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The Impacts of the Interest Rate, the Exchange Rate, and the Market Index on the Stock Returns of the Brazilian Banks

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Abstract

This paper aims to analyze the impact of interest rate, exchange rate, and market on the returns and volatility of the stocks of banks listed on the Brazilian Stock Exchange. This analysis used two statistical models: the linear model estimated using Ordinary Least Squares and the ARCH/GARCH time series volatility models. The econometric studies considered the daily data of 15 financial institutions listed on the stock exchange during the period from January 2009 to December 2021. Regarding the market effect, the Ibovespa index for the period was considered; for the interest rate, the CDI (Certificate of Interbank Deposit) was used; and, about the exchange rate, the dollar rate was adopted as a reference. The results indicate that the distribution of stock returns is asymmetrical, with an elongated tail on the right. It was observed, based on the econometric model applied, that the daily returns of the shares are significantly influenced by the market, and the interest rate exerts the least impact on the returns. These findings are relevant to the scientific community exploring the topic and provide valuable insights for bankers, analysts, market investors, regulatory authorities, and society in the decision-making process.

JEL classification numbers: C32, G00, G21.
Keywords: Banking, Interest rates, Exchange rate, Bank stocks.

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1. Introduction

The Brazilian financial system is made up of institutions of all sizes, with a crucial role in strengthening the economy. Among the various roles played, we highlight the financial intermediation between surplus and deficit agents, which favors the financing of infrastructure, companies, and new businesses. Furthermore, it should be noted that banks are impacted by various macroeconomic factors, structural decisions by legislators and government officials, as well as by the rules established in national and international regulatory frameworks.

Banking activity, by its nature and scope, is an essential and critical issue in any economy, having an impact on all economic activity. The health of a banking system is essential for the proper functioning of the economy and should, therefore, be based on research aimed at a better understanding of the factors that influence the results of banks and their relevance to society.

We can say that the proper measurement of the influence of changes in interest rates, exchange rates, and the market on bank stock returns is a topic of great interest to directors of financial institutions, market analysts and investors, regulatory authorities, communities' academics, and society in general.

Given this scenario, the objective of this work is to generate value for policymakers, investors, financial institutions, and other market agents, investigating the possible influence of relevant parameters on the Brazilian economy, such as the variation of the exchange rate, the interest rate of the economy and the main market index. This information is not only relevant for investors' decision-making but also contributes to improving the risk management processes of banking houses operating in Brazil.

In this context, the aim is to identify to what extent the volatility of bank returns is impacted by exchange rate, interest rate, and market volatility. For this purpose, the daily closing prices of bank stocks traded on the Brazilian Stock Exchange, the daily interbank discount rate linked to the basic interest rate of the economy, the exchange rate of the real against the dollar and the Ibovespa in the period between January 2009 and December 2021. In the empirical strategy, two econometric models are used, the Ordinary Least Squares (OLS) model and the generalized autoregressive conditional heteroscedasticity time series models (ARCH/GARCH).

The results indicate that the distribution of stock returns presents an asymmetry, with an elongated tail to the right, and that daily stock returns are influenced by market behavior and exchange rates, while the interest rate has a relatively minor impact on these returns. These findings contribute significant information for policymakers and financial market regulators, investors, as well as for the scientific literature that investigates finance and banking by bringing empirical evidence about the stock returns of Brazilian banks.

This work is structured and has four more sections, Section 2 presents the literature review used for the development of the work, Section 3 details the methodology and database considered to achieve the proposed objectives, Section 4 presents and discusses the results, and Section 5, finally, concludes the work, resuming its main contributions.

