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Is the brazilian exchange rate related to country risk? An uncovered interest parity approach

¿Está vinculado el tipo de cambio brasileño con el riesgo país? Un estudio basado en la paridad descubierta de las tasas de interés

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ABSTRACT

This paper analyzes the behavior of the nominal exchange rate between the Brazilian Real and the US Dollar by adapting the theoretical approach of uncovered interest parity to verify whether country risk influences exchange rate changes. For this purpose, ordinary least squares and vector autoregressive models are estimated considering data from 2012 to 2022. Impulse-response functions and variance flexibility were complementary methods to analyze the interaction between the variables. The results suggest that the nominal exchange rate in the period was influenced by its lags and by the country risk, represented by the EMBI+, and the CDS as in the robustness test, being fundamentally affected by the influence of retrospective and prospective expectations. The difference between domestic and foreign interest rates did not prove to be effective in influencing the behavior of the exchange rate. These findings are useful for the scientific literature investigating exchange rate movements in emerging markets by providing empirical evidence for the Brazilian real and policymakers and financial market agents.

RESUMEN

Este artículo analiza el comportamiento del tipo de cambio nominal entre el real brasileño y el dólar estadounidense adaptando el enfoque teórico de la paridad descubierta de intereses para verificar si el riesgo país influye en las variaciones del tipo de cambio. Para ello, se estiman modelos de mínimos cuadrados ordinarios y autorregresivos vectoriales considerando datos de 2012 a 2022. Las funciones de respuesta al impulso y la flexibilidad de la varianza fueron métodos complementarios para analizar la interacción entre las variables. Los resultados sugieren que el tipo de cambio nominal en el período se vio influido por sus retrasos y por el riesgo país, representado por el EMBI+ y el CDS, como en la prueba de robustez, viéndose afectado fundamentalmente por la influencia de las expectativas retrospectivas y prospectivas. La diferencia entre las tasas de interés nacionales y extranjeras no resultó ser eficaz para influir en el comportamiento del tipo de cambio. Estos hallazgos son útiles para la literatura científica que investiga los movimientos del tipo de cambio en los mercados emergentes, ya que proporcionan evidencia empírica para el real brasileño y los responsables de la política económica y los agentes del mercado financiero.

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INTRODUCTION

As one of the most important macroeconomic prices in open economies and considering the structural transformations of the economy and the respective financial innovations since the 1970s, there is a vast literature on the factors that influence exchange rate movements. Among these works, those that investigate the determinants of the real equilibrium exchange rate and its implications for the economic structure of national economies, especially in developing economies, stand out. Also abundant in the scientific literature are studies that use financial approaches to explore the relationships between nominal exchange rates and interest rates, along with the respective possibilities for arbitrage and derivative strategies.

The variation in the exchange rate represents the fluctuation in the price of domestic currency measured against foreign currency, indicating the change in the structure of relative prices, which impacts sectoral and socioeconomic class gains. Particularly in developing economies, exchange rate volatility significantly affects economic stability, both through the inflationary transmission mechanism (passthrough) during periods of strong depreciation and in situations of excessive currency appreciation, which have various repercussions on real wages, business costs, export competitiveness, and more. Excessive volatility harms the business environment, compromising predictability and fostering a greater perception of risks, both at the macro and microeconomic levels (Rossi, 2016).

The price-specie flow model, developed by David Hume, was the most influential theoretical exposition of the prevailing mechanism in the International Monetary System known as the Gold Standard. Like any effective model, it adopts some simplifying assumptions, such as the absence of the role of banks and the conception of a market where only gold coins circulated. Thus, when a country incurred a trade deficit, it would automatically suffer a loss of gold and consequently experience a drop in prices. The opposite would occur in the surplus country, and the movement in relative prices would eliminate the trade imbalance (Eichengreen, 2000).

At the end of the First World War, maintaining the fixed parity of respective currencies with gold encountered a trade-off by addressing various domestic issues, such as unemployment. From this perspective, the theoretical analysis of PPP (Purchasing Power Parity) was developed by Cassel (1918) and served as a theoretical reference for the institutional design of Bretton Woods. According to Cassel (1918), in the interwar period, there were significant divergences in inflation rates among different countries, and consequently, the equilibrium exchange rates between them should converge to the level that equalizes the prices of domestic goods with the prices of goods in foreign countries. Therefore, the equilibrium exchange rate of a given country is defined by the ratio between domestic price levels and international price levels (Rossi, 2016).

From the 1960s onwards, theoretical developments concerning exchange rate issues were particularly fruitful, as they generally sought to address the urgency brought about by the exhaustion of the Bretton Woods system, the resulting flexibilization of financial regulations, the increase in capital flows, and financial innovations. The model by Mundell (1960) and Fleming (1962), known as the Mundell-Fleming model, is one of these prominent theoretical advances and has significant implications for economic policies, such as the effectiveness of fiscal and monetary policies under fixed and flexible exchange rate regimes.

In the development of open economy models, interest rates and exchange rates play a fundamental role. Various approaches in macroeconomics and international finance work with the links and relationships between these variables. Among these, the Uncovered Interest Rate Parity stands out, which adopts the hypothesis of rational expectations as its fundamental assumption (Kalemli-Özcan and Varela, 2021).

For the analysis of exchange rate behavior in emerging countries, adaptations necessarily need to be made. Generally, these countries are found to be more susceptible to exchange rate volatility due to several factors, such as a more fragile economic structure, lower diversification, and currencies with little representativeness and credibility. Moreover, these are typically countries where there is a lack of institutional consolidation that would ensure a relatively stable environment. Bernstein (1997), in analyzing the evolution of studies on uncertainty and risk, emphasizes that the volatility of various securities, stocks, or currencies highlights how often expectations are disappointed.

Indeed, it is observed that Brazil's exchange rate issue is exceptional, considering that, according to data from the Bureau of Labor Statistics Data Finder (2020), the country exhibited the highest volatility in the real effective exchange rate among a group of 60 developed and developing countries analyzed from 1997 to 2020. Moreover, in terms of nominal exchange rates, Brazil was the third most volatile country, surpassed only by Argentina and Turkey (Araújo *et al*., 2020).

Thus, this work seeks to analyze the behavior of the nominal exchange rate between the Brazilian Real and the US Dollar by adapting the theoretical approach of Uncovered Interest Rate Parity to verify whether country risk influences exchange rate changes. The chosen period for analysis is from January 2012 to December 2022, characterized as one of the most politically unstable periods in the country. The aim is to determine whether the nominal exchange rate was primarily influenced by the interest rate differential and country risk during this period, marked by high political and economic instability.

The empirical analysis was conducted in two stages. First, a multiple linear regression was estimated to verify the relationships between the nominal exchange rate, the interest rate differential between Brazil and the US, and the EMBI+ - as a robustness test, the spread of the 5-year CDS Brazil was also used, adopted as a measure of systematic risk. Subsequently, using these same series, a Vector Autoregressive Model (VAR) was estimated, which, complementarily, uses impulse-response functions to assess the influence of shocks to the variables on the exchange rate and variance decomposition to better analyze the interaction between the model's variables.

The results of the first stage of the analysis demonstrated a negative relationship between the nominal exchange rate and the interest rate differential, meaning that an increase in the internal and external interest rate differential tends to cause a reduction in the nominal exchange rate and a positive relationship between the nominal exchange rate and the risk measure. An increase in the risk measure, therefore, implies an increase in the exchange rate.

Regarding VAR, the results demonstrate that shocks in the interest rate differential lead to a reduction in the exchange rate, while shocks in the country risk cause increases in the exchange rate. This variable was shown to be highly influenced by its past values and by the risk measure, highlighting the role of both backward-looking and forward-looking expectations. Nonetheless, the interest rate differential presents a low percentage of representativeness.

These findings are valuable for the scientific literature investigating emerging markets, by providing empirical evidence on exchange rates in Brazil, as well as for policymakers, financial market analysts, and other economic agents who consider these aspects in their decision-making.

In addition to this introduction, the work comprises four more sections. Section one presents a brief theoretical foundation relevant to the topic, and section two outlines the data and econometric models used. Section three presents and discusses the results and finally, last section concludes.

