identified two temporary regimes in each country similar to that reported by Acosta, Barráez and Urbina (2014): a first regime, linked to periods of relative stability or *low uncertainty*, where the relation between country risk and fundamentals behaves according to the reported in the literature, and a second regime associated to periods of *high uncertainty*. The most significant finding of this research demonstrates that the changes occured in the relation between the risk and its explanatory variables depends on the causes of uncertainty in both regimes. If the source of uncertainty is associated with external events, such as international crises, financial market volatility gains relevance, while solvency and liquidity variables are less relevant, such as in the case of Mexico and Brazil. If the causes of uncertainty are of domestic origin, the opposite occurs, such as observed in Argentina and Venezuela. In the case of the latter, the results coincide with the findings of Acosta, Bárraez and Urbina (2014).

It is important to mention that the *subprime* crisis is the only common shock in the high uncertainty regime for all the countries, except Brazil, in whose case the relation of sovereign default risk with its determinants remained in the stability regime. Such behavior is probably explained by economic policy measures adopted in this country to address the crisis.

From the model estimated in this paper we obtained country risk elasticities with respect to their determinants in each regime. These elasticities are useful because they allow for assessing economic policies aimed at reducing sovereign default risk.

The paper is divided as follows. Sections 2 and 3 describe the main aspects of the data and econometric methodology. The fourth section presents the empirical model estimated. The fifth shows the results. Finally, the conclusions are given.

2. DATA

The database used for the estimation contains quarterly information for the period 1998-2013, for Argentina, Brazil, Mexico and Venezuela.

The EMBI+ index calculated by JP Morgan, obtained from Bloomberg, was used as a measure of sovereign default risk for each country included in the study. The variables considered as country risk determinants are divided into three groups: *macroeconomic fundamentals, solvency and liquidity variables, and global indicators*. The first group consists of the growth rate of real GDP, inflation and exchange rate variations. The second group includes international reserves, commodity prices and external debt as percentage of GDP. The third group of variables includes *global indicators*, such as market volatility and international interest rates.

In the case of macroeconomic fundamentals, data for GDP growth rate, inflation and the exchange rate are taken from IMF statistics for Argentina, Brazil and Mexico. In the case of Argentina, the price index registered by PriceStats was also used. In the case of Venezuela, these variables were obtained from Central Bank statistics, except for the parallel market exchange rate employed for calculating the spread with respect to the official rate as a measure of exchange rate imbalance, which is obtained from different sources.

Regarding liquid and solvency indicators, international reserves were expressed as months of imports obtained from IMF statistics. Data related to external debt was obtained from the statistics of the respective ministries of finance and statistics institutions of each country. This variable was expressed as a percentage of gross domestic product.

With respect to global indicators, market volatility is captured through the Chicago Board Options Exchange Volatility Index (VIX). The 3-month United States Treasury bill rate, obtained from Federal Reserve statistics, was used as the measure of international interest rates. Commodity prices were incorporated via the commodity price index, obtained from the IMF for Brazil and Mexico. The commodity price index published by the Banco de la República Argentina was used for Argentina, while for Venezuela the price series of the Venezuelan oil basket, obtained from the Venezuelan Energy and Oil Ministry, was employed. These criteria for selecting the indexes were based on the structure of exports, taking into account the most representative commodities of each country.

Before starting the estimation, unit root tests were carried out to detect stationarity in the series. Thus, the test of Levin, Lin and Chu (to verify the existence of common unit root processes), and those of Pesaran and Shin, W-Stat, ADF Fisher and PP Fisher, were employed to prove the existence of individual unit root processes. All the variables were transformed into logarithmic differences, except the coefficients (external debt/GDP, reserves/imports) and the interest rate, which are assumed at stationary in levels.

Selection of these economies was made considering the most representative Latin American countries in terms of the size of the economies for which the EMBI+ is elaborated (JP Morgan calculates the EMBI+ for 16 countries, six of which belong to Latin America). The study period was chosen taking into account the availability of statistical data.

3. METHODOLOGY

The multiple structural changes in Latin American economies would seem to suggest that a linear model for explaining default risk for each of the countries considered would be an inappropriate simplification. Thus, nonlinear Markov regime switching models seem to be more appropriate for adjusting to this type of behavior.

The instability in regression models is frequently associated to changes experienced by the equation's parameters from one sample period (regime) to another. If knowledge is available on when such regime changes occur, and the subgroups of the sample are well defined, the Chow F-test can be applied to prove the existence of the structural change hypothesis. However, in many cases very little information is available about the occurrence of such structural changes, then, in addition to the estimation of the model's parameters, the structural breaks of the equation must also be inferred as unobservable variables.

The SUR methodology was used in order to jointly estimate the Markov regime switching model, this provides information aboutthe correlation between the shocks to which risk is exposed in each considered country.

The Markov-switching SUR model can be written as follows:

$$y_{i,t} = x_{i,t}\ \beta_{i,s_t} + e_{i,t}\ , \tag{1}$$

with $t=1,\ldots,T$ observations for each of the $i=1,\ldots,N$ equations (countries). $y_{i,t}$ denotes the sovereign default risk observation at time t of equation i, $x_{i,t}$ is a $1\times k_i$ vector that contains the explanatory variables of equation i at time t, β_{i,s_t} represents the respective vector coefficients of equation i at time t, which has the following structure:

$\beta_s = \beta_i^0\left(1-s_{i,t}\right)+\beta_i^1 s_{i,t}$, $s_{i,t}=0$ or 1 (regime 0 or 1).