2. Literature Review

In work carried out in the North American market, Tai (2000) proposed to examine the market risks, interest rate, and exchange rate in the pricing of a selected sample of shares of commercial banks in the United States of America. The author used three different econometric methodologies: *Non-Linear Seemingly Unrelated Regression* (NLSUR) via Hansen's MM (1982), Dumas and Solnik's Generalized Moments Method (GMM) (1995), and the GARCH in-mean model (MGARCH-M). The third approach was considered the most appropriate to the object of study. In its conclusion, relevant risk premiums were identified in stock returns about the volatility of exchange and interest rates, however, about market risk a low relationship was identified.

It is relevant to mention the research conducted on the market of Turkey, a country of emerging economy, by Kasman et Al. (2011). This work also aimed to investigate the effects of fluctuations in interest and exchange rates on the stock returns of Turkish banks. The researchers applied the linear models of OLS and GARCH estimates to analyze the data and draw conclusions. The authors maintain that the volatilities observed in interest and exchange rates have a significant negative impact on the return of bank stocks.

A study prepared by Lael Joseph and Vesos (2006) investigated the impact of changes in interest rates and exchange rates on the stock returns of a group of American banks. This study is based on three main criteria: the use of daily data to measure the sensitivity of banks' stock returns; joint modeling of interest rate and exchange rate sensitivity; and the reliability of statistical inferences based on the OLS and GARCH estimation methods. The exchange rate sensitivity coefficients were typically positive for both estimates, while the interest rate sensitivity coefficients showed a mixture of positive and negative signs (for both models). The variation in the signal of the coefficient of sensitivity to the interest rate may be related, as defended by the authors, to a certain degree of exposure in debts indexed to interest rates. The return of the interest market index was shown to account for most of the variation in bank returns.

Da Silva Junior et Al. (2011) considered the period from January 2000 to December 2010 to investigate the relationships between the stock market, through the Ibovespa index and certain macroeconomic variables, such as exchange and interest rates and inflation index (represented by IGP-M and GDP). The authors identified, in the period evaluated, a significant relationship, on the one hand, between the Ibovespa index and the exchange rate and, on the other, between the Ibovespa and the interest rate – the second, however, on a smaller scale. The researchers did not identify a relationship between GDP and the Ibovespa index, a finding different from what is observed in developed markets.

In the work of Andrade et Al. (2022) an analysis of the influence of macroeconomic indicators on the stock prices of companies in the financial sector is presented. These assets are listed on the B3 exchange for the period from 2011 to 2020. In this study, the following indicators were considered: GDP, IPCA, SELIC, unemployment rate, and exchange rate. The authors concluded that the SELIC interest rate has a negative relationship with the stock prices of companies in the financial sector listed on the B3 exchange. In other words, a decrease in the SELIC rate leads to an appreciation in the stock prices of these companies in the financial sector. As for the other macroeconomic variables considered in the regression model applied by the authors (inflation, unemployment rate, and exchange rate), it was concluded that they do not present a significant relationship with stock prices.

Another relevant study conducted in Brazil by Bernardelli and Bernardelli (2016) aimed to evaluate the influence of economic variables on the Brazilian stock market. The research covered the period from 2004 to 2014 and analyzed several macroeconomic variables, namely: the Ibovespa index, average exchange rate, GDP, SELIC Over rate, and Broad Producer Price Index - IPA. The researchers identified a strong relationship between stock market volatility and macroeconomic indicators. In addition, they established that macroeconomic variables explain 93.10% of stock market swings.

It is with this scientific literature that the present work seeks to contribute by bringing empirical evidence of the impacts of interest rates, exchange rates, and market performance on the returns of Brazilian financial institutions.

3. Methodology

3.1 Data

The objective is to understand how the market, the interest rate, and the exchange rate of the Brazilian currency can impact the daily return of stocks of financial assets listed on the stock exchange. For this, we used data from 15 financial institutions listed on the stock exchange: Banco da Amazônia, Banco do Brasil, Banco de Sergipe, Bradesco, Itaú Unibanco, Alfa, Banco do Espírito Santo, BANRISUL, Mercantil, Banco do Nordeste, PINE, Santander, ABC Brasil, PAN, and BRB, totaling 31 assets and 78,547 observations. We used data from the time window from January 2009 to December 2021.