I. THEORETICAL FRAMEWORK

Uncovered Interest Rate Parity (UIP) represents a central concept in Macroeconomics and International Finance, linking interest rates to expected changes in exchange rate expectations (Kalemli-Özcan and Varela, 2021). UIP is a derivation of Covered Interest Rate Parity (CIRP), initially introduced by Keynes (1924). CIRP can be described as an equation that establishes equality, neutralizing arbitrage in the international arena and serving as a reference for the formation of forward prices in the derivatives market.

The variables are known in the present as the relationships are established between the spot exchange rate, the forward exchange rate, and domestic and foreign interest rates (Rossi, 2016). Besides these characteristics, Frankel (1991) attributes CIRP to the feature of being an efficient measure of perfect capital mobility, where the differential observed would be a country risk. According to Kalemi-Özcan and Varela (2021), this reflects the degree of political uncertainty.

In studies addressing UIP, the primary focus is on confirming its empirical validity. In the international literature, the prominent work of Fama (1984) stands out, which has influenced and resonated through various publications, mainly directed at advanced and developed economies. Fama evaluated currencies from these countries and explained the existence of the "forward premium puzzle," where the exchange rate traded in the futures markets does not reflect the spot rate at a future date, due to distortions caused by currency risk premiums and the fact that the risk premium and expected depreciation rates have a negative covariance. Fama adopts the hypothesis of rational expectations and full information, known as Full Information Rational Expectations (FIRE).

Froot and Frankel (1989) assessed whether the "forward premium puzzle" arises from the risk premium and concluded that this hypothesis is not possible. According to the authors, contrary to the prevailing approach at the time, forecasting errors in future exchange rate expectations are not related to the risk premium but rather to systematic expectation errors.

Kalemli-Özcan and Varela (2021) conducted a comprehensive study, which included a sample of 34 currencies from different countries between 1996 and 2018, with 12 currencies from advanced countries and 22 from emerging countries. After analyzing the respective deviations from Uncovered Interest Rate Parity (UIP), the authors concluded that risk premiums and deviations from rational expectations and full information are intrinsically linked in emerging countries, as global investors demand compensation for excess risk related to political risk. The presence of political risk disrupts the formation of agents' rational expectations.

For Brazil, Garcia and Olivares (2001) stand out, which uses the theoretical framework of Fama (1984), demonstrating that the change in the exchange rate regime in 1999 led to a decrease in the variance of the risk premium about the expected depreciation rate. The importance of the Uncovered Interest Rate Parity model is evident in the work of Bogdanski *et al* (2000), who, in an article on the implementation of the inflation targeting regime, present a family of models used to simulate and identify the transmission mechanisms of monetary policy. Among these models, the UIP condition stands out. The authors present the model in the first difference of the variables: exchange rate, domestic interest rate, foreign interest rates, and risk premium.

Santos and Curado (2013) also use the Uncovered Interest Rate Parity equation in the first difference, employing the same framework presented by Bogdanski, *et al* (2000) for the period from January 2003 to March 2008. According to the authors, exchange rate variation was more influenced by its own lagged variations and country risk, represented by the EMBI+ Brazil, calculated by JP Morgan. The authors used the impulse response function through the vector autoregression (VAR) methodology.

Cieplinski *et al*. (2017) analyzed the validity of the Uncovered Interest Rate Parity theorem for the Brazilian economy between 2000 and 2014 by estimating the parameters related to the interest rate differential. The study found an empirical failure in the parameter, implying a negative relationship between the interest rate differential and exchange rate variation. The work interprets this relationship as indicating that, in times of relative economic stability, the interest rate differential stimulates capital inflows and exchange rate appreciation, justifying the negative relationship. Conversely, in times of instability, capital flight, and exchange rate depreciation, the monetary authority attempts to mitigate capital outflows by manipulating the interest rate differential, resulting in a positive coefficient between exchange rate variation and the interest rate differential.

Regarding the exchange rate issue in Brazil, Rossi *et al*. (2020) utilize the hypothesis of Covered Interest Rate Parity (CIRP) in their work to verify the adjustment of spot and forward exchange rates between the Brazilian Real and the U.S. Dollar through shocks related to the interest rate differential and country risk. The study considers the institutional framework of the Brazilian foreign exchange market, characterized by the greater liquidity of the futures market compared to the spot market. By analyzing the impulse response functions of the VAR model, the effects of shocks in the interest rate differential and the increase in country risk are examined. In the first case, the accumulated effect is the appreciation of the spot and forward exchange rates, but with greater volatility in the spot exchange rate. In the second case, the effect is depreciation, also with greater volatility in the spot rate.

Several studies have investigated exchange rates and Uncovered Interest Rate Parity, providing significant contributions, including Throop (1993), Lothian and Wu (2011), Orellana and Pino (2021), Dreger (2010), Engel (2019), Dimitriou, Kenourgios, and Simos (2017), Hoffmann and Suter (2010), Schmitt-Grohé and Uribe (2022), Engel (2016), Lacerda *et al*. (2010), Burnside (2019), Hsing (2007), Olmo and Pilbeam (2011), and Kouretas (1997). Thus, this work aims to contribute to this scientific literature by providing empirical evidence for the Brazilian exchange rate through Uncovered Interest Rate Parity.

II. METHODOLOGY

Data

The data considered are monthly time series from January 2012 to December 2022, referring to the Brazilian basic interest rate and the nominal exchange rate - both obtained from the Central Bank of Brazil - the U.S. federal funds rate - obtained from the Federal Reserve -, EMBI+, and the 5-year Brazil CDS spread, used as a proxy for country risk. The data frequency is monthly. Table 1 presents the descriptive statistics of the variables considered.

Table 1
Descriptive statistics

	Exch.	*Df Rate*	*EMBI+*	*CDS*
Average	3.62	8.05	279.6	210.9
Std. Dev	1.19 1.72	3.87 1.81	71.46 142.0	79.24
Min.				99.11
Max.	5.65	14.03	523.0	488.99

Statistics of the series at the level and the three series are composed of 132 observations.

Source: elaborated by authors.

The descriptive statistics of the series indicate a behavior of high volatility, as evidenced by both the standard deviation and the range between the minimum and maximum values. The time series was transformed into logarithms to reduce discrepancies in the values.

Ordinary Least Squares

The econometric analysis was conducted in two stages. First, a multiple linear regression was used to examine the relationships between the nominal exchange rate and the interest rate differential between Brazil and the U.S., as well as the risk measure. Complementarily, a VAR (Vector Autoregressive) econometric model was estimated, where the variables were ordered from the most exogenous to the most endogenous. For analyzing the interaction between the variables, the impulse response function was used along with variance decomposition.

The equation for Covered Interest Rate Parity in logarithms is expressed as follows:

$$f - s = i_{brl} - (i_{usd} + \alpha) \tag{1}$$

where i_{brl} and i_{usd} are the domestic interest rate in Brazilian reais and the foreign interest rate in U.S. dollars, respectively; f is the forward exchange rate; s, is the spot exchange rate; and α represents the non-currency risk premium (Rossi *et al*., 2020).

Frankel (1979) expresses the above relationship assuming market efficiency and that securities from different countries are perfect substitutes:

$$d = i - i^{*} \tag{2}$$

where i represents the domestic interest rate, i^{*} is the international interest rate, and d, is the discount rate represented by the logarithm of the future exchange rate f and s, the spot exchange rate.

Using the same relationship, the Uncovered Interest Rate Parity is derived, where d represents the difference between the expected exchange rate and the spot exchange rate of the reference currency (Santos and Curado, 2013). Therefore,

$$d = E[e_{t+1}] - e_t \tag{3}$$

$$E[e_{t+1}] - e_t = i_{brl} - (i_{usd} + \alpha) \tag{4}$$

In this work, the approach of Bogdanski, Tombini, and Werlang (2000) was adopted, which assumes the simplification that changes in exchange rate expectations follow a white noise process, meaning they have constant mean and variance:

$$E[e_{t+1}] - E_{t-1}[e_t] = \eta \tag{5}$$

According to the authors, this hypothesis follows a “random walk with monetary surprise,” where the surprise is characterized by changes in the interest rate differential and the risk premium. Moreover, by taking the first difference of equation (5), we obtain:

$$E[e_{t+1}] - E_{t-1}[e_t] - \Delta e_t = \Delta i_t - \Delta i_t^{*} - \Delta \alpha_t \tag{6}$$

Therefore, the dynamics of the exchange rate are specified as follows:

$$\Delta e_t = \Delta i_t - \Delta i_t^{*} + \Delta \alpha_t + \eta_t \tag{7}$$

Santos and Curado (2013) highlight that this model differs from the one usually presented by Uncovered Interest Rate Parity. Moreover, this method demonstrates distinctive characteristics by not requiring the formulation of hypotheses about future exchange rates, while combining the random walk hypothesis with the characteristic of exchange rate sensitivity to the interest rate differential.