$s_{i,t}$ is the unobservable variable that governs the regime change of equation i, during regime 0 the parameters of this equation are given by β_i^0, while during regime 1 they would be given by β_i^1.

Up until now nothing has been said regarding the characteristics of random errors in the model. $e_t=(e_{1,t},e_{2,t},\ldots,e_{N,t})'$ is defined to allow error correlation between cross-section units, we should assume that $e_t \sim N(\mathbf{0}_N,\Sigma)$ for $t=1,\ldots,T$, where Σ is a co-variance matrix $N\times N$. Then, the likelihood function to maximize is given by:

$$\ln(L)=\sum_{t=1}^{T}\sum_{s_1=0}^{1}\sum_{s_2=0}^{1}\cdots\sum_{s_N=0}^{1} f(y_t \mid s_{1,t},s_{2,t},\ldots,s_{N,t},\psi_{t-1})\prod_{i=1}^{N} f(s_{i,t}\mid\psi_{t-1}) \tag{2}$$

where

$$f\left(y_t \mid s_{1,t},s_{2,t},\ldots,s_{N,t},\psi_{t-1}\right)=\frac{1}{(2\pi)^{\frac{N}{2}}\left|\Sigma\right|^{\frac{1}{2}}}\exp\left\{-\frac{1}{2}\left(y_t-x_t\beta_{s_t}\right)'\Sigma^{-1}\left(y_t-x_t\beta_{s_t}\right)\right\},$$

$$y_t=\left(y_{1,t}\ y_{2,t}\cdots y_{N,t}\right)',\ x_t=\begin{pmatrix} x_{1,t} & 0 & \cdots & 0 \\ 0 & x_{2,t} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & x_{N,t}\end{pmatrix},\ \beta_{s_t}=\begin{pmatrix}\beta_{1,s_t}\\ \beta_{2,s_t}\\ \vdots \\ \beta_{N,s_t}\end{pmatrix},\ s_t=\begin{pmatrix}s_{1,t}\\ s_{2,t}\\ \vdots\\ s_{N,t}\end{pmatrix}.$$

Ψ_{t-1} represents the data available at time $t-1$.

Finally, an assumption must be imposed on the stochastic behavior of the unobservable variables $s_{i,t}$, which will allow to determine $f(s_{i,t}\mid\psi_{t-1})$. If it is assumed that these follow a first-order Markov random process, the specification of a Markov regime switching model will have been completed. Inference of these variables is carried out through the Hamilton filter (1989).

When the model presented in Equation 1 depends on multiple cross-section units, each with explicative variables, the number of parameters to be estimated increases considerably and maximization of the likelihood function expressed in Equation 2 by classical methods becomes a very complicated task. Moreover, Bayesian methods provide several important advantages that avoid difficulties related to numerically maximizing the likelihood function with restrictions on the parameters imposed by economic theory. The use of prior densities, in addition to including information not contained in the sample into the estimation process, allows for working with smaller sized samples than those required by frequentist methods, which is of particular interest in our case. Regarding the estimation technique, the Bayesian simulation algorithms proposed by Kim and Nelson (1998) were employed for estimating the model. The idea is to use Gibbs sampling to obtain the posterior distribution of the parameters β_i^0, β_i^1, Σ, $i=1,\ldots,N$ and the state vectors $s_{i,t}$ from which their mean and variance can be inferred, thereby avoiding direct maximization of the likelihood function.

Gibbs sampling only requires posterior simulation of the conditional distributions of each parameter. Assuming a multivariate normal prior distribution for the vector of parameters $\beta = \left[\beta_1^{0\prime} \beta_2^{0\prime} \ldots \beta_N^{0\prime} \beta_1^{1\prime} \beta_2^{1\prime} \ldots \beta_N^{1\prime} \right]' \sim N\left(B_0, V_0\right)$ the posteriorconditional distribution $f(\beta \mid \Psi_T, \Sigma, s_{1,t}, s_{2,t}, \ldots, s_{N,t})$ will be given by $\beta \sim N(B_1, V_1)$, where:

$$V_1 = \left(V_0^{-1} + \mathbb{X}'\Sigma^{-1}\mathbb{X}\right)^{-1},$$

$$B_1 = V_1\left(V_0^{-1}B_0 + \mathbb{X}'\bar{\Sigma}^{-1}\mathbb{Y}\right),$$

$\bar{\Sigma} = \Sigma \otimes I_T$ ($\otimes$: Kronecker product operator),

$$\mathbb{Y} = \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_N \end{pmatrix}, Y_i = \begin{pmatrix} y_{i,1} \\ y_{i,2} \\ \vdots \\ y_{iT} \end{pmatrix}, i = 1,\ldots,N$$

$$\mathbb{X} = \begin{pmatrix} X_1 & 0 & \cdots & 0 \\ 0 & X_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & X_N \end{pmatrix} \odot \left(\iota_K \otimes S\right),$$

($\odot$: element-wise product operator)

$$X_i = \begin{pmatrix} x_{i,1} \\ x_{i,2} \\ \vdots \\ x_{iT} \end{pmatrix}, S = \begin{pmatrix} S_1 \\ S_2 \\ \vdots \\ S_N \end{pmatrix}, S_i = \begin{pmatrix} s_{i,1} \\ s_{i,2} \\ \vdots \\ s_{iT} \end{pmatrix}, K = \sum_{i=1}^{N} k_i, \ i = 1,\ldots, N,$$

ι_K denotes a $K\times 1$ vector that only contains ones.