To represent the effect of the market, the Ibovespa index was used in the period; for the effect of the interest rate, the CDI (Certificate of Interbank Deposit) was used; and for the exchange rate, the dollar collected at the Central Bank of Brazil from the closing PTAX rate on working days was used. Table 1 presents some descriptive statistics of the data used.

Table 1: Descriptive Statistics

	Min..	25%	Average	75%	Máx.	S.D.	Asymm.	Kurtosis	Jarque-Bera
ABCB4	-0,1498	-0,0120	0,0008	0,0129	0,1710	0,0220	0,1231	3,9800	2122,8*
BAZA3	-0,1693	-0,0118	0,0005	0,0079	0,2035	0,0263	0,8635	7,9240	7899,3*
BBAS3	-0,2117	-0,0131	0,0008	0,0143	0,1716	0,0259	-0,018	6,7282	6041,3*
BBDC3	-0,1435	-0,0116	0,0007	0,0119	0,1640	0,0210	0,1748	4,7768	3062,1*
BBDC4	-0,1430	-0,0111	0,0007	0,0121	0,1692	0,0213	0,2004	5,2418	3688,8*
BEES3	-0,2489	-0,0089	0,0006	0,0089	0,4861	0,0238	2,8755	63,9365	544510*
BEES4	-0,2764	-0,0120	0,0010	0,0143	0,3585	0,0334	0,8618	12,8409	17617*
BGIP3	-0,2088	-0,0146	0,0073	0,0148	0,5014	0,0630	2,5381	17,5262	5751*
BGIP4	-0,1834	-0,0092	0,0014	0,0106	0,3118	0,0317	1,4639	15,3659	22507*
BMEB3	-0,3624	-0,0147	0,0020	0,0163	0,3990	0,0446	0,7611	11,9450	9648,5*
BMEB4	-0,1910	-0,0094	0,0010	0,0113	0,2083	0,0265	0,3649	7,4157	6282,7*
BMIN4	-0,3060	-0,0237	0,0014	0,0216	1,2674	0,0566	5,8573	115,03	127014*
BNBR3	-0,1556	-0,0154	0,0026	0,0206	0,2435	0,0448	0,4276	3,2964	506,6*
BPAC11	-0,2682	-0,0121	0,0020	0,0152	0,2784	0,0317	0,1149	15,8209	12358*
BPAN4	-0,3360	-0,0137	0,0010	0,0132	0,4627	0,0332	1,2964	23,3806	73795*
BRIV3	-0,1660	-0,0118	0,0010	0,0084	0,8386	0,0436	5,3032	88,7257	540675*
BRIV4	-0,1364	-0,0098	0,0008	0,0105	0,2637	0,0289	0,7206	6,9030	4905,8*
BRSR3	-0,2944	-0,0140	0,0021	0,0134	0,8987	0,0559	4,2422	58,4040	254867*
BRSR5	-0,3652	-0,0215	0,0056	0,0270	0,6659	0,0852	2,6530	19,9614	12878*
BRSR6	-0,2018	-0,0145	0,0007	0,0157	0,1497	0,0262	-0,011	3,2771	1434,1*
BSLI3	-0,1764	-0,0120	0,0155	0,0129	1,4365	0,1236	8,1699	82,9597	109363*
BSLI4	-0,3202	-0,0216	0,0167	0,0167	1,9988	0,1594	8,3278	90,8391	131179*
CRIV3	-0,9629	-0,0129	0,0168	0,0129	25,6188	0,6384	39,736	1590,57	171936*
CRIV4	-0,7966	-0,0091	0,0008	0,0107	0,2000	0,0287	-4,013	129,93	332129*
ITUB3	-0,1212	-0,0099	0,0007	0,0108	0,1105	0,0184	0,0022	2,9223	1140,5*
ITUB4	-0,1201	-0,0112	0,0007	0,0117	0,1103	0,0202	0,1371	2,5976	911,3*
MERC4	-0,3247	-0,0136	0,0045	0,0108	0,9984	0,0890	4,0573	38,3552	38121*
PINE4	-0,2194	-0,0116	0,0004	0,0106	0,3403	0,0282	2,1981	26,3164	284319*
SANB11	-0,1347	-0,0125	0,0006	0,0133	0,1580	0,0223	0,2237	4,0964	2143,7*
SANB3	-0,1529	-0,0154	0,0011	0,0161	0,2500	0,0377	0,3208	2,1125	637,9*
SANB4	-0,1445	-0,0113	0,0012	0,0117	0,3137	0,0353	0,4772	3,9823	2221,8*