The specified model, considering the unknown parameters, is therefore:

$$\Delta e_t = \beta_0 + \beta_1 \Delta\alpha_t + \beta_2 \Delta (i_t - i_t^*) + \eta_t \tag{8}$$

Where:

Δe_t is the change in the nominal exchange rate;

$\Delta\alpha_t$ is the risk measure represented by the country risk;

$\Delta (i_t - i_t^*)$ is the difference between the domestic and foreign interest rates;

β_0, β_1, and β_2 are the parameters of the model.

When estimating the model, the hypothesis to be tested is $\beta_1 > 0$ and $\beta_2 < 0$.

Therefore, a positive relationship between the nominal exchange rate and the country risk, and a negative relationship with the interest rate differential, is expected.

Vector Autoregressive Model (VAR)

Since the research fundamentally utilizes time series data, these are evaluated for stationarity through formal unit root tests, namely ADF (Augmented Dickey-Fuller), KPSS (Kiwatkowski, Phillips, Schmidt, Shin), and PP (Phillips-Perron).

Frequently, situations arise, especially in economic models, where evidence suggests that a specific variable is defined endogenously. This scenario is illustrated through short-term models in which the Gross Domestic Product (GDP), consumption, investment, and government spending are simultaneously determined (Ferreira *et al*., 2018).

In this context, Vector Autoregressive (VAR) models emerge as a solution that proposes to treat all variables of a given system symmetrically, by combining matrix algebra and the Ordinary Least Squares (OLS) Method.

Among the functionalities of VAR models, the ability to capture the effects of shocks in the variables included in the system stands out through impulse response functions, where, for a given set of time series, the model captures the dynamic interactions between these variables (Rossi *et al*., 2020).

Complementarily, this study employs variance decomposition, which is a function that allows for the analysis of the forecast error variance arising from each endogenous variable (Bueno, 2012).

Since the focus of the study is on the analysis of the nominal exchange rate, in summary, its response to impulses or shocks is analyzed. Through variance decomposition, it is possible to assess the percentage contribution of the studied variables to the total variation of the nominal exchange rate.

The VAR model of order p, in its basic form, can be represented according to the notation used by Rossi *et al*. (2020):

$$Y_t = \sum_{1}^{p} AY_{t-1} + u_t \tag{9}$$

Where a set A represents the matrix of coefficients (KxK) for a set of time series variables $Y_t = (Y_{1t}, \ldots, Y_{kt})$ and u_t are the error terms, where $u_t = (u_{1t}, \ldots, u_{kt})$.

For estimating the model, selecting the lag order is also a task of utmost importance, considering the need to balance between a sufficient number of lags for analyzing the temporal dynamics between variables and ensuring that an excess does not impair statistical tests (Bueno, 2012). Therefore, the study uses the main information criteria: Akaike, Schwarz, and Hannan-Quinn.

III. RESULTS

According to Bueno (2012), it is of fundamental importance to verify the stationarity of the analyzed series, as it is possible to find econometric relationships between two or more variables without any causal relationship. On this aspect, the same author warns that visual inspection rarely allows distinguishing series as having deterministic or stochastic trends. For these reasons, the ADF, PP, and KPSS tests are used complementarily, with the null hypotheses being the presence of a unit root in the first two tests and the absence of a unit root in the last one.

Table 2
Unit Root Tests for the Analyzed Series

Series	*ADF*	*KPSS*$^{(1)}$	*PP*
Δ Exchange Rate	-7,5977***	0,1006***	-88,706
Δ EMBI+	-8.2924***	0.0384***	-123.51
Δ Interest Rate Differential	-4,115***	0,2334***	-36,5481
Δ CDS	-8,0932***	0,0451***	-109,2601

The series is in logarithms and first differences.
(1) *p<0.1; **p<0.05; ***p<0.01.
(2) The null hypothesis of the KPSS test is stationarity.

Source: elaborated by authors.

Table 2 presents the results of the unit root tests, indicating that all three series are stationary at a 1% significance level, as determined by both the ADF and KPSS tests. Additionally, based on the Phillips-Perron test, the null hypothesis of a unit root is rejected for all series.

Main Results

The empirical findings presented in Tables 3 to 6 and Figures 1 to 5 provide substantive evidence on the dynamics governing the Brazilian nominal exchange rate relative to country risk and the interest rate differential.

Results of the Multiple Linear Regression

The multiple linear regression results presented in Table 3 reveal two critical aspects regarding the determinants of the Brazilian nominal exchange rate. First, the statistically significant and positive coefficient associated with the EMBI+ measure indicates that increases in country risk are systematically linked to currency depreciation. This relationship supports the theoretical argument that in emerging economies, elevated risk premiums, often driven by political and economic instability, contribute directly to exchange rate fluctuations (Kalemli-Özcan & Varela, 2021).

Second, the lack of statistical significance for the interest rate differential suggests that traditional arbitrage mechanisms posited by the Uncovered Interest Rate Parity (UIP) condition do not hold in this context, a finding consistent with prior Brazilian studies (Cieplinski *et al*., 2017) that document empirical deviations from UIP under conditions of heightened market uncertainty. Thus, preliminary evidence suggests that the change in Brazilian exchange rate markets is more sensitive to country risk than interest rate differentials.

Table 3
Multiple Linear Regression

	Dependent Variable
	Δe_t
Intercept	0.008003** (0.002900)
EMBI+	0.177319*** (0.028311)
Interest Rate Differential	-0.027202 (0.042632)
EMBI+	0.177319*** (0.028311)
Observations	396
R2	0.2374
Adjusted R²	0.2254
F Statistic (DF = 128)	19.92***

This Table reports the results of the multiple linear regression estimating the impact of country risk (EMBI+) and interest rate differential on the Brazilian nominal exchange rate from 2012 to 2022.

Source: elaborated by authors.

Results of the Vector Autoregressive Model

The Granger causality tests summarized in Table 4 further substantiate the exogenous role of country risk in driving exchange rate dynamics. The rejection of the null hypothesis that EMBI+ does not Granger-cause changes in the nominal exchange rate and interest rate differential confirms that past fluctuations in country risk significantly influence future exchange rate behavior. Conversely, the inability to reject the null hypothesis for the reverse causality pathways suggests that the nominal exchange rate and interest rate differential do not independently exert a predictive effect on country risk within the analyzed period. These findings reinforce the critical role of risk perceptions as a primary exogenous factor shaping exchange rate movements in Brazil, in line with theoretical models emphasizing the role of sovereign risk in emerging market currency dynamics (Rossi, 2016).

Table 4
Granger Causality Tests

H0	Nominal Exchange Rate Does Not Granger-Cause Embi+ and Rate Difference	p-value	0.4411
H0	Non-Granger-caused Rate Differences between Embi+ and Nominal Exchange Rates	p-value	0.1273
H0	Embi+ does not Granger-cause difference in rates and Nominal Exchange Rates	p-value	5.113E-05

This Table presents the Granger causality test results among the EMBI+, interest rate differential, and nominal exchange rate, indicating the direction of predictive relationships.

Source: elaborated by authors.

Table 5, detailing the lag selection criteria, indicates that a lag length of one period is optimal across the Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ) measures. This parsimonious model structure balances the need to capture dynamic interrelationships among the variables while avoiding over-parameterization. The selected lag structure ensures that the subsequent impulse-response and variance decomposition analyses adequately reflect the immediate temporal dynamics without introducing excessive complexity, consistent with best practices in time series econometrics (Bueno, 2012).

Table 5
Lag selection

Lag (p)	*AIC*	*SC*	*HQ*
1	-1.747751e+01	-1,713092e+01	-1,733675e+01
2	-1,741148e+01	-1,685695e+01	-1,718626e+01
3	-1,737300e+01	-1,661052e+01	-1,706333e+01
4	-1,730671e+01	-1,633627e+01	-1,691258e+01
5	-1,724009e+01	-1,606170e+01	-1,676150e+01

This Table shows the optimal lag selection for the *VAR* model based on the Akaike (AIC), Schwarz (SC), and Hannan-Quinn (HQ) information criteria.

