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Article

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What are the main variables that influence the dynamics of Ecuador's sovereign risk?

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ABSTRACT

This paper analyzes the determinants of Ecuador's sovereign spreads as measured by the EMBI index. We use Bayesian algorithms to estimate a structural vector autoregressive model with three blocks (international, regional, and domestic). Global variables drive most of the dynamics of the Ecuadorian EMBI, also influenced by the evolution of sovereign risks in other Latin American countries like Chile and Peru. We likewise show that the increase in public debt is the primary domestic variable affecting the Ecuadorian EMBI.

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EMBI; Blocked SVAR; International market; Spillover effect

1. Introduction

This study aims to identify the main variables that determine the dynamics of the interest rate spread of international bonds issued by the Ecuadorian sovereign. It uses the Emerging Markets Bonds Index (EMBI) or country risk to understand the determinants of the cost of Ecuador's public debt. In principle, the EMBI is the interest rate premium over U.S. bonds that investors will demand to invest in Ecuador's sovereign bonds. Therefore, it is usually interpreted as a measure of the country's level of sovereign risk (Longstaff et al., 2011).

Upon adopting the U.S. dollar as Ecuador's legal tender in the year 2000, the authorities gave up the use of monetary and exchange rate policies as instruments for macroeconomic stabilization. At this point, fiscal policy became the main macroeconomic policy over which the government maintained some level of discretion; partially constrained by a succession of fiscal rules adopted over the past two decades (see Camino-Mogro & Brito-Gaona, 2021; Cueva et al., 2018; SRI, 2012).

Ecuador's level of fiscal spending has been primarily constrained by the government's capacity to raise revenues. In this context, over the past decades, the government has attempted to increase tax collection through various fiscal reforms and institutional revenues (Carrillo-Maldonado, 2017). However, authors such as Cueva et al. (2018) or de la Cruz et al. (2020) indicate that the level of taxes collected in Ecuador has persistently remained below the Latin America average. This suggests a more ambitious domestic

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revenue mobilization strategy may be needed going forward. Oil revenues have amounted to close to 27 percent of total public spending between 2000 and 2019, determined by relatively stable production and highly volatile prices. The oscillations of international oil prices are crucial to understanding the Ecuadorian business cycle and recent episodes of macroeconomic instability (see Carrillo-Maldonado & Díaz-Cassou, 2019; Cueva & Diaz, 2018; Díaz-Cassou & Ruiz-Arranz, 2018).

The other source of resources to sustain public spending has been public debt obtained from multilateral and bilateral sources, banks, and institutional investors. Illustrating the growing relevance of this last source of financing, between 2014 and 2019, Ecuador's stock of international bonds has increased from 13% to 38% of the total debt (Ministerio de Economía y Finanzas, 2020a). The main advantages of sovereign bond issues vis-a-vis the other source of finance are the depth of global financial markets and that these resources are not directly linked to specific investment projects or the implementation of a given reform. This has allowed greater flexibility in the execution of the budget.

The growing relevance of bonded debt justifies analyzing the determinants of Ecuador's sovereign spreads conducted in this paper. We build on other early contributions, such as Hilscher and Nosbusch (2010) or Comelli (2012). These contributions have already tried to identify the determinants (or fundamental variables) that explain the dynamics of the EMBI in emerging and developing countries. This paper is related to Del Cristo and Gómez-Puig (2017). They indicate that the country's risk of having a dollarized economy (Panama and Ecuador) shows a more stable dynamic than other Latin American economies such as Argentina or Brazil. Moreover, their results suggest that international factors are more important than national variables when explaining the variation of sovereign spreads.

To the best of our knowledge, no empirical contributions have yet tried to identify "al" domestic and international variables that determine the dynamics of the Ecuadorian EMBI. Díaz-Cassou and Ruiz-Arranz (2018) show qualitatively that the global oil price (West Texas Intermediate, WTI) is the main variable explaining Ecuador's country risk evolution. Del Cristo and Gómez-Puig (2017) use a vector autoregressive model with a correction equation, concluding that public debt is the most important domestic determinant of sovereign spreads in Ecuador. However, they only include four domestic variables in their specification. Our paper contributes to the literature by expanding to 21 the set of variables included in the analysis, including most of the factors identified in other contributions on the determinants of country risk.

Another contribution of this paper is our empirical strategy. Given that Ecuador is a small open economy, we build structural autoregressive vectors (SVAR) with blocks of variables. International and domestic variables are included in the SVAR model, following the literature mentioned above. The national variables do not affect the global factors (neither the contemporary nor lagged ones). The EMBI of other Latin American countries is also added to assess the relevance of contagion or spillover effects in Ecuadorian economy. By contrast, global VAR (GVAR) models, such as Favero (2013) or Temizsoy and Montes-Rojas (2019), allow for the interdependence of all variables among the countries included in the analysis. We use Bayesian econometrics to estimate this medium SVAR (21 variables), which allows us to obtain better estimates than the frequentist approach (see Chan, 2020; Karlsson, 2013; Koop & Korobilis, 2010).

The rest of the paper is structured as follows. Section 2 sketches a short history of the Ecuadorian public debt and the relationship between interest rate and the EMBI. Section 3 presents our methodology. Section 4 shows the main results of our estimations. Finally, section 5 concludes with the main takeaways of our analysis on the dynamics of the Ecuadorian EMBI.

2. Ecuadorian public debt and the EMBI

Ecuador's first sovereign bond issuance dates back from 1889, and was aimed at raising resources for the construction of the railroad (Acosta, 2006) .[1] Throughout its history, the Republic of Ecuador has defaulted or restructured its bonded debt on various occasions. For instance, in 1999, Ecuador became the first country ever to default on Brady bonds, themselves the product of another debt restructuring (Díaz-Cassou et al., 2008).

Another notorious debt event was that of 2008 when the government announced that it would suspend the servicing of two global bonds because these obligations were "odious, illegitimate and illegal".[2]This announcement led to a sharp reduction in the value of these two bonds in secondary markets and the EMBI exploded to a value of over 4000 points (see Figure 1); enabling the government to repurchase them at a steep discount (the equivalent of a 30 percent cut in face value terms). However, the 2008 debt event expelled Ecuador from international financial markets. It was not until 2014 that a new sovereign issuance could be placed. Since then, the participation of sovereign bonds issued internationally over total debt gradually increased, reaching a peak of 38 percent in 2019. The last reprofiling took place in 2020. It aimed to restore the sustainability of Ecuadorian public debt after the prolonged financial crisis that began with the end of the commodity super-cycle. However, it was aggravated by the COVID-19 pandemic (Ministerio de Economía y Finanzas, 2020b). These events have caused the Ecuadorian EMBI to be one of the highest and one of the most volatile in Latin America (see Figure 1).

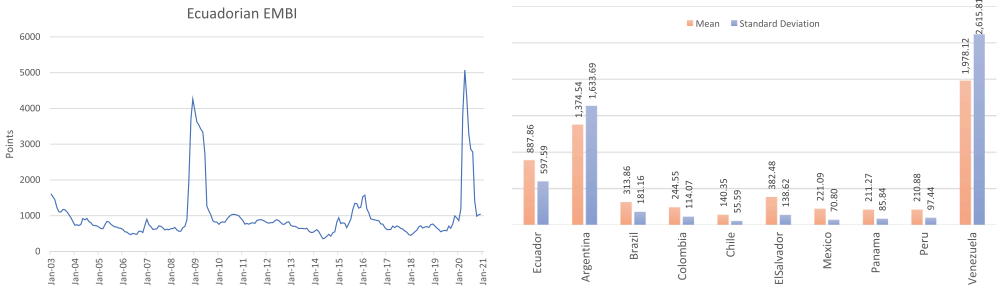

Figure 1. Evolution of Ecuadorian EMBI and comparison with other Latin American countries.