Source: Elaborated by authors.

Note that all Jarque-Bera test statistics are significant, that is, there are statistical indications that the distribution of asset returns is not well adhered to a normal distribution. This is because the null hypothesis of the test is rejected at the significance level of 1%. This result is expected in financial assets that, in general, have heavy tail distributions, diverging from the Gaussian distribution. In addition, from the measure of asymmetry, it is perceived that the returns, in large part, are positively asymmetric, since their average is positive. The CRIV3 asset has the

highest asymmetry (39.7367), a considerably high value, indicating that the returns of this asset had a high decay in the time window.
Kurtosis indicates the way the distribution of the data occurs, which can be mechaocurtic (distribution not very flattened or elongated), as is the case of the Gaussian distribution, platicurtic (very flattened distribution), or even leptocurtic (very elongated distribution). The rule for this definition is: (i) mesocurtic distribution: kurtosis = 0.263; (ii) platicurtic distribution: kurtosis > 0.263; and (ii) leptocurtic distribution: kurtosis < 0.263. All assets have positive and high kurtosis measures, indicating that the distributions are platicurtic, that is, quite flattened.
Then, analyzing the measures of central tendency and quartiles, it is possible to see that there is no asset with strongly discrepant returns from the others. In addition, as well as the greater asymmetry, the CRIV3 asset is also the one with the greatest variability in returns, with an average return of 0.0168 and a deviation around this average of plus or minus 0.6384.

3.2 Ordinary least squares regression

Among the techniques of Regression Analysis, there is Linear Regression, in which the relationship between two or more variables occurs linearly. If only one independent variable is considered, it is a Simple Regression Analysis, but if two or more variables are considered, it is a Multiple Regression Analysis. Additionally, to estimate the coefficients of the model, some estimation method is used, depending on the fulfillment of certain assumptions. In this work, we used the Ordinary Least Squares Method (OLS).
The Linear Regression Analysis has as its starting point a Linear Correlation Analysis. According to Garson (2009), correlation is a measure of bivariate association that assesses the strength of the relationship between two variables. In turn, Moore (2007) explains that correlation evaluates the direction and degree of the linear relationship between two quantitative variables.
To quantify the relationship between two variables, Pearson's Linear Correlation Coefficient is used (Rodrigues, 2012). If these variables follow a normal distribution, otherwise, we can consider these quantitative variables as rank and then use the Spearman rank correlation coefficient. In addition, you can represent the values of the variables in a scatterplot. In this sense, it is stated that there is a linear relationship between the variables if the points approach a line (Rodrigues, 2012).
The Correlation Coefficient (r) ranges from -1 to 1. The sign indicates the positive or negative direction of the relationship, while the value suggests the strength of the relationship between the variables. A perfect correlation (-1 or 1) indicates that the value of one variable can be exactly determined by knowing the value of the other. On the other hand, a correlation with a value close to zero indicates the absence of a linear relationship between the variables (Aldrich, 1995).
In the Linear Regression model, it is possible to use the independent variables to predict the values of the dependent variable, as well as it is possible to identify the contribution of each independent variable on the predictive capacity of the model

as a whole. Technically, saying that the model is fitted using the functional form of Ordinary Least Squares means that a line that minimizes the sum of squares of the residuals will be used to summarize the linear relationship between Y and X (Krueger, 2008). Thus, the estimated model consists of the following equation:

$$Return_i = \beta_0 + \beta_1 MarketI + \beta_2 InterestR + \beta_3 ExchangeR + \varepsilon_t \quad (1)$$