To simulate the variance-covariance matrix Σ, an inverse Wishart priori distribution $\Sigma \sim IW(D_0,\delta_0)$ will be assumed, where D_0 and δ_0 represent a $N\times N$ scale matrix and degrees of freedom, respectively. The resulting posterior conditional distribution $f(\Sigma \mid \Psi_T, \beta, s_{1,t}, s_{2,t},\ldots, s_{N,t})$ is of the same functional form: $\Sigma \sim IW\left(D_1,\delta_1\right)$, where:

$$D_1 = D_0 + E'E$$

$$E = \begin{pmatrix} E_1 & E_2 & \cdots & E_N \end{pmatrix}, E_i = \begin{pmatrix} e_{i,1} \\ e_{i,2} \\ \vdots \\ e_{i,T} \end{pmatrix}, i = 1,2,\ldots,N, \ \delta_1 = \delta_0 + T.$$

To simulate the posterior distribution $f(S_i \mid \beta, \Sigma, \Psi_T)$ we use the Carter and Kohn (1994) result, which indicates that:

$$f\left(S_i \mid \beta,\Sigma,\Psi_T\right)=f\left(s_{i,T} \mid \beta,\Sigma,\Psi_T\right)\prod_{t=1}^{T-1} f\left(s_{i,t} \mid s_{i,t+1},\beta,\Sigma,\Psi_T\right),\ i=1,\ldots,N ,$$

where each of these distributions are obtained by implementing the Hamilton (1989) filter [for further details on this result see Carter and Kohn (1994) or Kim and Nelson (1999)].

4. EMPIRICAL MODEL

The base model estimation is given by:

$$EMBI_{i,t}=\theta_{S_t}^0+\theta_{S_t}^1\Delta PIB_{it}+\theta_{S_t}^2\pi_{it}+\theta_{S_t}^3 R_{it}+\theta_{S_t}^4 Tc_{it}+$$
$$+\theta_{S_t}^5 Vix_{it}+\theta_{S_t}^6 Ti_{it}+\theta_{S_t}^7 D_{it}+\theta_{S_t}^8\Delta PMP_{it}+\varepsilon_{it,S_t},$$

$$\varepsilon_{it,s_t}\sim N(0,\sigma_{s_t}^2),$$

$$\theta_{S_t}^i=\theta_0^i\left(1-S_t\right)+\theta_1^i S_t ,$$

$$S_t=0 \text{ o } 1 \text{ (regime 0 or 1)},$$

where subindexes i and t denote the country and the time respectively, ΔPIB_{it} represents real GDP growth rate; π_{it} the inflation rate; R_{it} is international reserves expressed in months of imports; Tc_t is the variation of the exchange rate;[3] Vix_{it} is the CBOE volatility index; Ti_{it} is the three-month US Treasury bill interest rate; D_{it} is external debt as percentage of GDP and ΔPMP_{it} is the variation of commodity prices.

5. RESULTS

The results of the parameter estimation are shown in Table 1 of the Annex. Two regimes were identified for each country. The first regime, which we will call regime L (*low uncertainty*), is related to periods of stability, economic growth and favorable international conditions. The second one is the regime H (*high uncertainty*), which temporarily coincides with periods of domestic and international turbulence. The methodology employed allows regimes to be independent between countries and they do not necessarily coincide in temporality.

In regime L, for Argentina, Brazil and Mexico all of the determinants considered are statistically significant and the signs of the coefficients were as expected, except for the GDP growth rate in the case of Argentina. Out of the macroeconomic fundamentals, GDP growth rate has a negative sign, while inflation and the exchange rate have positive ones. Out of solvency and liquidity variables, debt has a positive sign, while international reserves and commodity prices have negative ones. Out of the global variables, the VIX has a positive sign. In this regime, the countries' sovereign default risk behaves as expected in the literature.

Unlike the rest of the countries, in Venezuela during regime L, risk is mainly determined by a small number of variables, being the most important oil prices and financial market volatility, confirming the results obtained by Acosta, Barráez and Urbina. This finding reflects the importance of oil revenues for the Venezuelan economy and the sensitivity of the yield curve of debt instruments to oil price shocks (Chirinos and Pagliacci, 2015): in periods of low uncertainty, sovereign debt risk perception is essentially linked to oil prices.

In contrast to regime L, regime H temporarily coincides with periods of high uncertainty where disturbances of international scope are present, such as the Russian crisis, the Argentine debt crisis and the subprime crisis, in addition to domestic events that adversely affected risk premia. In the case of Mexico and Brazil, the periods of high uncertainty are mainly associated with major external disturbances, while in Argentina and Venezuela this regime basically coincides with domestic type events.

Now we are going to analyze the results for each of country in regime H. In Mexico regime H is observed during the periods 1998Q1-1998Q3 and 2007Q2-2009Q2, coinciding with the Russian and subprime crises, respectively. Negative economic growth rates, depreciation of the Mexican peso and increased sovereign default risk were recorded in both periods.

With respect to the latter period, it is important to mention that out of the countries of the region, Mexico was most affected due to the synchronization of its business cycle with that of the United States.

With respect to the coefficients of regime H, inflation, GDP and the exchange rate cease to be significant. The international reserves and VIX coefficients are greater than those estimated for this variables in regime L. Unlike regime L, the sign of the coefficient for the United States Treasury bill ratesis negative in regime H, which reveals the importance of United States monetary policy in investors' valuation of Mexican debt.