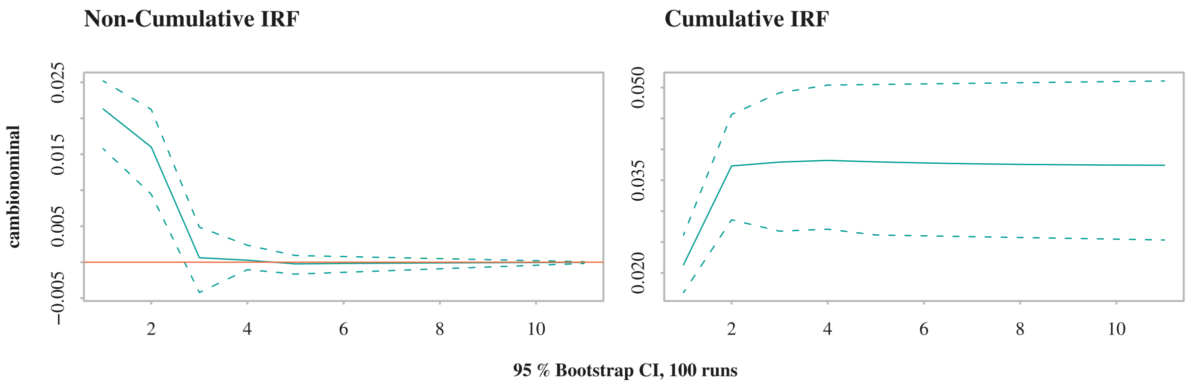
The lowest relative values are found with a lag in the three measurements.

Source: elaborated by authors.

Impulse Response Functions

The impulse-response analysis visualized in Figure 1 illustrates the dynamic effect of EMBI+ shocks on the nominal exchange rate. Specifically, a positive shock to country risk induces an immediate and pronounced depreciation of the Brazilian Real, with the effect dissipating after approximately three periods. This temporal pattern underscores the sensitivity of the Brazilian currency to shifts in sovereign risk perceptions, corroborating the argument that forward-looking expectations in emerging markets rapidly adjust to new information about country risk (Kalemli-Özcan & Varela, 2021).

Figure 1
Response of the Nominal Exchange Rate to Embi+ Shocks

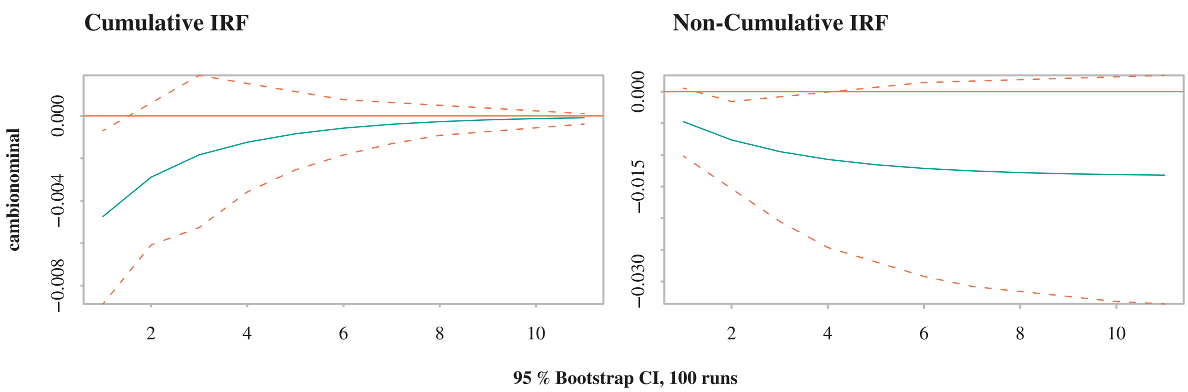


Note: this Figure depicts the impulse response of the nominal exchange rate to a one-standard-deviation shock in EMBI+, highlighting the immediate and short-term depreciation effect.

Source: elaborated by authors.

Complementary to this, Figure 2 demonstrates that shocks to the interest rate differential result in a moderate appreciation of the nominal exchange rate. However, the magnitude of this effect is considerably smaller and more persistent relative to the impact of country risk shocks. This asymmetry in the impulse responses indicates that while interest rate differentials exert some influence on exchange rate movements, their role is secondary to that of country risk in the Brazilian context, especially during periods characterized by significant political and economic instability.

Figure 2
Rate and Exchange Rate Response to Rate Differential

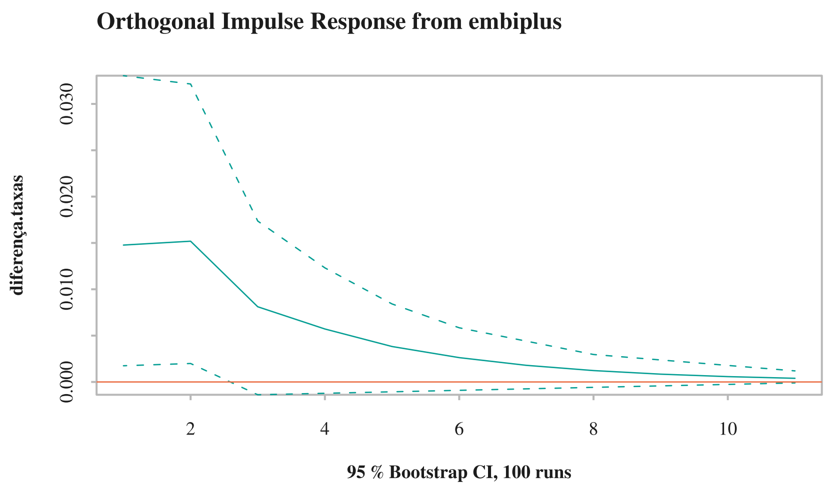


Note: this Figure shows the impulse responses of both the nominal exchange rate and the interest rate to shocks in the interest rate differential.

Source: elaborated by authors.

The interdependence between country risk and interest rate differentials is further explored in Figures 3 and 4. Figure 3 shows that an increase in country risk is followed by an elevation in the interest rate differential, reflecting the likely monetary policy response aimed at preventing capital flight and curbing further depreciation of the currency. This reaction is consistent with the policy behavior documented in previous studies (Rossi *et al*., 2020), which emphasize the strategic use of interest rates by monetary authorities to mitigate risk-induced exchange rate volatility. Conversely, Figure 4 illustrates that shocks to the interest rate differential exert only a marginal and transient effect on the EMBI+, suggesting that while monetary policy adjustments respond to country risk, they do not significantly alter market perceptions of sovereign risk in the short term.

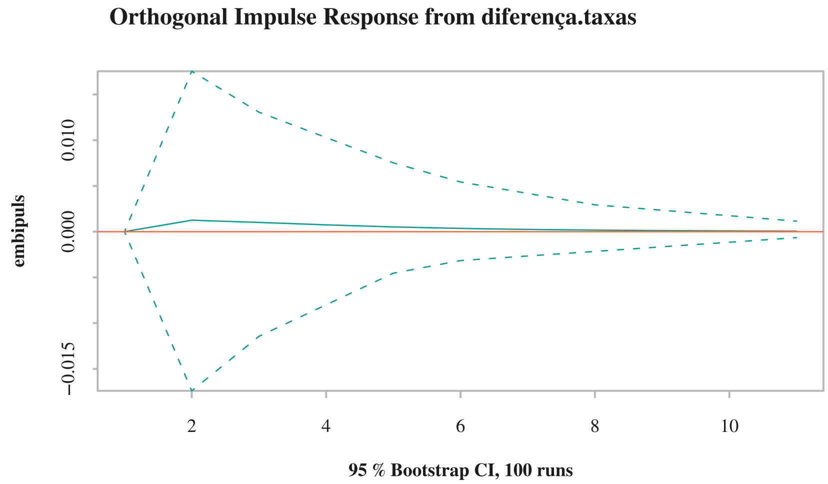
Figure 3
Interest Rate Differential Response to Embi+ Shock



Note: this Figure illustrates the dynamic response of the interest rate differential to a shock in EMBI+, suggesting a monetary policy reaction.

Source: elaborated by authors.

Figure 4
EMBI+ Response to Interest Rate Differential



Note: this Figure displays the response of EMBI+ to shocks in the interest rate differential, indicating minimal reverse causality.