The dependent variable $Return_i$ is the return on each stock in the Brazilian banking sector. Using the independent variables to explain the returns of each bank are $MarketI$ which are the returns of the main Brazilian stock index Ibovespa, $InterestR$ which is the interbank discount rate used as a proxy for the basic interest rate and $ExchangeR$ which is the quotation of the real against the dollar considered and exchange rate. Thus, the relationship between banking actions and the explanatory variables is estimated using the regression coefficients.

3.3 ARCH/GARCH

The OLS model starts from the premise that data has no time dependence. However, in many applications, the time variable is extremely relevant to model relationships, and, in this case, one must work with Time Series models. Time series (or historical) are sets of measures of the same magnitude, relative to several consecutive periods. In other words, the time series is a succession of values of a given variable observed at regular intervals of time (Downing and Clark, 2006).

There are several models available in the context of time series, and the most appropriate for each situation always depends on the application to be made. ARCH/GARCH models were introduced into the literature by Engle (1982) and Bollerslev (1986) and emerged to solve clustering problems in financial data. These models condition heteroscedasticity to track and manage changes in volatility and are currently two of the most applied for predicting returns and volatility of financial series (Nwogugu, 2006).

Volatility within the economy and for the financial market is very important and the GARCH models are increasingly effective, being applied in several studies. In general, the series of returns of financial assets present excess kurtosis and slight positive asymmetry, that is, the unconditional distribution of returns is not Gaussian. The Jarque-Bera Normality Test uses asymmetry and kurtosis and is therefore the most suitable for financial asset data.

The GARCH model, on the other hand, is effective with this non-normal data. Unlike OLS and some other time series models, such as the ARMA models, nonhomoscedasticity is the focus of the ARCH/GARCH models, especially in the univariate case. Based on this, the estimation and prediction of volatility should be different from classical time series models.

In this wake, Engle (1982) proposes to model the series of squares of returns by an Autoregressive model of order q (*AR*(q)), calling this model *the Autoregressive Conditional Heteroskedastic* ARCH(q). The author presented the ARCH model in a study on inflation to solve heteroscedasticity problems by modeling the variance of errors in a regression model as a linear function of lagged values of the quadratic errors of the regression. The model was given by:

$$R_t = \sigma_t \varepsilon_t \tag{2}$$
(conditional mean)

$$\sigma_t^2 = \alpha_0 + \alpha_1 R_{t-1}^2 + \cdots + \alpha_q R_{t-m}^2 \tag{3}$$
(conditional variance)

The ARCH model has conditional mean and variance specifications. R_t is the dependent variable of the model and represents the return of financial data, whereas the term σ_t^2 represents conditional volatility at time t. In turn, ε_t it represents a sequence of independent and identically distributed random variables, of zero mean and variance one. The alphas, finally, are the different parameters of the model.
The model proposed by Engle (1982), however, generally required many parameters to be effective. From this problem, Bollerslev (1986) adapted Engle's (1982) model, developing a technique that allocates the conditional variance to an ARMA process. The GARCH model (p, q) can be given by:

$$R_t = \sigma_t \varepsilon_t \tag{4}$$
(conditional mean)

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i R_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \tag{5}$$
(conditional variance)

In this sense, the GARCH model most used in studies is GARCH (1,1), that is, with autocorrelation function and partial autocorrelation of lag 1, having lag 1 more significant with exponential decay after this lag. The estimated GARCH model equations are as follows:

$$Return_i = \beta_0 + \beta_1 MarketI + \beta_2 InterestR + \beta_3 ExchangeR + u_t \tag{6}$$

$$u_t = \sigma_t \varepsilon_t \tag{7}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u^2{}_{t-1} + \beta\, \sigma_{t-1}^2 \tag{8}$$

This model is more careful in its handling of data volatility. The equation above describes the error term in two parts: σ the component of the standard deviation of the error, which is modeled as an autoregressive and moving average process of order 1; and ε a white noise.