In the case of Brazil, regime H, covering the period 2002Q2-2004Q2, was characterized by a significant deterioration in the terms of trade due to a decline in trade flows with Argentina as a consequence of the debt crisis affecting that country. In addition, the burst of the speculative bubble in 2000 and the events of September 2001 generated volatility in international markets. This unfavorable international environment caused a slowing of economic activity. During this period sovereign bond spreads surpassed 2,000 basis points (bp) and the real suffered a sharp depreciation.

With respect to the coefficients of regime H as in the case of Mexico, a group of variables ceased to be significant: inflation, external debt, GDP and United States interest rates. The exchange rate and the VIX increased their weight as risk determinants compared to those obtained by regime L. While the coefficients of international reserves and commodity prices are similar to those of regime L, the signs of the coefficients are as expected a priori.

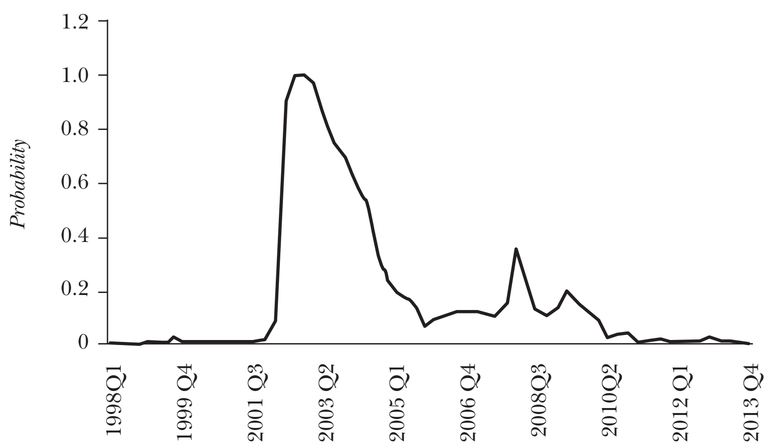
During 1998Q4-1999Q2 the presence of macroeconomic imbalances were seen after the collapse of the Plan Real, which increased risk premia. However, the methodology employed did not associate this period with regime H, given that this regime depends on the behavior of global indicators.

During the subprime crisis, no change of regime was observed either in sovereign default risk for Brazil, which remained in regime L, despite the increase in the regime switching probability

(Figure 1). Such behavior could be explained by the effectiveness of economic policy measures (mainly monetary and fiscal) mitigating the impact of the crisis.

Figure 1

PROBABILITY OF REGIME SWITCHING FOR BRAZIL



Source: own elaboration.

To assess whether monetary policy in Brazil influenced the evolution of sovereign default risk during the subprime crisis, a Taylor rule was estimated.

$$i-\overline{\pi}=\overline{r}+a\left(\pi-\overline{\pi}\right)+b\left(y-\overline{y}\right)+\varepsilon\,,$$

where i is the monetary policy interest rate of the Banco Central do Brasil (SELIC), $\overline{r}$ is the long-term interest rate, $\overline{\pi}$ is the inflation target, $\pi-\overline{\pi}$ is the difference between the actual inflation rate and the target, $y-\overline{y}$ is the GDP gap and ε is the monetary policy shock.

In order to test whether the policy mesures influenced the fact that soveriegn default risk remained in the regime of low uncertainty during the crisis period, the residuals of the Taylor rule (which express the orientation and magnitude of monetary policy) were captured for estimating a logistic model on the regime switching probability.

Figure 2 shows the probability of a change in country risk regime during the implementation of an expansive monetary policy measure (Figure 2a), comparing it with a counterfactual exercise assuming the implementaion of a neutral monetary policy (null shocks in the Taylor rule), which is shown in Figure 2b. In this regard, it can be seen how the regime change probabilityduring the crisis is higher in the abscence of monetary policy measures, i.e., monetary policy contributed to stay in the low uncertainty regime during the subprime crisis.

It is important to point out that fiscal policy actions were included in the logistic model, and counterfactual exercises were carried out similarly to those mentioned above, employing variables such as tax revenues and expenditures. However, these variables were not statistically significant, i.e., no statistical evidence was found to support the premise that fiscal policy influenced the presence of the Brazilian economy in the low uncertainty regime during the crisis.