Source: elaborated by authors.

Variance Decomposition

The decomposition of forecast error variance, as reported in Table 6 and visualized in Figure 5, provides quantitative confirmation of the dominant role of country risk and past exchange rate values in driving exchange rate variability. Specifically, the variance decomposition indicates that approximately 42% of the variation in the nominal exchange rate is attributable to the EMBI+, while about 56% is explained by its own lagged values. In stark contrast, the interest rate differential accounts for a negligible share, stabilizing around 1,3%. This distribution highlights the dual influence of forward-looking risk perceptions and backward-looking expectations in determining exchange rate dynamics, aligning with the broader literature on emerging market exchange rate behavior (Santos and Curado, 2013).

Table 6
Variance Decomposition

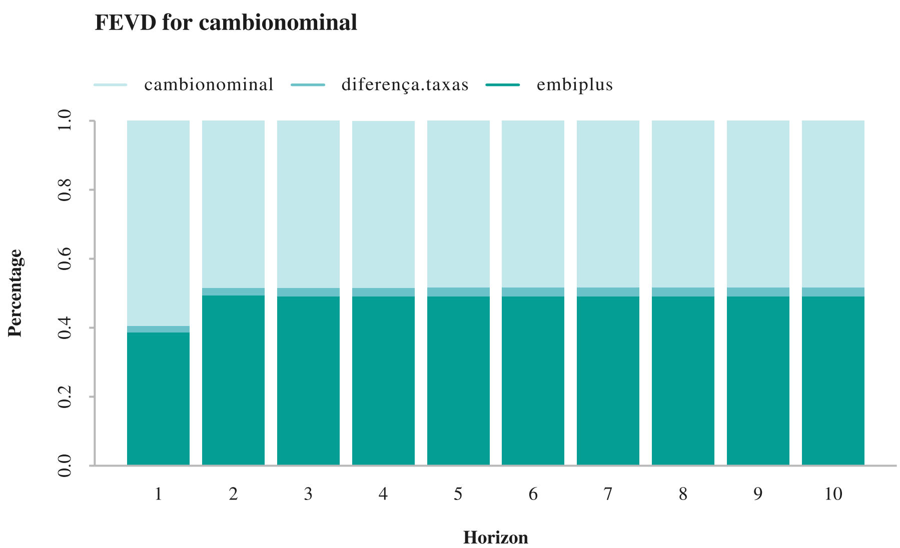
EMBI+	*TX Difference*	*Nominal Exchange Rate*
0.2936109	0.004778686	0.7016104
0.4221087	0.009690017	0.5682013
0.4209061	0.011252927	0.567841
0.4206322	0.012097556	0.5672702
0.4204789	0.012478431	0.5670426

EMBI+	*TX Difference*	*Nominal Exchange Rate*
0.4204044	0.012663152	0.5669325
0.4203705	0.012751099	0.5668784
0.4203542	0.012793305	0.5668525
0.4203465	0.012813522	0.56684
0.4203427	0.012823214	0.566834

This Table presents the variance decomposition of the forecast error in the nominal exchange rate, showing the relative contributions of its lags, EMBI+, and interest rate differential.

Source: elaborated by authors.

Figure 5
Variance Decomposition



Note: this Figure visualizes the results of the variance decomposition from Table 6, emphasizing the dominant role of past exchange rates and country risk.

Source: elaborated by authors.

In summary, the collective results from the multiple linear regression, VAR model, impulse-response functions, and variance decomposition analyses converge on a coherent narrative: the Brazilian nominal exchange rate during the period from 2012 to 2022 was predominantly shaped by country risk and historical exchange rate levels, with minimal influence from the interest rate differential.

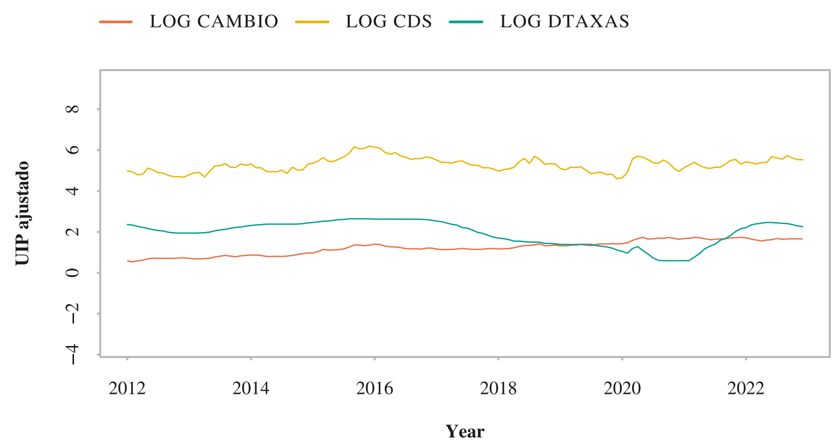
These findings reinforce critiques of the UIP condition's applicability in emerging markets, emphasizing the need for policymakers to prioritize risk management and institutional stability as central components of exchange rate policy. The Brazilian case illustrates how heightened political and economic uncertainty amplifies the role of sovereign risk in driving exchange rate dynamics, providing valuable insights for both scholars and practitioners concerned with the complexities of currency behavior in similar economic environments.

Robustness Checks

The assumption to be tested as a robustness check is that of Embi+ as a credible measure of country risk. To test that assumption, we use the 5-year Credit Default Swaps (CDS) as an alternative measure of country risk.

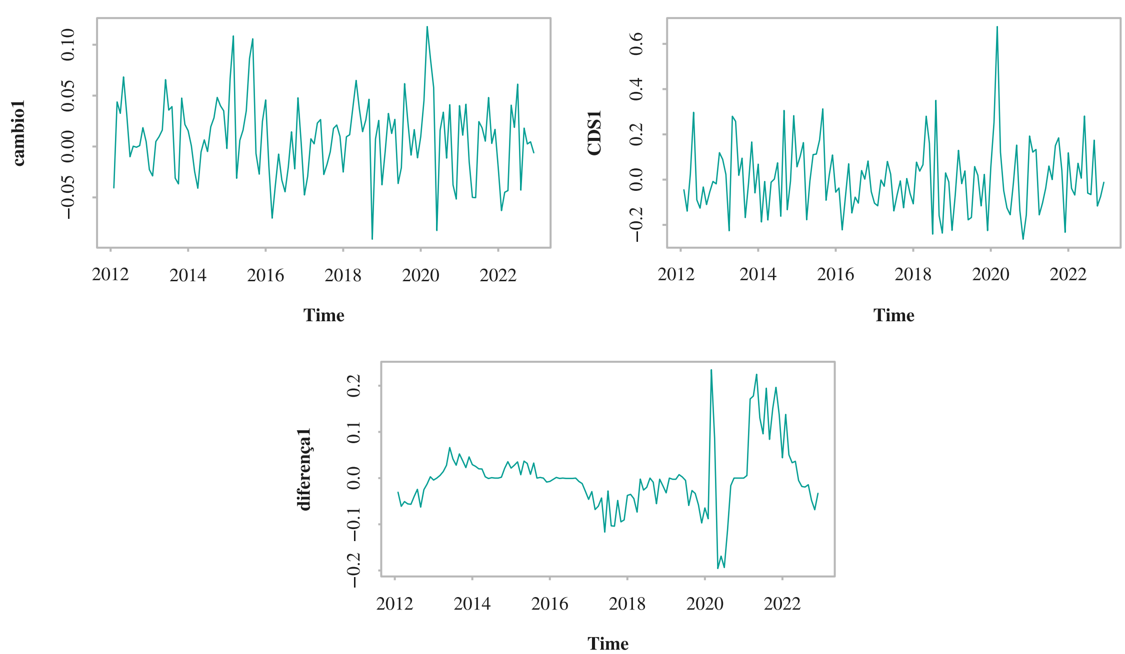
Figure 6 presents the historical trajectory of the series after the transformation, and Figure 7 shows the series in the first difference.

Figure 6
Series in natural logarithm



Source: elaborated by authors.

Figure 7
Series in first difference



Source: prepared by the authors.

Results of the Multiple Linear Regression

Table 7 presents the multiple linear regression results using this specification. Consistent with the baseline model, the coefficient for the CDS variable remains positive and statistically significant at the 1% level, reaffirming the critical role of country risk in explaining nominal exchange rate movements. The interest rate differential, once again, fails to achieve statistical significance, underscoring the limited explanatory power of arbitrage conditions implied by Uncovered Interest Rate Parity (UIP).