[1]However, upon the foundation of the Republic, Ecuador "inherited" bonded debt from the Gran Colombia, which was issued to repay Great Britain for its support during the independence war.

[2]For more details about this concept, see Sack (1927) and the different cases on the website https://www.cadtm.org/.

The EMBI index tracks the performance of emerging markets sovereign debt instruments in secondary markets. It is calculated as a spread over comparable (and presumably risk-free) U.S. government debt securities. Therefore, the EMBI is commonly used as a proxy for the level of sovereign risk perceived by international investors in a particular country (or emerging market debt as an asset class). As such, at each specific point in time, the level of the EMBI index is expected to be correlated with the interest rate at which a country could issue new securities. Figure 2 shows a positive relationship between the cost of new bond issuances and Ecuador's EMBI. This relationship is observed with the average country risk both one week and one month before the new allocation. This implies that gaining a better understanding of the determinant of its EMBI will help us shed some light on the drivers of the cost of finance for the Ecuadorian sovereign.

Note: The graph shows the nominal bond interest rate since 2014, and the daily average of the EMBI in a week and a month before the bond issue (excluding Saturday and Sunday). The labels present the contract year and maturity of the bond. Also, bonds issued by oil companies are not considered.

The literature has distinguished between "push" and "pull" determinants of the financial cost of sovereign bonds. The first set of variables is associated with external conditions. For instance, Del Cristo and Gómez-Puig (2017), Longstaff et al. (2011), Ordoñez-Callamand et al. (2017), and Presbitero et al. (2016) use variables to capture the performance international financial and commodity markets. Meanwhile, other studies such as Hilscher and Nosbusch (2010), Longstaff et al. (2011), and Uribe and Yue (2006) use other variables to capture U.S. Federal Reserve monetary policy stance. Finally, Comelli (2012),and Hilscher and Nosbusch (2010) use variables that capture financial markets' volatility. These variables also are most important to explain the business cycles of developing countries (see Carrillo-Maldonado & Díaz-Cassou, 2019; Fernández et al., 2017). In addition, these external factors are associated with the global financial cycle, which denotes fluctuations in financial activities such as the prices of risky assets, the increase in credit levels, gross capital flows, and the leverage of financial intermediaries worldwide. This financial cycle could also be affected in a certain way by the US monetary policy since a monetary contraction in this country leads to a considerable reduction in the leverage of global financial intermediaries, as well as an increase in aggregate risk aversion (see S. Miranda-Agrippino & H. Rey, 2020b).

In turn, pull determinants are country-specific characteristics, such as economic activity, or fiscal variables such as expenditure or levels of public debt (Comelli, 2012;

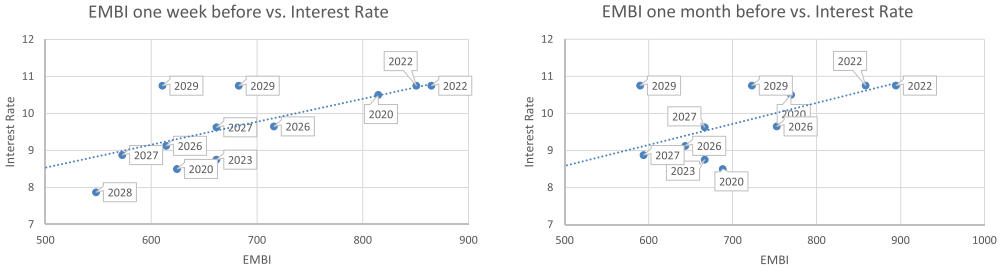

Figure 2. Relationship between interest rate and EMBI of Ecuador. Source: Bloomberg.

Fracasso, 2006; Hilscher & Nosbusch, 2010; Presbitero et al., 2016). In addition, a number of studies use variables to capture the external position, as the current account balance, the terms of trade, or the level of international reserves, which are particularly relevant for developing and emerging economies (Hilscher & Nosbusch, 2010; Presbitero et al., 2016). Meanwhile, Gómez-Puig et al. (2014) also uses private banks' leverage. Some researchers explain that these variables capture the dynamic of the country risk, however the historical defaults of (external) sovereign debt and (long-run) macroeconomic volatility explain the level of the EMBI (see Reinhart et al., 2003; C. M. Reinhart & K. S. Rogoff, 2004, 2009).

Various studies, such as Presbitero et al. (2016), and Comelli (2012), find that institutional and political variables can also influence developing countries' EMBI. Among the institutional variables that could be used, the authors see government effectiveness, institutional stability, the quality of the bureaucracy, or various socio-economic conditions. On the political front, the find democratic accountability, internal and external conflicts, the level of corruption, or religious tensions.

3. Methodology

We implement a structural vector autoregressive model (SVAR) to identify the main determinants of the Ecuadorian EMBI, following Karlsson (2013) and Koop and Korobilis (2010). In addition, we include a block exogeneity model to distinguish between the effects of pull and push variables, with an Independent Normal-Inverse Wishart distribution (INIW).

3.1. Structural vector autoregressive model

Following Rubio-Ramírez et al. (2010), consider the SVAR model as:

$$A_0 Y_t = A_+ X_t + \varepsilon_t, \quad \in_t \sim \mathcal{N}(0, I_n) \tag{1}$$

where Y_t is a vector of n endogenous variables, $X_t = \left[Y_{t-1}, Y_{t-2}, \ldots, Y_{t-p}, C\right]$ is the vector of retards (lags) of endogenous ($Y_{t-j}, j = 1, \ldots, p$) and deterministic variables (C, constant). A_+ is an $n \times k$ matrix of structural parameters of X_t, ε_t is a vector of structural shocks, p is the number of lags, $k = np + 1$ is the number of right-hand side variables (RHS), and T is the sample size. The $n \times n$ matrix A_0 contains the contemporaneous relationships with a recursive identification, like lower triangular matrix as:

$$A_0 = \begin{bmatrix} a_{1,1} & 0 & \ldots & 0 \\ a_{2,1} & a_{2,2} & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ a_{n,1} & a_{n,2} & \ldots & a_{n,n} \end{bmatrix}$$

Conditional on past information and initial conditions, the structural shocks follow a (Gaussian) Normal distribution with mean zero and an $n \times n$ identity matrix (I_n) as

covariance matrix. If A_0 is invertible, the reduced form of the SVAR can be defined as:

$$Y_t = BX_t + \mu_t \tag{2}$$

where $B = A_0^{-1}A_+$, $\mu_t = A_0^{-1}\varepsilon_t$, $\Sigma = E[\mu\mu'] = \left(A_0^{-1}\right)\left(A_0^{-1}\right)$ is matrix of covariance of μ. Equation (1) and Equation (2) show us that there is a relationship between reduced form parameters (B, μ) and structural parameters (A_0, A_+), that allows us to identify the structural shocks $\in_t$.

3.2. Blocks in the model

As discussed in section 2, the empirical literature has distinguished between international (*push*) and domestic (*pull*) determinants. Given that Ecuador is a small open economy model, the pull variables do not affect the dynamics of the global variables or those of developed countries (see Agénor & Montiel, 2015). Meanwhile, there is the possibility that developments in large emerging markets such as Argentina, Brazil, or Mexico impact other Latin American countries, given the size of their economy in the region. These cross-country spillover effects have been documented in past episodes of financial instability, such as the tequila crisis of the 1990s or the debt crisis in the 1980s (see Kehoe et al., 2021).