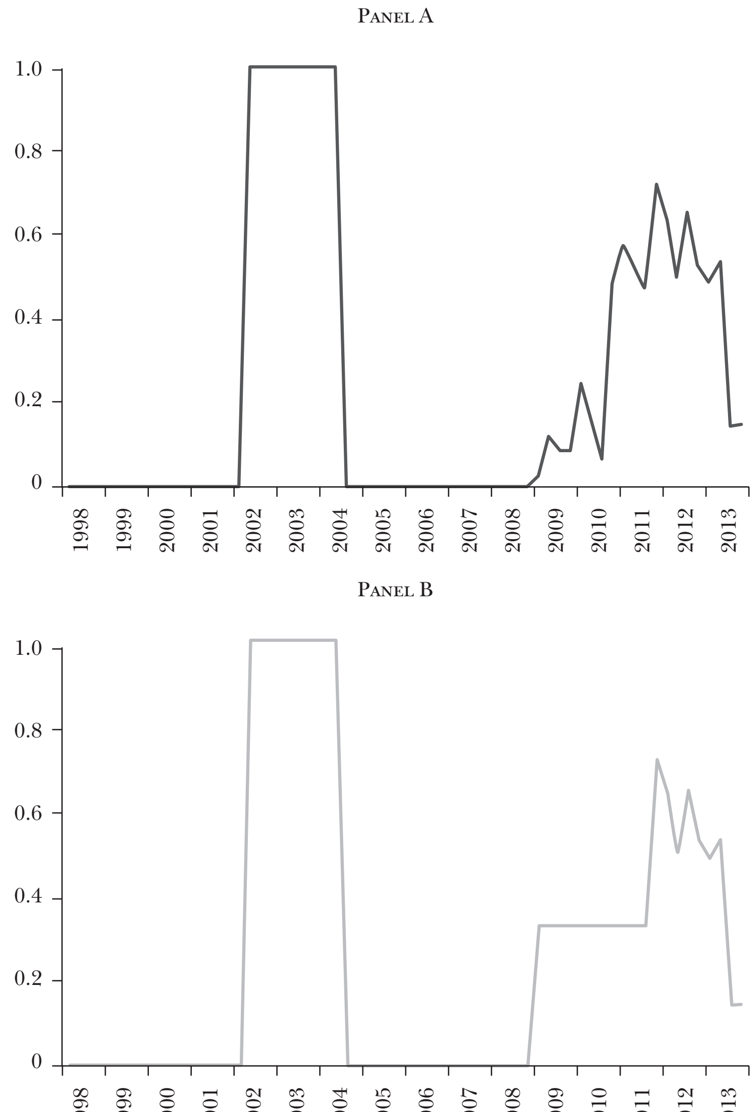
On the other hand, regarding Mexico and Brazil, international reserves is only variable of the solvency and liquidity group whose coeffcient increased during this regimeis in the case of Mexico. The other two of this group remained unchanged or even lost their significance, such as in the case of debt in Brazil, while the coefficient of the global variable VIX is higher in this regime for both economies.

In the cases of Argentina and Venezuela, regime H consists of three periods, mainly associated with adverse domestic economic and political events.

In Argentina, the first period (2001Q4-2005Q2) was marked by the public debt crisis of December 2001 and the subsequent social and political events that led to the resignation of the then president. The economy suffered a substantial contraction during this period, accompanied by a significant fall in

Figure 2

PROBABILITY OF BRAZIL COUNTRY RISK REGIME SWITCHING, GIVEN THE IMPLEMENTATION OF ECONOMIC POLICY MEASURES (PANEL A) OR NOT (PANEL B)



Fuente: own elaboration.

international reserves, depreciation of the exchange rate and a cessation of external public debt payments.

The second period (2008Q4-2009Q2) coincides with the outbreak of the subprime crisis that affected various countries in the region. The international crisis caused a slowing of economic activity, a decline in the terms of trade and a depreciation of the currency in Argentina. During this period, fears in the financial markets increased with respect to the Argentine government's ability to meet debt and interest payment commitments maturing in 2009. Thus, although the initial disturbance was of external origin, it passed through the domestic economy, affecting fundamentals, and solvency and liquidity variables.

The third period (2012Q1-2013Q4) was characterized by the application of economic policy measures, the most important ones being those related to renationalization of a majority share in the oil company Repsol YPF, foreign currency controls on domestic operations (mainly in the real estate sector) and the reduction of foreign currency hoarding by residents.

With respect to the coefficients, those for debt and the exchange rate cease to be significant in regime H. The most important changes are expressed in the size of the coefficient of commodity prices and the constant term, which represent almost double and triple the estimates for regime L, respectively. This reflects the growing importance that agents give to this liquidity indicator in response to the drop in international reserves.

For Venezuela, the first period that took place during 1998 coincides with the collapse of the fixed exchange rate regime and capital controls implemented since 1994, and the start of a system of exchange rate bands in July 1996. In the international context, several events occured during this period, such as the Asian crisis in July 1997, the Russian crisis of 1998 and the fall of international oil prices to historically low levels.

During the second period (2002Q1-2003Q2), important events such as the attempted coup d'état of April 2002 and the subsequent oil strike in December of the same year, which had economic and political repercussions. In the economic field, the substantial fall in international reserves led to the application of a new fixed exchange rate regime and capital controls.

The third and final period (2005Q3-2013Q4) was characterized by high risk premia deriving from domestic events such as socialist economic initiatives (nationalization of private companies: steelmakers, cement producers, and food processing firms, among others). In the international context, 2008 saw the default of Ecuador and the subprime crisis, which led to a contraction in the global economy, significant market volatility and a decline in oil prices. All the aforementioned considerably increased Venezuela's risk premium.

In regime H, Venezuela maintains its atypical behavior; all the variables are significant, except GDP and the exchange rate. It should be mentioned that the external debt and international reserves in regime L are not significant, while in this regime the former of these is the variable with the largest coefficient. The absolute values of the coefficients for the VIX and for commodities are smaller than in regime L. The behavior of Venezuela's sovereign default risk obeys to the specific characteristics of an oil economy, in periods of low uncertainty agents focus on oil prices and international market volatility to form their risk perceptions, while in periods of high uncertainty they consider other variables, besides those mentioned early.