These findings resonate with Kalemli-Özcan and Varela (2021), who argue that in emerging economies, deviations from UIP are often driven by sovereign risk considerations rather than interest rate differentials. Moreover, the increase in the adjusted R^2 to 0.341 suggests a stronger model fit when CDS is employed, implying that CDS may more precisely capture market perceptions of country-specific risk relative to EMBI+.

Table 7
Multiple Linear Regression

	Dependent Variable
	Δe_t
Intercept	0.007529** (0.002676)
CDS	0.154205*** (0.018624)
Interest Rate Differential	-0.043706 (0.039417)
Observations	396
R2	0,3512
Adjusted R^2	0,341
F Statistic (DF = 128)	34,64***

This Table shows regression results using CDS as an alternative proxy for country risk, confirming its significant influence on the nominal exchange rate.

Source: elaborated by authors.

The statistical validity of these results is further supported by diagnostic tests. The Shapiro-Wilk test for normality and the Breusch-Pagan test for homoscedasticity confirm that the residuals of the regression model satisfy standard econometric assumptions, thereby enhancing the reliability of the estimated coefficients. These diagnostics bolster the credibility of the CDS-based specification and affirm its appropriateness for capturing the impact of country risk on exchange rate dynamics in the Brazilian context.

Results of the Vector Autoregressive Model

Turning to the Vector Autoregressive model, Table 8 presents the Granger causality results for the model incorporating the CDS measure. As in the main specification, the CDS is found to Granger-cause both the nominal exchange rate and the interest rate differential, reaffirming its exogenous influence within the system. Conversely, the reverse causal relationships are not statistically supported.

This outcome corroborates findings by Froot and Frankel (1989), who argue that systematic expectation errors—rather than forward-looking arbitrage—drive exchange rate movements when risk premiums are salient. The sustained exogeneity of CDS confirms its pivotal role in shaping forward-looking expectations among market participants.

Table 8
Granger Causality Tests

H0	Nominal Exchange Rate Does Not Granger-Cause CDS and Rate Difference	p-value	0.2573
H0	Non-Granger-caused Rate Differences between CDS and Nominal Exchange Rates	p-value	0.1567
H0	CDS does not Granger-cause difference in rates and Nominal Exchange Rates	p-value	5.86E-05

This Table provides Granger causality results with CDS, supporting the exogeneity of country risk about the exchange rate and interest rate differential.

Source: elaborated by authors.

Table 9 offers updated lag selection criteria based on the revised VAR model. Consistent with earlier results, a one-period lag is preferred across all three information criteria. This suggests that the dynamic interactions among CDS, interest rate differentials, and the exchange rate are most effectively captured with minimal lag length, aligning with the specification adopted in the main analysis. The Breusch-Godfrey LM test for serial correlation indicates no significant autocorrelation in the residuals, while eigenvalue stability tests confirm the stationarity of the VAR system, supporting the robustness and reliability of the dynamic specifications.

Table 9
Lag selection

Lag (p)	*AIC*	*SC*	*HQ*
1	-1,69e+01	-1,65e+01	-1,67e+01
2	-1,68e+01	-1,63e+01	-1,66e+01
3	-1,68e+01	-1,60e+01	-1,65e+01
4	-1,67e+01	-1,57e+01	-1,63e+01
5	-1,67e+01	-1,55e+01	-1,62e+01

This Table reports lag order selection for the VAR model incorporating CDS, with a one-lag structure being optimal across all criteria.

The lowest relative values are found with a lag in the three measurements.

Source: elaborated by authors.

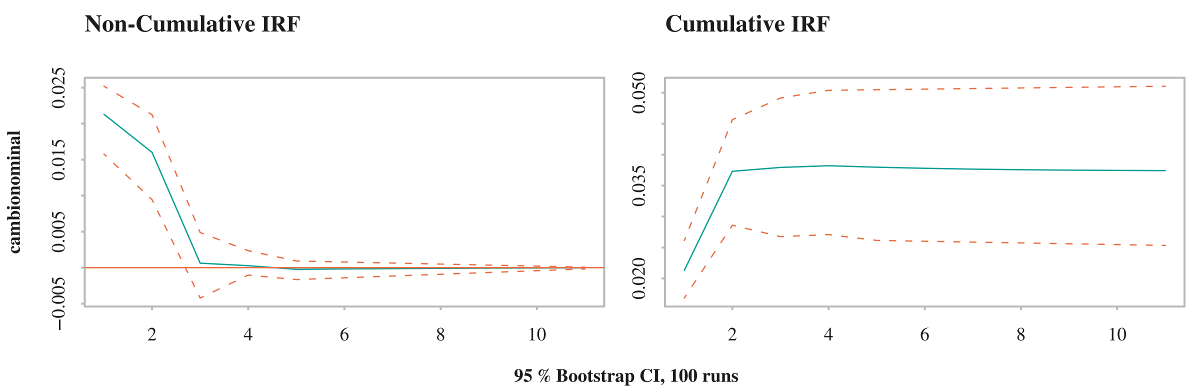
Impulse Response Functions

The impulse-response functions presented in Figures 8 and 9 illustrate the dynamic responses of the nominal exchange rate to shocks in the CDS and the interest rate differential, respectively. In Figure 8, a shock to CDS generates an immediate depreciation of the Brazilian Real, with the response stabilizing at a higher exchange rate level after three periods. This finding reiterates the conclusions drawn from the baseline analysis using

EMBI+ and is strongly aligned with the empirical narrative posited by Santos Souza and Curado (2013), who underscore the significance of political risk shocks in destabilizing exchange rates in Brazil.

Figure 9 confirms that while the interest rate differential induces an appreciation of the exchange rate, the magnitude and persistence of this effect are notably weaker than those of CDS shocks, again suggesting a subordinate role for UIP-based mechanisms in this context.

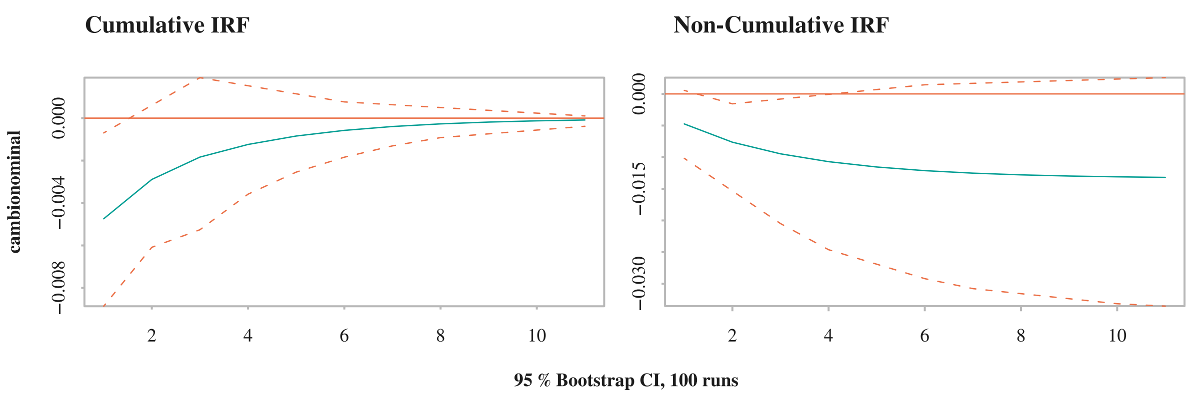
Figure 8
Response of the Nominal Exchange Rate to CDS Shocks



Note: this Figure shows the nominal exchange rate's impulse response to CDS shocks, illustrating depreciation effects like those observed with EMBI+.

Source: elaborated by authors.