First, we include the global variables that are not expected to be affected by developments in Ecuador or other Latin American economies, the "External Block". Second, we add a block with the EMBI of various Latin American countries to capture potential intra-regional spillover effects, the "Regional Block". Finally, the "Domestic Block" contains the pull variables that the literature has indicated as potential determinants of the EMBI, which are not expected to affect neither the push nor the regional variables.

Equation (1) can be represented with blocks as:

$$\begin{bmatrix} A_0^{E,E} & 0 & 0 \\ A_0^{E,R} & A_0^{R,R} & 0 \\ A_0^{E,D} & A_0^{R,D} & A_0^{D,D} \end{bmatrix} \begin{bmatrix} Y_t^E \\ Y_t^R \\ Y_t^D \end{bmatrix} = \begin{bmatrix} A_+^{E,E} & 0 & 0 \\ A_+^{E,R} & A_+^{R,R} & 0 \\ A_+^{E,D} & A_+^{R,D} & A_+^{D,D} \end{bmatrix} \begin{bmatrix} X_t^E \\ X_t^R \\ X_t^D \end{bmatrix} + \begin{bmatrix} \varepsilon_t^E \\ \varepsilon_t^R \\ \varepsilon_t^D \end{bmatrix} \tag{3}$$

where E, R, D indicate the variables and parameters of the external, regional and domestic blocks. Then, Equation (3) shows that domestic variables and the EMBI of Latin American countries do not interact in the external block. We also observe that the domestic block do not affect the regional and external variables.

3.3. Identification

The main challenge of SVAR models is identifying the structural shocks that enable us to generate consistent results. In the identification, sign and zero restrictions can be imposed under different short-term and long-term (see Kilian & Lütkepohl, 2017). We

use the recursive methodology, as the A_0 matrix is presented, with the Cholesky decomposition imposing a specific ordering from the most exogenous to the most endogenous variable at time t. This identification is used for two particular reasons: i) we seek to identify the effect of all variables on the EMBI, regardless of their effect on the rest of the variables in the model, and ii) the order of the variables (a disadvantage of the recursive identification) essential for obtaining the parameters, since a change in order among a specific group of variables generates the same estimate (see Christiano et al., 1999).

However, the direct interpretation of these parameters is complicated by their multivariate nature, so we use the impulse-response functions (IRF), the forecast error variance decomposition (FEVD) and the historical decomposition with shocks (HD) of the EMBI. The first (IRF) captures the effect of structural shock j on the EMBI for period h, the FEVD presents the share of shock j in the variance of the EMBI at horizon h, and the HD shows the evolution of the EMBI based on the identified structural shocks. Kilian and Lütkepohl (2017) explain with more detail the derivation of these various SVAR tools.

3.4. Data and estimation

Our model contains monthly data between December 2006 and December 2019. The variables included in the external block are the following: the West Texas Intermediate price of oil (WTI), Morgan Stanley Capital International (MSCI)' developed markets financial index, the volatility index (VIX), and the real effective Federal Funds rate of the U.S. Federal Reserve (FED). The (regional) second block includes the country risk of Argentina, Brazil, Colombia, Chile, El Salvador, Mexico, Panama, Peru, and Venezuela. Finally, the domestic block includes oil revenues, tax revenues, public expenditure, public debt, international reserves, broad money (M2), the Non-oil Business Activity Index of the Internal Revenue Service, and the EMBI of Ecuador. These variables were transformed to the first difference of the logarithm, except for fiscal variables, international reserves, broad money (which are in percent of the nominal gross domestic product), and the FED's rate.[3]

We used the Bayesian econometrics to estimate the SVAR model with Markov Chain Monte Carlo method (MCMC) (see Karlsson, 2013). Thus, we propose that the prior distribution of reduced form parameters follow an independent Normal-Inverse Wishart distribution $INIW(\beta, V, \Sigma^{-1}, \nu)$, i.e., the parameters of matrix β (Normal) and the matrix Σ (Inverse Wishart) have independent distributions of each other (see Koop & Korobilis, 2010). This prior distribution (INIW) allows us to impose restrictions on each equation of the multivariate model, unlike other distributions such as the conjugate distribution (see Karlsson, 2013). Therefore, this prior facilitates the construction of the SVAR blocks. Then, we assign a prior distribution for the parameters as:

$$\beta \sim N(\underline{\beta}, \underline{V}) \tag{4}$$

[3]The Table A1 contains an summary statistics of the variables that include the SVAR model. The Table B1 presents the unit root test of the variables following M. W. McCracken and S. Ng (2016, 2021). Also, all variables were seasonally adjusted with X-13ARIMA-SEATS procedure.

$$\Sigma^{-1} \sim W(\underline{S}^{-1}, \underline{v}) \tag{5}$$

where β is the vectorization of B that has mean $\underline{\beta}$ and variance $\underline{V}$. Meanwhile, Σ^{-1} has a $n \times n$ scale matrix S^{-1} and degrees of freedom v. For the purpose of inference, we propose a prior distribution, where $\underline{\beta}$ is the vector 0, 10*$\underline{V}$ is an identity matrix I, $\underline{S}$ is an identity matrix I y $\underline{V}$ is $n * p$.

The INIW distribution does not allow us to obtain a convenient analytic form of posterior distribution $p(\beta, \Sigma^{-1}|Y)$ to facilate the Bayesian inference. However, we can approximate it with conditional posterior distribution $p(\beta|Y, \Sigma^{-1})$ and $p(\Sigma^{-1}|Y, \beta)$ as:

$$\beta|Y, \Sigma^{-1} \sim N(\overline{\beta}, \overline{V}) \tag{6}$$

$$\Sigma^{-1}|Y, \beta \sim W(\overline{S}^{-1}, \overline{v}) \tag{7}$$

where:

$$\overline{V} = (\underline{V}^{-1} + (I \otimes X)'\Sigma^{-1}(I \otimes X))^{-1}$$

$$\overline{\beta} = \overline{V}(\underline{V}^{-1}\underline{\beta} + (I \otimes X)'\Sigma^{-1}y)$$

$$\overline{S} = \underline{S} + (Y - BX)'(Y - BX)$$

$$\overline{v} = T + \underline{v}$$

We used the Gibbs sampler to approximate the posterior distribution of the SVAR parameters. We simulated sequentially with 11,000 draws and we discard 1,000, as burning draws, to eliminate the initial value effect. Formally, we implemented the following algorithm:

(1) Set the initial values of β, V, Σ^{-1} and V
(2) Generate the parameters of Equation (6)
(3) Generate the variance based with Equation (7)
(4) Repeat the second and third steps to obtain 11,000 draws

With the last 10,000 iterations (after burn-in draws) we obtain the matrix A_0, which determines the contemporaneous relationship between the variables, based on the Cholesky decomposition of matrix $\Sigma = \left(A_0^{-1}\right)\left(A_0^{-1}\right)$. As mentioned, the order of the variables is from the most exogenous (WTI) to the most endogenous (EMBI),