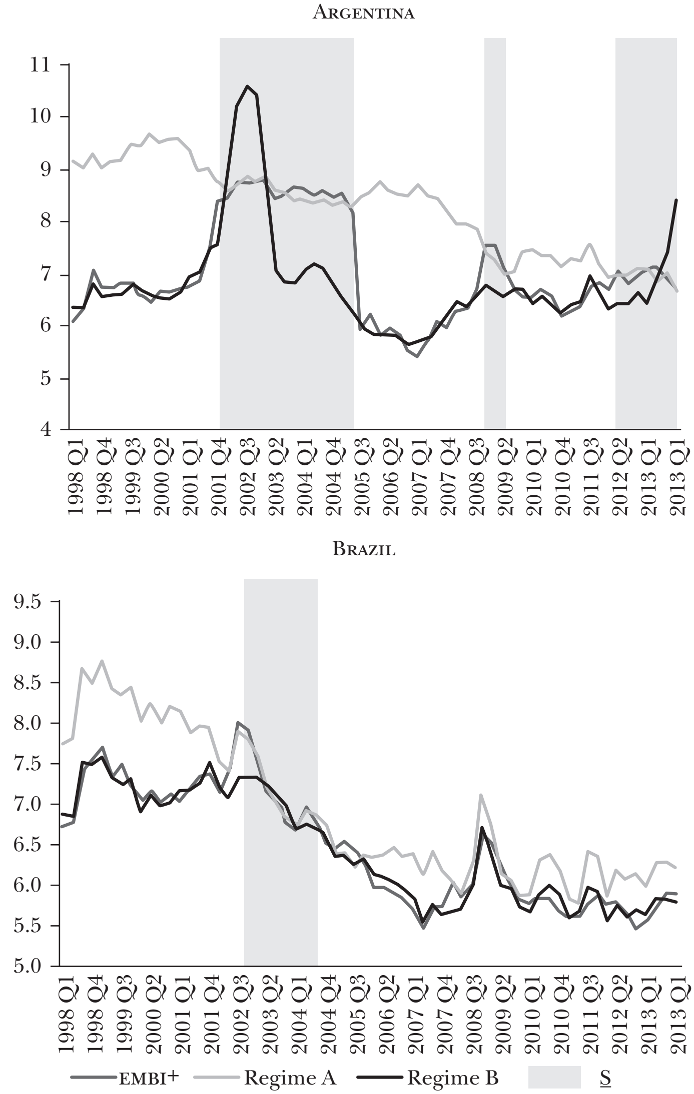
For Argentina and Venezuela, where the high uncertainty regime is associated with domestic events, the coefficient of the VIX decreased compared to those of the regime L in both cases. Regarding the solvency and liquidity group of variables, only the coefficientes of oil prices for Venezuela and debt for Argentina decreaseor lose their significance, the others increase their weight or remain the same. In Argentina's case, although two different measures of inflation were used, none of them were significant, regardless of the regime. The same was also observed for Venezuela.

The results obtained allow extracting some characteristics that are common to all the economies. In general terms, the results suggest that a change of regime in the relation between country risk and its determinants depends on the origin of the uncertainty. If the uncertainty's source is associated with external shocks (such as international crises), financial market volatility gains relevance, whereas the solvency and liquidity variables

Figure 3

MARKOV REGIME SWITCHING BY COUNTRY

(1998Q1-2013Q4)

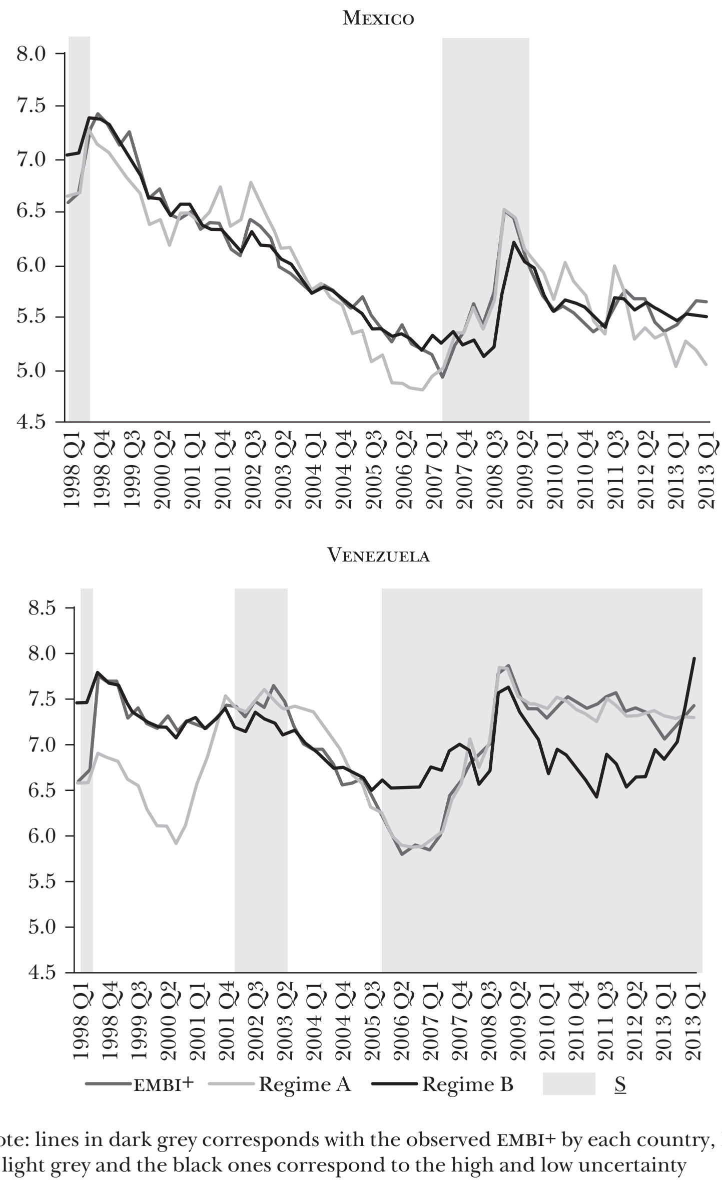


Note: lines in dark grey corresponds with the observed EMBI+ by each country, lines in light grey and the black ones correspond to the high and low uncertainty regimes, respectively. Shaded area is associates to high uncertainty and allows observing the regime switching easily.
Source: own elaboration.