Figure 9
Rate and Exchange Rate Response to Rate Differential



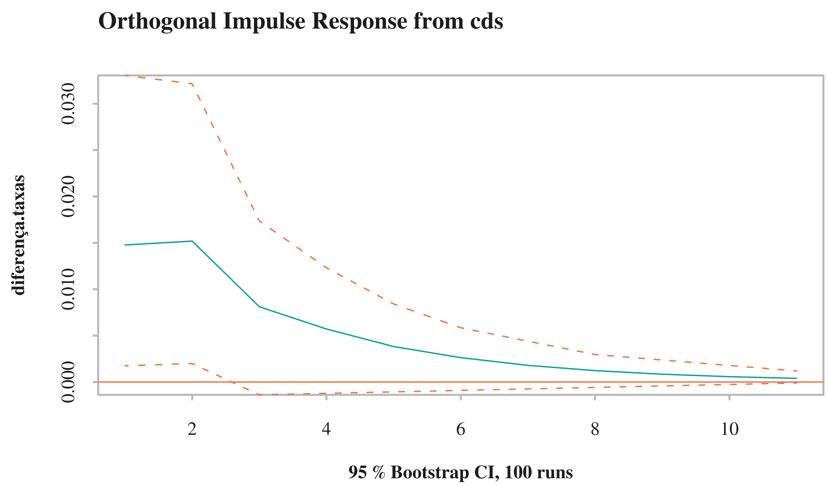
Note: this Figure depicts the impulse response of the exchange rate and interest rate to shocks in the rate differential using the CDS-based model.

Source: elaborated by authors.

Figures 10 and 11 further dissect the interaction between CDS and the interest rate differential. In Figure 10, an increase in CDS leads to a subsequent rise in the interest rate differential, suggesting that the Central Bank may adjust policy rates to counteract capital outflows and restore exchange rate stability, a behavior consistent with the policy transmission mechanisms documented by Bogdanski *et al*. (2000). In Figure 11, the reciprocal effect is weaker: a shock to the interest rate differential only marginally increases CDS levels.

This suggests that while monetary policy shifts may have short-term impacts on market sentiment, they are insufficient to durably reshape investor perceptions of sovereign risk. These asymmetries highlight the limited scope of conventional monetary tools in managing exchange rate expectations during periods of elevated political uncertainty.

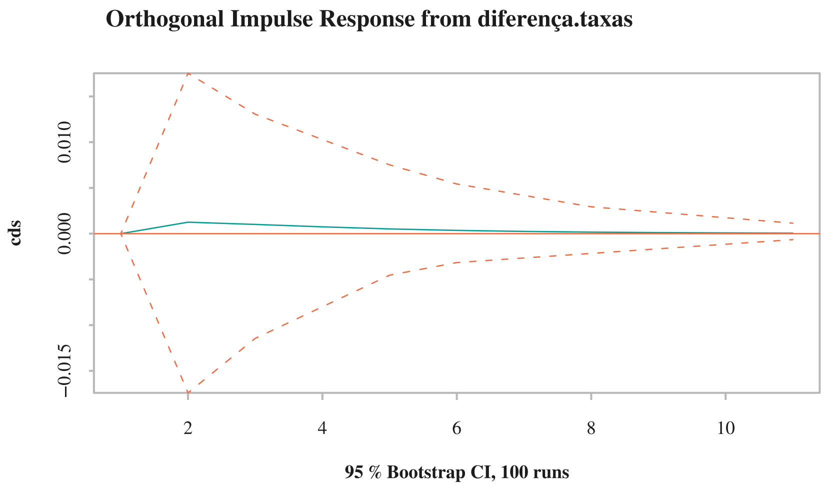
Figure 10
Interest Rate Differential Response to CDS Shock



Note: this Figure presents the reaction of the interest rate differential to a CDS shock, indicating policy adjustments in response to rising risk.

Source: elaborated by authors.

Figure 11
CDS Response to Interest Rate Differential



Note: this Figure shows the minor effect of shocks in the interest rate differential on CDS, suggesting limited reverse feedback.

Source: elaborated by authors.

Variance Decomposition

The results of the revised variance decomposition are detailed in Table 10 and Figure 12. Similar to the baseline analysis, CDS emerges as the dominant explanatory factor, accounting for approximately 49% of the variance in the nominal exchange rate. Past values of the exchange rate itself explain nearly 48%, while the contribution of the interest rate differential remains marginal at approximately 2.5%. These proportions mirror those observed with the EMBI+ measure, reinforcing the robustness of the study's central conclusion: exchange rate movements in Brazil during 2012–2022 are primarily driven by country risk and retrospective expectations. The near-identical variance structure across both risk proxies further substantiates the theoretical insights of Engel (2016), who emphasizes the role of risk premiums in mediating exchange rate behavior in financially open, politically volatile economies.

Table 10
Variance Decomposition

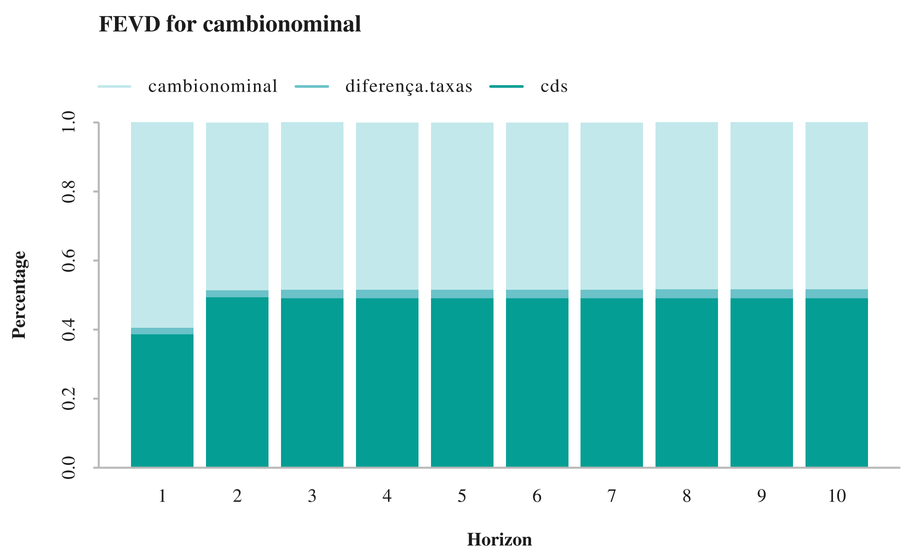
CDS	*TX Difference*	*Nominal Exchange Rate*
0.3863419	0.0191514	0.5945067
0.4932743	0.02142816	0.4852976
0.4917112	0.02368076	0.484608
0.4912043	0.02471669	0.484079
0.4909753	0.02519443	0.4838303

CDS	*TX Difference*	*Nominal Exchange Rate*
0.4908716	0.02541775	0.4837107
0.4908246	0.02552226	0.4836531
0.4907924	0.02557127	0.4836261
0.4907924	0.02559426	0.4836133
0.4907876	0.02560505	0.4836074

This Table details the variance decomposition results with CDS, reinforcing the dominant role of country risk and exchange rate lags.

Source: elaborated by authors.

Figure 12
Variance Decomposition



Note: this Figure visualizes the forecast error variance shares in the CDS-based VAR model, highlighting the minimal impact of the interest rate differential.

Source: elaborated by authors.

In conclusion, the robustness checks conducted with CDS as an alternative proxy for country risk confirm the central findings of the study. The consistency across regression outcomes, VAR dynamics, impulse responses, and variance decompositions affirms the dominant influence of sovereign risk perceptions on the nominal exchange rate. The negligible role of the interest rate differential across all models further challenges the empirical relevance of UIP in the Brazilian context. These results underscore the importance of incorporating political risk considerations into exchange rate modeling for emerging markets and validate the robustness of the empirical framework employed in this analysis.

Additionally, with the results being maintained with the different variables used to represent country risk, firstly, the EMBI+ and - as a measure of robustness - the CDS, these results also reinforce how much one of these variables can serve as a proxy for the other, in cases of the absence of databases.

CONCLUSION

This work aimed to investigate the Brazilian exchange rate by analyzing the behavior of the nominal exchange rate between the Real and the Dollar through the uncovered parity of the interest rate to verify whether country risk influences exchange rate changes. For this purpose, data related to the period from 2012 to 2022 were considered and a multiple linear regression model was estimated – aiming to verify the relationship between the variables – and a multivariate VAR model with the combination of impulse-response functions and variance decomposition.

The results of the multiple linear regression indicate that there is a negative relationship between the nominal exchange rate of the Real/Dollar and the Brazilian interest rate differential and the US interest rate differential, while there is a positive relationship between country risk. The VAR model estimates identified the responses of the exchange rate to shocks in the interest rate differential and country risk, with the variance decomposition indicating a relatively low influence of the interest rate differential found in the variance decomposition with a percentage of approximately 2.5%.