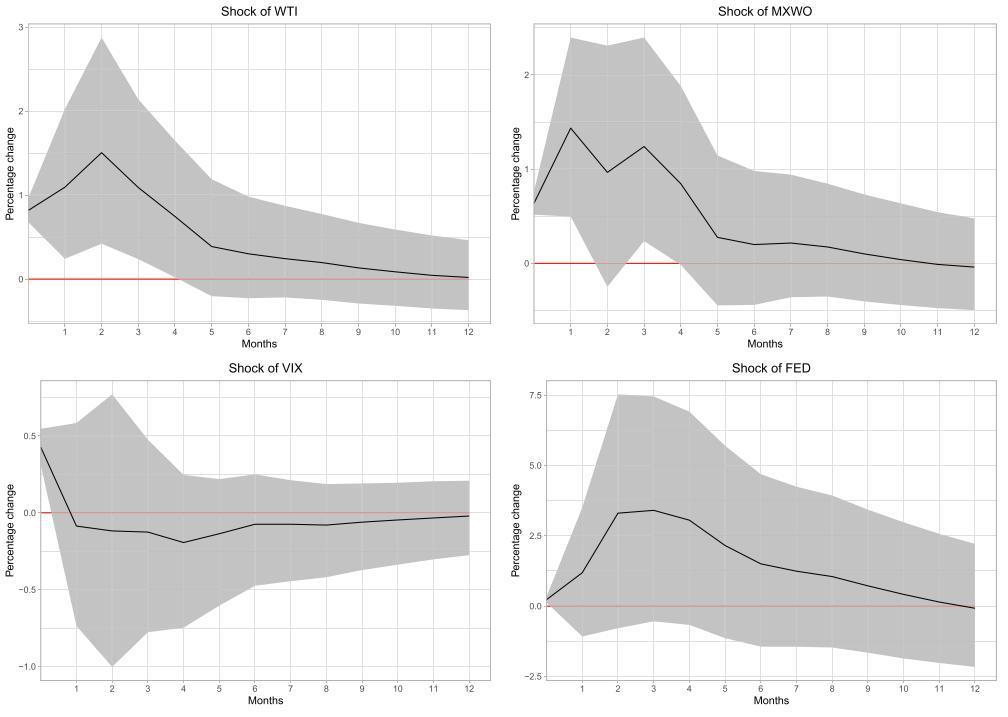

Figure 3. Effect of an external variable on EMBI. Note: The solid line depicts a posterior point-wise median response of EMBI. The shaded area represent the 68 percent equal-tailed point-wise posterior probability bands.

considering the external, regional and domestic blocks of Equation (3). We obtain the median for the point estimate as the 68 percent point-wise probability bands to confidence interval.

4. Main results

This section presents the impulse-response function, the forecast error variance decomposition, and the historical decomposition of the SVAR model with three blocks. As mentioned, we use an Independent Normal-Independent Wishart before estimating the model, which allows us to add restrictions in the external, regional, and domestic blocks. We normalize the IRF so that the interpretation is a rise of 1% for the variables. Then, we show the FEVD and HD to understand the relevance of each variable on the variance and historical dynamic of Ecuador's EMBI. Finally, we present a robustness exercise to validate our results.

4.1. External block IRF

Figure 3 shows the impulse-response function with a fall of 1% in the international factors, except for VIX, which rises. Our estimation shows that the international oil price and the first financial index (MXWO) significantly impact Ecuador's EMBI. A reduction

of one percentage point in the international price of oil leads to an 0.8% increase in the EMBI on impact ($t = 0$), an effect that increases to 1.5% 2 months after the shock. Losing its statistical significance only after the fifth month. Meanwhile, a fall in the MXWO causes a 0.7% increase in country risk in the same month (impact) and a 1.5% increase in the following month. In addition, we observe that the international stock market volatility (VIX) shock increases country risk by 0.4%, although this effect is statistically significant only in the month of the shock. The FED rate shock appears to impact the EMBI with a marginal IRF at $t = 0$, with no statistically significant effects in the following months.

These results ratify those of Díaz-Cassou and Ruiz-Arranz (2018), emphasizing the importance of international oil prices as the crucial determinant of country risk in Ecuador. However, these authors failed to identify the relevance of the performance of global financial markets as another determinant of Ecuador's EMBI. Primarily because of the increasing financialization of the oil market in recent years (see Smyth & Narayan, 2018; Wen et al., 2019). It is fundamental to recognize that the MXWO and WTI shocks may have large statistically significant cumulative effects both in the short and in the medium-term. Our results are also in line with papers such as Longstaff et al. (2011) or

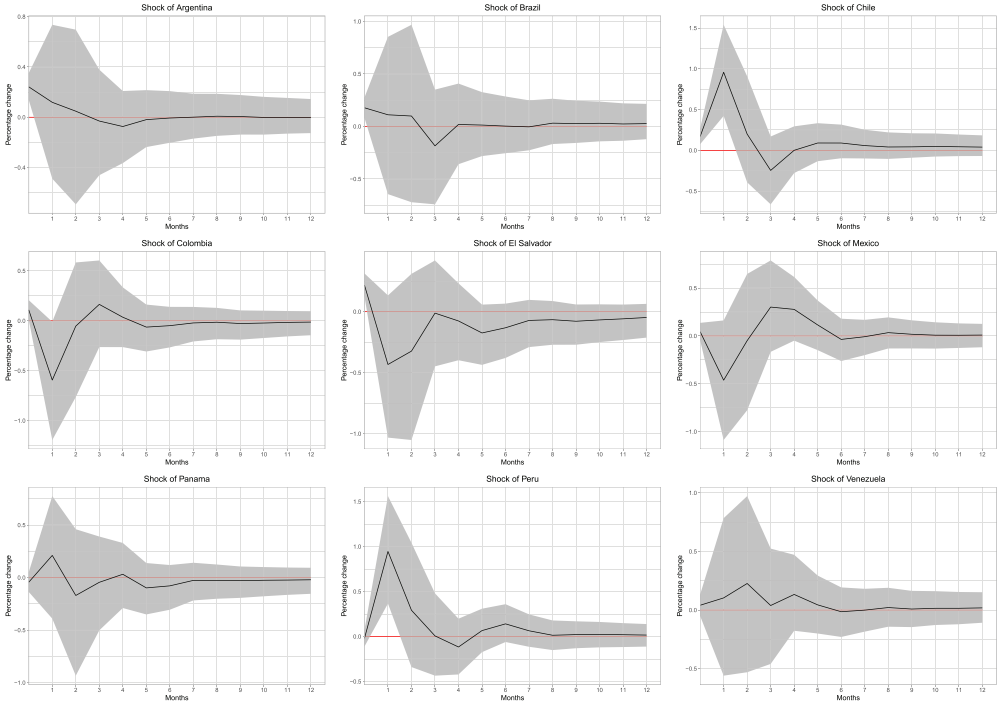

Figure 4. Effect of countries on EMBI. Note: The solid line depicts a posterior point-wise median response of EMBI and the shaded area represent the 68 percent equal-tailed point-wise posterior probability bands.

Comelli (2012), which highlight the importance of international factors or *push* variables in conditioning country risk dynamics.

4.2. Regional block IRF

We include the country risk of Argentina, Brazil, Colombia, Chile, El Salvador, Mexico, Panama, Peru, and Venezuela to identify intra-regional spillover effects.[4] Figure 4 presents the impulse-response functions for a rise of 1% in the EMBI of these economies.

Only the largest Latin American emerging markets (Brazil, Argentina, Peru, and Chile) appear to generate spillover effects on the Ecuadorian EMBI. Indeed, a 1 percent increase in their country risk causes a rise between 0.2% and 0.3% in Ecuador's EMBI in the impact period ($t = 0$), However, this effect appears to fade away relatively fast. The two that have a more substantial impact on Ecuador's EMBI are Chile and neighboring Peru. Moreover, this effect is observed both on impact and 1 month after the shock. Meanwhile, despite being another neighboring country, the Colombian EMBI is not found to have a statistically significant effect on Ecuador's country risk dynamics. Interestingly, despite the small size of its economy, we observe that a shock on El Salvador's country risk increases Ecuador's EMBI by 0.2% effect on impact ($t = 0$). A possible explanation is that El Salvador is another dollarized economy. It, therefore, could be perceived as being belonging to the same asset sub-class. The dynamics of country risk in the other countries do not seem to impact the Ecuadorian EMBI significantly.