Figure 3 (cont.)

MARKOV REGIME SWITCHING BY COUNTRY

(1998Q1-2013Q4)



Note: lines in dark grey corresponds with the observed EMBI+ by each country, lines in light grey and the black ones correspond to the high and low uncertainty regimes, respectively. Shaded area is associates to high uncertainty and allows observing the regime switching easily.
Source: own elaboration.

are less relevant.While, if the triggers of uncertainty are of domestic origin, the latter are the key variables.

On the other hand, to assess the robustness of the base model, alternative models were estimated that took into consideration other control variables such as the degree of openness, government effectiveness, political stability/absence of violence and regulatory quality. The first is measured as the ratio between total imports plus total exports and GDP, while the rest of them are indexes prepared by the World Bank.

The model specificationthat includes degree of openness is the same as in the baseline model, but excludes the ratio of international reserves to imports and the external debt as a percentage of GDP because of problems of collinearity. The results of the estimation of this model are shown in Table 2 of the Annex. It can be seen that the model is robust after this variable is incorporated given that the regime changes registered and the majority of the parameters do not change significantly compared to the baseline model. This measure of openness was significant for Argentina and Brazil, with a positive sign in regime H and a negative one in regime L for both countries. This indicates that the more open these economies are during periods of high uncertainty, the more sovereign default risk is affected due to fears of contagion.

With respect to the other variables considered for estimating the alternative models, none of them were significant except for government effectiveness in the case of Argentina in regime H, with a negative sign as would be expected.

The model estimated allows for sovereign default risk elasticities to be derived with regard to their determinants in each regime. By simulating percentage increases in the respective exogenous variable, the resulting percentage variations in the endogenous variable are counted in order to obtain the desired elasticity. These elasticities, shown in Table 3 of the Annex, are useful for elaborating policies aimed at mitigating the impact of crises on sovereign default risk. The Table shows, for instance, how an increase of 1% in the exchange rate leads to an increase of 0.49% in sovereign default risk for the case of Mexico in the low uncertainty regime.

6. CONCLUSIONS

The results of this research point to the fact that the relation between sovereign default risk and its determinants for the countries considered has been disturbed by different types of events. In the international context, these events are related to the economic and financial crises that occurred during the study period: Russian crisis, Argentine debt crisis and the subprime crisis. In the domestic environment, these events are linked to macroeconomic imbalances, political instability and socialconflicts. The nonlinearity associated with this behavior was captured by estimating a Bayesian Markov-switching SUR model. This methodology allowed two independent regimes to be identified for each country.

The first regime, named regime L (*low uncertainty*), is related to periods of stability, economic growth and favorable international conditions. The second, regime H (*high uncertainty*), temporarily coincides with periods of international and domestic turbulence.

The results suggest that in the period of high uncertainty, agents give more importance to some key variables for forming their risk expectations. Such variables depend on the causes of the uncertainty. If the source of uncertainty is associated with external events, such as international crises, financial market volatility becomes important, such as in the case of Mexico and Brazil. If the triggers of uncertainty are of domestic origin, the key variables are the liquidity and solvency indicators of the country in question, as observed in Argentina and Venezuela. In the case of Venezuela, the results coincide with the findings of Acosta, Barráez and Urbina (2014), despite the differences with respect to the frequency of the statistical data used.

It should be pointed out that the subprime crisis is the only common event in regime H for all the economies, except Brazil, in whose case the relation between sovereign default risk and its determinants remained stable in regime L as a result of effective economic policy measures (mainly monetary and fiscal).

Annex A

Table 1

RESULTS OF ESTIMATES FOR THE BASE MODEL

Country	Coefficient	Regime H: *Posterior mean*	Regime H: *Posterior 90% confidence bands*	Regime L: *Posterior mean*	Regime L: *Posterior 90% confidence bands posterior*
Argentina	Constant	13.5524	(12.52;14.57)	7.19	(4.36; 10.01)
	GDP	–	–	–	–
	IR/I	–	–	−0.28	(−0.40; −0.14)
	ED/GDP	–	–	2.85	(2.31; 3.38)
	VIX	0.38	(0.27; 0.49)	0.46	(0.37; 0.54)
	Treasury Bill	0.21	(0.16; 0.26)	−0.15	(−0.17; −0.12)
	IPMP	−1.35	(−1.46; −1.23)	−0.64	(−0.86; −0.41)
	ER	–	–	2.29	(1.66; 2.91)
Brazil	Constant	5.81	(2.40; 9.07)	7.95	(7.76; 8.13)
	π	–	–	3.23	(2.27; 4.22)
	GDP	–	–	−1.21	(−1.91; −0.51)
	IR/I	−0.21	(−0.31; −0.11)	−0.22	(−0.24; −0.20)
	ED/GDP	–	–	2.24	(1.53; 2.96)
	VIX	0.66	(0.41; 0.92)	0.27	(0.23; 0.31)