There is a strong influence of backward-looking expectations, represented by the influence of the lagged exchange rates themselves, with a percentage of approximately 48% captured through variance decomposition. Regarding country risk, a notable relevance of approximately 49% is noted, which suggests the influence of the political instability environment observed during the period, in which an impeachment process took place, various moments of tension in relations between the powers of the republic, and a process of political polarization. As each of the models was estimated separately using two different variables that represent country risk, firstly the EMBI+ and - as a measure of robustness - the CDS, and the results remained the same, the results of the work also contribute evidence for the use of one of these variables as a proxy for the others, in the absence of observations.

These findings are useful for the scientific literature that investigates emerging markets, by providing empirical evidence for the Brazilian nominal exchange rate based on the Uncovered Interest Rate Parity, as well as for policymakers, financial market analysts, and other economic agents who consider these aspects in their decisions. As a suggestion for future research, it is suggested that the influences of institutional development on the exchange rates of emerging countries in the recent period be investigated.

Finally, we state the absence of COVID-19 related factors in the analysis as a limitation. In addition to political instability, the COVID-19 pandemic also contributed to exchange rate volatility during the analysis period by disrupting financial markets and reducing international mobility. Given Brazil's strong tourism sector, especially related to its coastal destinations, the decline in tourist inflows likely amplified exchange rate fluctuations. This highlights the need to consider pandemic-related shocks alongside institutional factors in understanding exchange rate dynamics in future studies.

REFERENCES

Araújo, E. C., Araujo, E. L. & Brito, E. C. (2020). Exchange rate volatility, uncertainty, and investment: evidence for Brazilian companies (1997-2019). In *National meeting of economics*, 48, 2020, Brasília. Proceedings […]. Brasília: Anpec, p. 1-20.

Bernstein, P. L. (1997). *Against the Gods: The Remarkable Story of Risk*. 3rd ed. Rio de Janeiro: Campus.

Bogdanski, J., Tombini, A. A. & Werlang, S. R. Da C. (2000). *Implementing inflation targeting in Brazil*. Brasília: Banco Central do Brasil. (Working Paper, n. 1).

Bueno, R. de L. da. S. (2012). *Time Series Econometrics*. São Paulo: CENGAGE Learning Editions Ltda.

Bureau of Labor Statistics. (2020). *Bureau of Labor Statistics Data Finder: Consumer Price Index – All Urban Consumers*. Washington, DC: BLS.

Burnside, C. (2019). Exchange rates, interest parity, and the carry trade. In *Oxford Research Encyclopedia of Economics and Finance*.

Cassel, G. (1918). Abnormal Deviations in International Exchanges. *The Economic Journal*, *28*(112), 413-415. https://doi.org/10.2307/2223329

Cieplinski, A., Braga, J. & Summa, R. (2017). An assessment of the empirical failure of the uncovered parity theorem of the interest rate between the Real and the Dollar. *Economia e Sociedade*, *26*(2), 401-426.

Dimitriou, D., Kenourgios, D. & Simos, T. (2017). Financial crises, exchange rate linkages and uncovered interest parity: Evidence from G7 markets. *Economic Modelling*, *66*(C), 112-120. https://doi.org/10.1016/j.econmod.2017.06.003

Dreger, C. (2010). Does the nominal exchange rate regime affect the real interest parity condition? *The North American Journal of Economics and Finance*, *21*(3), 274-285. https://doi.org/10.1016/j.najef.2010.01.001

Eichengreen, B. (2000). *Globalização do Capital: história do sistema financeiro mundial*. São Paulo: Editora 34.

Engel, C., Lee, D., Liu, C., Liu, C. & Wu, S. P. Y. (2019). The uncovered interest parity puzzle, exchange rate forecasting, and Taylor rules. *Journal of International Money and Finance*, 95, 317-331. https://doi.org/10.1016/j.jimonfin.2018.03.008

Engel, C. (2016). Exchange rates, interest rates, and the risk premium. *American Economic Review*, *106*(2), 436-474. https://doi.org/10.1257/aer.20121365

Fama, E. F. (1984). Forward and spot exchange rates. *Journal of Monetary Economics*, *14*(3), 319-338. https://doi.org/10.1016/0304-3932(84)90046-1

Ferreira, P. C., Barros, A. C., Mattos, D. M., Oliveira, I. C. L., Ferreira, P. G. C. & Duca, V. E. L. A. (2018). *Time Series Analysis in R: introductory course*. Rio de Janeiro: Elsevier FGV IBRE.

Fleming, J. M. (1962). Domestic Financial Policies under Fixed and under Floating Exchange Rates. *IMF Staff Papers*, 9, (November).

Frankel, J. A. (1991). Quantifying international capital mobility in the 1980's. In: Bernheim, B. D. & Shoven, J. B. (eds.). *National saving and economic performance*. Chicago: The University of Chicago Press, National Bureau of Economic Research.

Froot, K. A. & Frankel, J. A. (1989). Forward discount bias: is it an exchange risk premium? *The Quarterly Journal of Economics*, *104*(1), 139- 161. https://doi.org/10.2307/2937838

Garcia, M. & Olivares, G. (2001). O Prêmio de Risco da Taxa de Câmbio no Brasil durante o Plano Real. *Revista Brasileira de Economia*, *55*(2), 151-182.

Hsing, Y. (2007). Exchange rate fluctuations in Croatia: test of uncovered interest rate parity and the open economy model. *Applied Economics Letters*, *14*(11), 785-788. https://doi.org/10.1080/13504850600689980

Hoffmann, M. & Suter, R. (2010). The Swiss franc exchange rate and deviations from uncovered interest parity: global vs domestic factors. *Swiss Journal of Economics and Statistics*, *146*(1), 349-371.

Kalemli-Özcan, S. & Varela, L. (2021). Five Facts about the UIP Premium. *National Bureau of Economic Research*, n. 28923.

Keynes, J. M. (1924). *A tract on monetary reform*. London: Macmillam and Co.

Kouretas, G. P. (1997). Identifying linear constraints in the monetary exchange rate model and uncovered interest parity: evidence from Canadian-US dollar cointegration. *The Canadian Journal of Economics*, *30*(4a), 875-890. https://doi.org/10.2307/136275

Lacerda, M., Fedderke, J. W. & Haines, L. M. (2010). Testing for purchasing power parity and uncovered interest parity in the presence of monetary and exchange rate regime shifts. *South African Journal of Economics*, *78*(4), 363-382.

Lothian, J. R. & Wu, L. (2011). Uncovered interest-rate parity over the past two centuries. *Journal of International Money and Finance*, *30*(3), 448-473. https://doi.org/10.1016/j.jimonfin.2011.01.005

Mundell, R. (1960). The Monetary Dynamics of International Adjustment under Fixed and Flexible Exchange Rates. *Quarterly Journal of Economics*, *74*(2), 227-257. https://doi.org/10.2307/1884252

Olmo, J. & Pilbeam, K. (2011). Uncovered interest parity and the efficiency of the foreign exchange market: a re-examination of the evidence. *International Journal of Finance & Economics*, *16*(2), 189-204. https://doi.org/10.1002/ijfe.429

Orellana, V. & Pino, G. (2021). Uncovered interest rate parity: A gravity-panel approach. *Heliyon*, *7*(11). e08350. https://doi.org/10.1016/j.heliyon.2021.e08350

Rossi, P., Araújo, E. & Barbosa-Filho, N.H. (2020). Adjustment of the exchange rate to the covered interest rate parity in Brazil. *Nova Economia*, *30*(1), 95-110. https://doi.org/10.1590/0103-6351/4700

Rossi, P. (2016). *Exchange rate and exchange rate policy in Brazil: theory, institutionality, role of arbitration and speculation*. 1st ed. Rio de Janeiro: FGV Editora.

Santos, G. R. & Curado, M. (2013). Exchange rate behavior in Brazil: an analysis based on uncovered interest rate parity. *Análise Econômica*, *31*(59), 103-122. https://doi.org/10.22456/2176-5456.17145

Schmitt-Grohé, S. & Uribe, M. (2022). The effects of permanent monetary shocks on exchange rates and uncovered interest rate differentials. *Journal of International Economics*, 135, 103560. https://doi.org/10.1016/j.jinteco.2021.103560

Throop, A. W. (1993). A generalized uncovered interest parity model of exchange rates. *Economic Review-Federal Reserve Bank of San Francisco*, (2), 3-16.