4.3. Domestic block IRF

Unlike the global and regional variables analyzed before, the government can be expected to retain some influence over domestic variables. Therefore, the domestic block is particularly relevant from an economic policy perspective. This section presents the IRFs for Ecuador's domestic variables, interpreting the shocks as being triggered by a deterioration in the variable under analysis (for example, a fall in economic activity or an increase in public debt). Moreover, it should be noted that these shocks represent unexpected changes in the variables of interest, always controlling by international and regional effects.

The only fiscal variable that appears to have a significant impact on Ecuador's EMBI is the level of public debt. This impact reaches a peak of 1.7% in the first month after the exogenous shock, gradually fading away and retaining its statistical significance for 1 year after the shock. Instead, neither a reduction in oil nor tax revenues appear to have a statistically significant impact on Ecuador's country risk. This same result is found for public spending (Figure 5). In other words, beyond the actual level of debt, none of the variables related with policy actions that could be expected to have a fiscal impact succeed in improving the perception of Ecuador's sovereign risk, reducing the cost of Ecuadorian bonds either in the short or in the medium-term.

The other macroeconomic variables included in the estimation were economic activity, broad money, and international reserves. An unexpected reduction in broad money increases the Ecuadorian EMBI by 1.9% effect 1 month after the shock and then dilutes. Surprisingly, we find that a fall in international reserves could also reduce country risk after the second month of the shock, an effect that persists until the eighth month.

[4]We could not include countries such as Bolivia or Paraguay because of a lack of available date for the sample period.

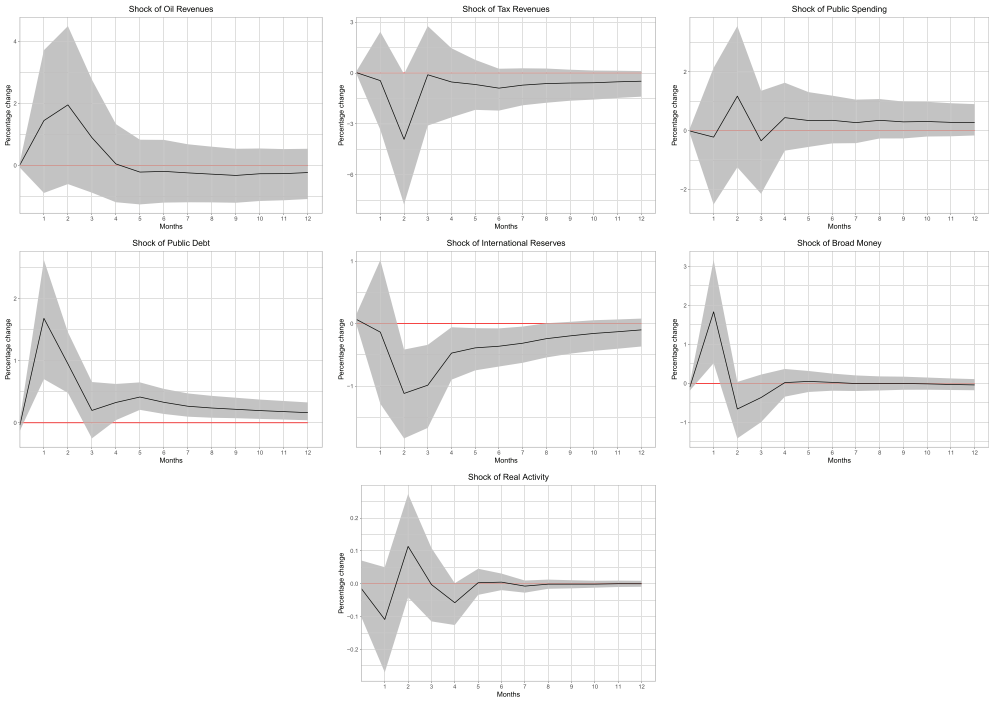

Figure 5. Effect of domestic variables on EMBI. Note: The solid line depicts a posterior point-wise median response of EMBI. The shaded area represents the 68 percent, equal-tailed point-wise posterior probability bands.

However, it is worth noting that international reserves stored at the Central Bank play a completely different role in a dollarized economy such as Ecuador. Possibly explaining why we find this counterintuitive effect. Indeed, under such a monetary regime, the entire stock of money in circulation could potentially be used to honor external obligations, which may explain why a reduction in broad money rather than a decline in international reserves increases the level of country risk perceived by the market participants. Finally, we find that economic activity has no statistically significant effect on the Ecuadorian EMBI (Figure 5).

Finally, as opposed to other papers such as that of Hilscher and Nosbusch (2010), Presbitero et al. (2016) or Uribe and Yue (2006), we find that macroeconomic variables do not have a major impact on the dynamics of Ecuador's EMBI. The only two variables that affect the EMBI are public debt (in line with Del Cristo and Gómez-Puig (2017)) and broad money. This result suggests that, beyond their aggregate level of indebtedness, the Ecuadorian authorities have limited policy tools at their disposal to contain sovereign spreads.

4.4. Variance decomposition of Ecuadorian EMBI

This subsection presents the variance decomposition of the historical dynamics of the Ecuadorian EMBI. First, we show the percentage share of all variables in the variance of

Table 1. FEVD of EMBI.

Variables	1	12	24
WTI	25.02 [18.58;31.36]	24.61 [18.67;30.64]	24.22 [18.17;30.33]
MXWO	16.7 [11.65;21.81]	16.2 [11.67;20.81]	15.96 [11.4;20.62]
VIX	6.56 [3.26;9.92]	5.69 [3.27;8.1]	5.61 [3.21;8.01]
FED	2.38 [0.63;4.13]	2.32 [1.05;3.54]	2.65 [1.22;3.95]
External Block	**50.65 [34.11;67.22]**	**48.82 [34.66;63.1]**	**48.43 [34;62.92]**
Argentina	2.78 [0.86;4.75]	4.28 [2.36;6.2]	4.19 [2.29;6.08]
Brazil	1.52 [0.26;2.76]	3.05 [1.52;4.6]	3.03 [1.49;4.58]
Colombia	0.85 [0.06;1.7]	1.91 [0.86;2.97]	1.88 [0.84;2.92]
Chile	1.32 [0.19;2.48]	4.39 [2.51;6.31]	4.3 [2.43;6.2]
El Salvador	1.86 [0.48;3.25]	2.37 [1.16;3.56]	2.35 [1.14;3.54]
Mexico	0.36 [0.01;0.71]	2.14 [0.94;3.35]	2.12 [0.93;3.33]
Panama	0.37 [0.02;0.73]	1.74 [0.79;2.66]	1.73 [0.79;2.66]
Peru	0.32 [0.01;0.62]	2.43 [1.22;3.66]	2.4 [1.2;3.61]
Venezuela	0.36 [0.02;0.72]	1.77 [0.81;2.72]	1.79 [0.81;2.74]
Regional Block	**9.75 [1.91;17.73]**	**24.08 [12.16;36.02]**	**23.8 [11.94;35.66]**
Oil Revenues	0.34 [0.01;0.68]	0.66 [0.24;1.07]	0.87 [0.29;1.32]
Tax Revenues	0.35 [0.01;0.68]	1.1 [0.32;1.66]	2.01 [0.37;2.28]
Public Spending	0.38 [0.02;0.75]	0.61 [0.21;1]	0.69 [0.23;1.11]
Public Debt	0.31 [0.01;0.6]	1.44 [0.71;2.17]	1.48 [0.73;2.22]
International Reserves	0.55 [0.03;1.11]	0.99 [0.38;1.59]	1.06 [0.4;1.69]
Broad Money	0.8 [0.06;1.57]	0.7 [0.24;1.13]	0.71 [0.26;1.14]
Real Activity	0.28 [0.01;0.54]	0.65 [0.21;1.09]	0.64 [0.21;1.07]
Domestic Block	**3.01 [0.15;5.93]**	**6.15 [2.32;9.71]**	**7.46 [2.48;10.82]**
EMBI	**36.59 [31.65;41.55]**	**20.95 [17.68;24.27]**	**20.3 [17;23.82]**