	Treasury bill	–	–	−0.06	(−0.07; −0.05)
	IPMP	−0.60	(−0.89; −0.29)	−0.59	(−0.62; −0.56)
	ER	0.66	(0.38; 0.93)	0.28	(0.18; 0.38)
Mexico	Constant	4.98	(3.78; 6.19)	4.44	(4.23; 4.66)
	π	–	–	3.77	(3.06; 4.49)
	GDP	–	–	−1.15	(−1.75; −0.56)
	IR/I	−0.88	(−1.41; −0.36)	−0.31	(−0.42; −0.19)
	ED/GDP	1.78	(0.58; 3.01)	3.18	(2.82; 3.53)
	VIX	0.85	(0.65; 1.05)	0.36	(0.30; 0.41)
	Treasury bill	−0.10	(−0.14; −0.06)	0.03	(0.02; 0.04)
	IPMP	−0.41	(−0.59; −0.24)	−0.30	(−0.34; −0.26)
	ER	–	–	0.49	(0.31; 0.66)
Venezuela	Constant	7.37	(7.01; 7.71)	6.24	(5.80; 6.67)
	GDP	–	–	–	–
	IR/I	−0.18	(−0.26; −0.10)	–	–
	ED/GDP	0.82	(0.40; 1.23)	–	–
	VIX	0.31	(0.25; 0.34)	0.56	(0.46; 0.66)
	Treasury bill	−0.31	(−0.32; −0.29)	0.03	(0.007; 0.04)
	IPMP	−0.29	(−0.33; −0.24)	−0.44	(−0.49; −0.37)
	ER	–	–	0.24	(0.11; 0.36)

Table 2

RESULTS OF ESTIMATIONS FOR THE MODEL INCORPORATING DEGREE OF OPENNESS

		Regime H		***Regime L***	
Country	*Coefficient*	*Posterior mean*	*Posterior 90% confidence bands*	*Posterior mean*	*Posterior 90% confidence bands*
Argentina	Constant	13.42	(12.81; 14.04)	9.54	(8.47; 10.57)
	GDP	–	–	–	–
	VIX	0.36	(0.25; 0.48)	0.8	(0.71; 0.89)
	Treasury bill	0.22	(0.17; 0.28)	−0.18	(−0.20; −0.16)
	IPMP	−1.47	(−1.61; −1.34)	−0.95	(−1.18;− 0.71)
	ER	−0.1	(−0.19; −0.01)	1.04	(0.20; 1.88)
	Degree of openness	1.01	(0.01; 2.02)	−2.83	(−3.83; −1.84)
Brazil	Constant	4.23	(3.32; 5.13)	6.46	(6.03; 6.90)
	π	–	–	8.09	(5.55; 10.61)
	GDP	–	–	–	–
	VIX	1.12	(0.91; 1.32)	0.33	(0.25; 0.40)
	Treasury bill	−0.08	(−0.12; −0.04)	0.03	(0.008; 0.04)
	IPMP	−0.35	(−0.57; −0.11)	−0.51	(−0.59; −0.41)
	ER	0.53	(0.27; 0.80)	0.32	(0.10; 0.53)
	Degree of openness	3.76	(0.00; 7.70)	−1.54	(−2.77; −0.32)

Mexico	Constant	4.87	(3.70; 6.06)	4.83	(4.52; 5.11)
	π	9.27	(6.10; 12.31)	8.93	(7.94; 9.86)
	GDP	-	-	−0.94	(−1.67; −0.22)
	VIX	0.41	(0.27; 0.55)	0.54	(0.46; 0.60)
	Treasury bill	−0.08	(−0.12; −0.04)	0.01	(0.00; 0.02)
	IPMP	-	-	−0.44	(−0.53; −0.34)
	ER	0.82	(0.28; 1.37)	-	-
	Degree of openness	-	-	-	-
Venezuela	Constant	7.88	(7.61; 8.13)	5.73	(5.17; 6.30)
	GDP	-	-	-	-
	VIX	0.25	(0.19; 0.30)	0.69	(0.55; 0.81)
	Treasury bill	−0.33	(−0.34; −0.31)	0.02	(0.00; 0.04)
	IPMP	−0.38	(−0.44; −0.31)	−0.41	(−0.53; −0.29)
	ER	-	-	0.26	(0.09; 0.43)
	Degree of openness	-	-	-	-

Table 3

COUNTRY RISK ELASTICITIES RELATIVE TO THEIR DETERMINANTS

Country	*Variable*	*Percentage change of EMBI + after a 1% increase in the variable* — *Regime H*	*Regime L*
Argentina	GDP	–	–
	Ir/I	–	−0.28
	D/GDP	–	0.93
	VIX	0.38	0.46
	Treasury bill	0.02	−0.01
	IPMP	−1.35	−0.63
	ER	–	2.32
Brazil	CPI	–	3.23
	GDP	–	−1.21
	Ir/I	−1.06	−1.28
	D/GDP	–	0.41
	VIX	0.66	0.26
	Treasury bill	-	−0.004
	Brent	−0.61	−0.58
	ER	0.66	0.28

Mexico	CPI	–	3.76
	GDP	–	−1.15
	Ir/I	−1.42	−0.50
	D/GDP	0.75	1.34
	VIX	0.85	0.35
	Treasury bill	−0.01	0.003
	Brent	−0.41	−0.29
	ER	–	0.49
Venezuela	GDP	–	–
	Ir/I	−0.17	–
	D/GDP	0.14	–
	VIX	0.31	0.56
	Treasury bill	−0.02	0.002
	Brent	−0.29	−0.43
	TC	–	0.24

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