Ecuador's country risk (volatility). Then, we decompose the evolution of the EMBI by the shocks that had the highest impact between January 2007 and December 2019, namely, the shocks to the global variables.

Table 1 shows the participation of all variables in the variance of the Ecuadorian EMBI. The values in parentheses are the 16% and 84% quantiles (68% confidence interval). Global variables explain 60.65% of the variability of country risk in the first month after the shock, participation that remains stable in the medium term (48.82% after 12 months and 48.43% after 24 months). In other words, global variables account for nearly half of the dynamics of the Ecuadorian EMBI.

Within this external block, the international price of oil has the highest participation in the FEVD of the EMBI, with a weight between 24% and 25%, both in the short and medium-term. Financial variables such as the MXWO and the VIX account for approximately 16% and 6% of Ecuador's country risk. Meanwhile, the Fed's effective interest rate has marginal participation in the EMBI dynamics. Table 1 shows that the participation of all these push variables stays relatively stable in the three-time horizons considered in this analysis.

The spillover effects from other countries in the region account for less than 10% of the variability of the Ecuadorian EMBI in the first month after the shock (9.75%). After 1 year (12 and 24 months), the participation of regional variables rises to approximately 24%. In the short term (less than 1 year), the countries with the highest contribution to the FEVD of Ecuador's EMBI are Argentina (2.78%), El Salvador (1.86%), Brazil (1.52%), and Chile (1.32%). In the medium-term (more than 1 year), the order changes, with Chile (4.39%) coming to the first position, followed by Argentina (4.28%), Brazil (3.05%), Peru (2.43%), El Salvador (2.37%), and Mexico (2.14%).

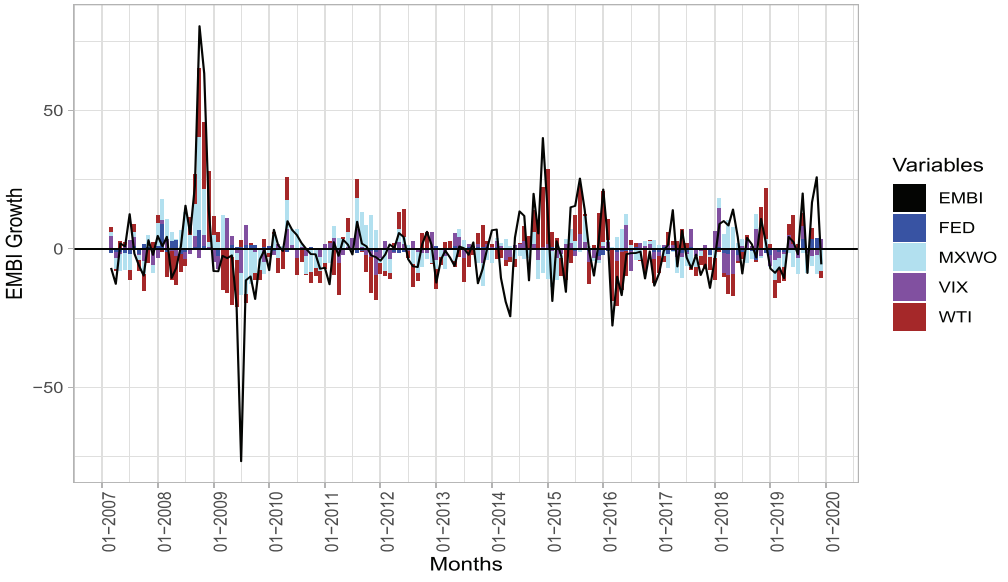

Figure 6. Historical decomposition of Ecuadorian EMBI by external variables. Note: The stacked bars depict a posterior point-wise median of the shock of external variables, and the black line represents the demeaned growth of the EMBI.

Table 1 shows that domestic variables have a minor contribution in the short term (3.01%), which increases moderately in the medium-term (6.15% and 7.46%). The only domestic variable that individually contributes to more than 1% of the variability of the Ecuadorian EMBI is public debt, taxes, and international reserves at medium run. In contrast, all the other domestic variables have a marginal contribution at all the time horizons considered in this exercise, which is in line with the results presented in the previous section.

The EMBI itself accounts for more than one-third of Ecuador's country risk (36.59%) in the first month, which then falls to 20.95% after 12 months and to 20.30% after 24 months. This may capture the effect of variables outside the economic system that we are not including in our estimations; such as political or institutional factors. In fact, papers such as Comelli (2012), Ordoñez-Callamand et al. (2017) or Presbitero et al. (2016) emphasize the relevance of these variables when analyzing the dynamics of the cost of sovereign bond debt. In this line, papers such as Fernández-Villaverde et al. (2011) or Erduman and Kaya (2016) emphasize the possibility of estimating the volatility of variables to identify whether the effect of a variable is in the level of variance. Furthermore, we make it clear that there could be other variables outside the economic system, such as institutional or political factors.

Because of the overwhelming weight of the external block variables when explaining Ecuador's country risk dynamics, we further decompose the EMBI (demeaned) based on shocks to these variables (Figure 6). This decomposition enables us to dynamically assess the relative importance of the various international variables under analysis between 2007 and 2019 (Kilian & Lütkepohl, 2017). It confirms that WTI or MXWO account for most of the variability of the Ecuadorian EMBI. Moreover, this holds even for periods in

which the Ecuadorian economy was going through its idiosyncratic shocks. For instance, early in 2009, the Ecuadorian EMBI shot upwards, which at the time was attributed to the government's decision to suspend the servicing of two of its international bonds (see section 2). Instead, Figure 6 suggests that most of this variability in Ecuador's country risk is attributable to shocks in the price of oil and global financial variables. These which were going through a highly volatile period in the context of the global financial crisis. The same can be said for the volatile EMBI dynamics observed from late 2014 onward, mainly explained by the dynamics of the international price of oil following the end of the commodity price super cycle.

4.5. Robustness check

This section shows the results of various modifications to the base model presented in section 3, an SVAR estimated with 21 variables (median model). Most of them are in the first difference of logarithm, with a partially informative prior distribution. First, we

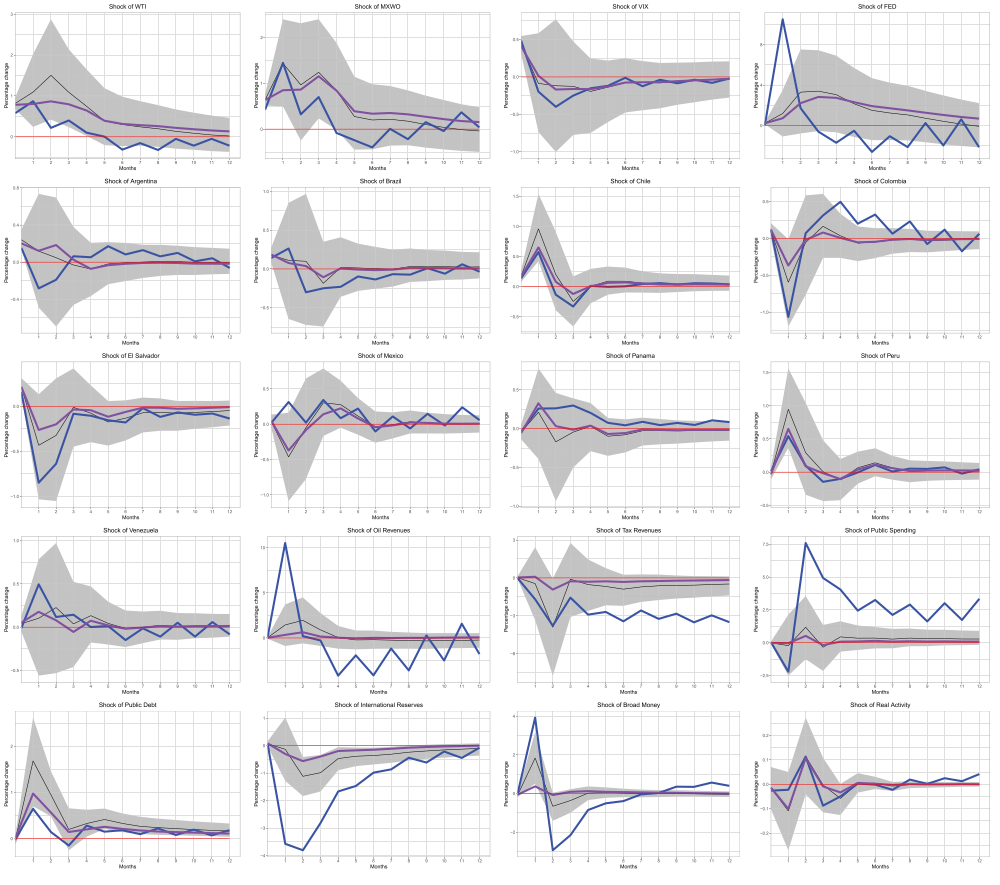

Figure 7. IRF with other priors distribution. Note: The solid line depicts a posterior point-wise median response of EMBI. The shaded area represents the 68 percent, equal-tailed point-wise posterior probability bands. The blue and purple lines show a posterior point-wise median response of EMBI with uninformative and OLS priors.

assess the sensitivity of the IRFs to changes in the prior distributions. Second, we present the results with the variables only in levels (logarithm). Third, we compare our results with those obtained using local projections, as in Jordá (2005).

One of the criticisms of Bayesian estimations is the arbitrary imposition of the prior distribution (Chan, 2020; Koop, 2003). To address it, we can modify the preceding distribution and analyze the impact that this has on the results of our estimations. To do so, we introduced two new prior distributions. The first one is an entirely uninformative prior distribution in line with Arias et al. (2018) or Uhlig (2005), i.e., initial distribution $INIW(0, I, I, 0)$. The second modification was to include the parameters estimated with the Ordinary Least Squares (OLS) methodology, in other words, prior distribution $INIW(\beta_{OLS}, 10 * I, \Sigma_{OLS}, 0)$.

Figure 7 shows the results obtained after modifying the prior distributions. For the most part, we can see that changing the priors does not substantially alter the results of our analysis. We can also see that the IRFs of the baseline model are similar to those obtained with an uninformative prior: strictly speaking, the results are statistically the

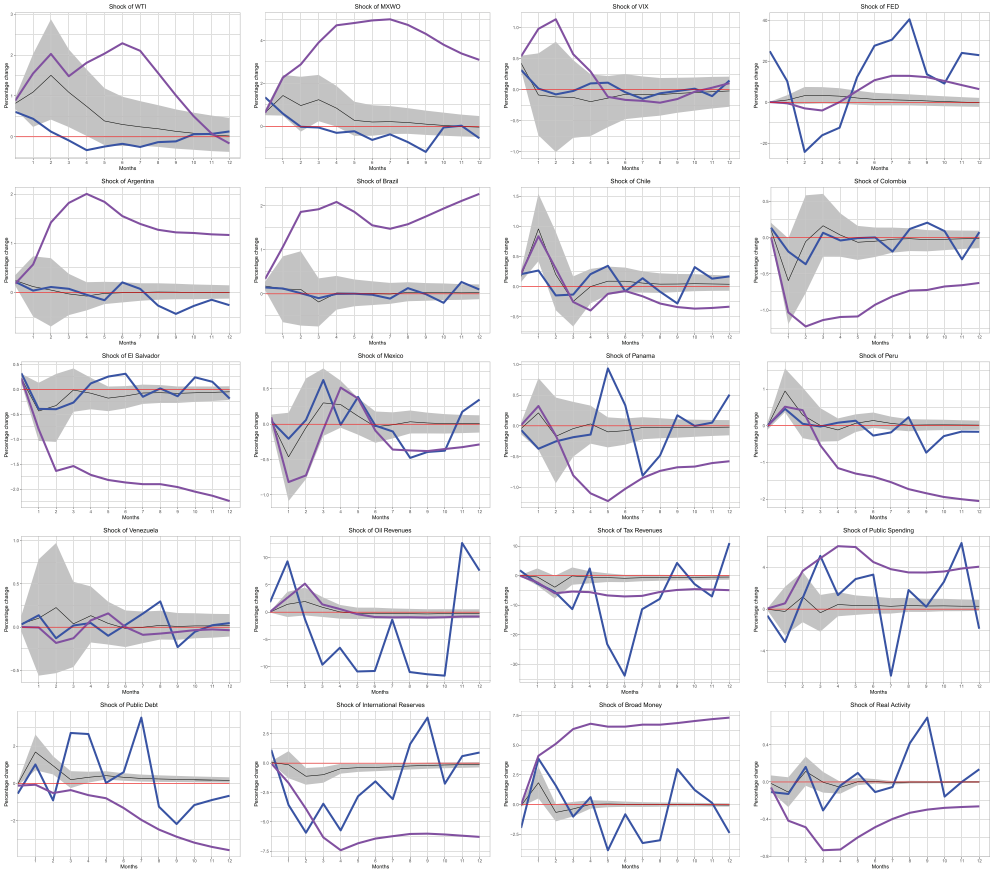

Figure 8. IRF with transformation of growth, level and local projections. Note: The solid line depicts a posterior point-wise median response of EMBI. The shaded area represents the 68 percent, equal-tailed point-wise posterior probability bands. The purple and blue lines show a posterior point-wise median response of EMBI in logarithm and local projections.

same. Meanwhile, the results with the OLS priors are also similar. Still, they have a more volatile dynamic in their median point-wise estimation. Upon focusing on individual variables, the most salient changes are related to the FED's monetary policy, the Colombian and the Mexican EMBI, tax revenues, and other domestic variables.

Our initial estimation obtained the first difference of the logarithm for most variables (e.g., oil price or EMBI). Some variables were included as a share of GDP (e.g., oil revenues or international reserves) or in levels (the Fed rate). There is some debate over the use of this type of transformations in SVAR models (see Kilian & Lütkepohl, 2017; Sims et al., 1990; Sims & Uhlig, 1991). The purple line in Figure 8 presents the results of using the variables in level or logarithm. The short-run effect of most variables is similar to that obtained with the first difference. However, a higher persistence is observed, which is in line with Caldara and Kamps (2017).

Jordá (2005) proposed the local projections methodology to generate impulse response functions similar to those of SVAR models in the short-run (see Li et al., 2021; Plagborg-Møller & Wolf, 2021). Therefore, we estimated the IRFs with local projections to ratify our results.[5] This estimation uses frequentist methods, and its results are presented in Figure 8 (blue line). The short-term effects are similar to those of our base model for most variables. However, we also identify more significant variability in the medium term (as with the OLS prior) without converging to our Bayesian estimation of the block SVAR.

5. Conclusions

This study has analyzed the determinants of the Ecuadorian EMBI, a commonly used proxy for country risk. A particularly relevant topic in the Ecuadorian context. After the full dollarization of its monetary regime in the early 2000s, fiscal policy constitutes the only macroeconomic stabilization tool under the partial control of the authorities. Moreover, since 2014, the participation of bonded debt over the total public debt has increased considerably, exposing the sovereign to shocks in the level of country risk perceived by private investors. This coincides with a period of high instability for the Ecuadorian economy.

Our contributions to the literature are twofold: First, to the best of our knowledge, this is the empirical contribution that uses a more extensive set of explanatory variables, enabling us to conduct a more granular analysis of the dynamics of Ecuador's country risk. Second, apply a novel methodological approach (using an SVAR model with external, regional, and domestic blocks) estimated with Bayesian algorithms that enable us to introduce restrictions in the model.

The most relevant result highlighted in this paper is that the external block of variables explains most of the variation observed in the Ecuadorian EMBI. More specifically, oil price is the most relevant determinant of investors' perceptions about Ecuador's country risk, followed by conditions in global financial markets. We also find that the EMBI of other Latin American countries matters too, evidencing the presence of intraregional spillover or contagion effects. By contrast, domestic developments appear to be less relevant for investors. The only domestic variable that has significant explanatory

[5]Specifically, we use the R package of local projections by Adämmer (2019).

power over the dynamics of the EMBI is the level of public debt. Moreover, this result holds even for periods in which Ecuador was going through its idiosyncratic shocks (2008–09), following the government's announcement of its decision to suspend the servicing of two international bonds.

These results have relevant policy implications. a) implying that primarily relying on international financial markets to cover fiscal needs increases the vulnerability of the Ecuadorian economy to shocks over which the authorities have very limited control. Reducing the debt stock and ensuring its sustainability appears to be the only strategy to contain the EMBI and reduce its volatility potentially. In this context, including a debt limit within the configuration of Ecuadorian fiscal rules seems to be justified if one of the objectives of this institutional setup is to improve access to private external financing.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Table A1. Summary statistics.

Variables	Tansformation	Frequency	Mean	Standard Deviation	Minimum	Maximum	Correlation with EMBI
WTI	Difference of the logarithm	Monthly	−0.0225	9.1433	−34.0730	21.8869	−0.5448
MXWO	Difference of the logarithm	Monthly	0.2684	4.0319	−26.6319	10.4318	−0.5676
VIX	Difference of the logarithm	Monthly	0.1420	18.5131	−37.9252	71.9178	0.4317
FED	Level	Monthly	1.0192	1.4208	0.0670	5.2655	0.0282
Argentina	Difference of the logarithm	Monthly	1.3457	12.4384	−24.4054	68.5865	0.4437
Brazil	Difference of the logarithm	Monthly	0.0478	10.0481	−20.6765	53.5536	0.4984
Colombia	Difference of the logarithm	Monthly	−0.0300	11.3466	−24.9793	64.9867	0.5336
Chile	Difference of the logarithm	Monthly	0.3210	9.7156	−36.3627	48.9656	0.5745
El Salvador	Difference of the logarithm	Monthly	0.6310	8.7416	−16.2747	58.5411	0.5898
Mexico	Difference of the logarithm	Monthly	0.5765	9.7249	−22.2330	59.1869	0.5408
Panama	Difference of the logarithm	Monthly	−0.1721	10.7499	−26.1790	58.9407	0.5343
Peru	Difference of the logarithm	Monthly	−0.0780	11.7305	−23.6574	67.3054	0.5055
Venezuela	Difference of the logarithm	Monthly	2.7132	12.0005	−27.5802	59.9660	0.3897
Oil Revenues	Percentage of GDP	Monthly	0.8032	0.3460	0.2664	2.0501	0.0219
Tax Revenues	Percentage of GDP	Monthly	1.1067	0.1485	0.8203	1.9235	0.0484
Public Spending	Percentage of GDP	Monthly	3.0770	0.4563	1.7217	3.9151	0.0970
Public Debt	Percentage of GDP	Monthly	28.8171	11.3998	14.9378	53.3813	0.0485
International Reserves	Percentage of GDP	Monthly	4.8300	1.6327	1.7890	9.7744	0.2216
Broad Money	Percentage of GDP	Monthly	35.5793	8.6346	23.3854	51.9911	0.0170
Real Activity	Difference of the logarithm	Monthly	0.3033	4.8992	−17.6315	15.5538	−0.0155
EMBI	Difference of the logarithm	Monthly	0.1603	14.4531	−76.6837	80.4063	1.0000

Source: Bloomberg, FRED, Banco Central del Ecuador, Ministerio de Economía y Finanzas, Servicio de Rentas Internas.

Table B1. Unit Root Test.

	Modified Akaike Information Criteria			Modified Akaike Information Criteria		
Variables	No transform	Logarithm	First difference of Logarithm	No transform	Logarithm	First difference of Logarithm
WTI	−1.54	−1.13	−5.36	6.61	8.46	1.63
MXWO	0.58	0.09	−2.73	33.54	39.23	0.12
VIX	−2.16	−1.58	−2.61	2.29	2.82	2.43
FED	−1.74	−1.34	−3.49	4.40	6.67	0.59
Argentina	−0.32	−0.89	−4.60	27.15	14.55	0.06
Brazil	0.38	−0.14	−4.28	157.98	38.84	10.07
Colombia	−0.31	−0.54	−2.58	18.11	16.55	0.91
Chile	−3.15	−2.27	−5.83	0.85	3.02	0.09
El Salvador	−3.09	−2.31	−6.20	1.19	2.41	0.82
Mexico	−2.14	−1.84	−4.14	1.07	3.93	0.69
Panama	−0.92	−0.65	−4.46	6.17	12.08	0.30
Peru	−0.23	−0.36	−5.63	33.43	19.19	0.06
Venezuela	1.66	−0.11	−8.43	230.94	16.24	13.88
Oil Revenues	−2.19	−2.08	−6.58	3.42	3.52	0.18
Tax Revenues	−1.15	−1.01	−8.84	7.11	9.05	0.01
Public Spending	−0.50	−0.41	−6.39	27.77	32.82	0.17
Public Debt	−0.37	−0.54	−4.82	14.07	58.17	6.73
International Reserves	−2.24	−2.23	−4.93	2.41	1.94	0.30
Broad Money	3.44	2.70	−0.26	369.30	361.58	17.02
Real Activity	0.96	1.14	−8.16	156.56	170.12	3.25
EMBI	−2.73	−1.88	−4.58	1.10	3.00	5.60

Note: The critical values for 1%, 5% and 10% are − 2.58, − 1.94, and − 1.62 with the MAIC selection. For SIC, the critical values are 1.99, 3.26, and 4.48.