4. Results

Initially, to evaluate eventual changes in stationarity in the time series used in the present work, unit root tests were applied. Table 2 shows the results of the unit root tests.

Table 2: Unit root tests

	ADF	DF GLS	KPSS
ABCB4	-5,98***	-3,99***	0,21***
BAZA3	-5,70***	-3,90***	0,19***
BBAS3	-5,85***	-3,95***	0,20***
BBDC3	-2,16**	-2,75**	0,37**
BBDC4	-4,27***	-3,42***	0,09***
BEES3	-3,51***	-3,17***	0,04***
BEES4	-3,43***	-3,14***	0,04***
BGIP4	-4,92***	-3,64***	0,14***
BMEB3	-5,90***	-2,58**	0,34**
BMEB4	-0,67	-2,36**	0,39**
BNBR3	-5,11***	-3,70***	0,15***
BPAC11	-5,95***	-3,98***	0,21***
BPAN4	-5,25***	-3,75***	0,16***
BRIV4	-4,41***	-3,47***	0,10***
BRSR3	-4,65***	-3,55***	0,12***
BRSR5	-2,59**	-2,86**	0,40**
BRSR6	-4,35***	-3,45***	0,10***
BSLI3	-2,12**	-2,04**	0,33**
BSLI4	-5,37***	-3,79***	0,17***
CRIV4	-3,31***	-3,10***	0,03***
ITUB3	-5,81***	-3,95***	0,20***
ITUB4	-0,66	-0,98	0,01*
PINE4	-3,51***	-3,17***	0,04***
SANB11	-4,68***	-3,56***	0,12***
SANB3	-3,60***	-3,20***	0,05***
SANB4	-5,88***	-3,97***	0,20***
MarketI	-14.15***	-20,37***	0,08***
InterestR	-3,26***	-3,45***	0,14***
ExchangeR	-3,71***	-3,33***	0,14***

Note: *** Significance of 1%, ** Significance of 5%, and *Significance of 10%.
Source: Prepared by the author.

The stationarity tests did not indicate the presence of unit root in any of the analyzed series, except for ITUB4. Even in this case, the KPSS test demonstrated stationarity with a p-value of 10%. This suggests that it is feasible to adopt the premise of stationarity.

Following Kasman et Al. (2011), the first estimated model was a linear regression estimated by OLS. Although the financial series does not present the characteristics of normality and homoscedasticity necessary for the efficiency of the OLS, a fact that is consensual in the literature and is exemplified in the table of descriptive statistics, this method was still used to have an initial notion of this model.

Like Kasman et Al. (2011), the first estimated model adopted a linear regression approach using OLS. Although it is widely recognized in the literature that the financial series do not meet the assumptions of normality and homoscedasticity necessary for the efficiency of the OLS (a fact that is exemplified in Table 1 of descriptive statistics), this method was employed as a preliminary approach to evaluate the model. This allowed us to obtain a first view of the scenario, despite the limitations of the financial series.

Table 3 presents the results of the linear model having as dependent variable the return of assets, and as independent variables the Market Index, the Interest Rate, and the Exchange Rate in the time.

Table 3: OLS Results

	Intercept	Market	Interest	Exchang	R2 Adjusted	ARCH (1)
ABCB4	0,0006*	0,7077*	-0,0354	-0,2351	0,3081	457,4*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
BAZA3	0,0004*	0,4111*	0,0184	-0,1429	0,0757	315,4*
	(0,0018)	(0,1206)	(0,1183)	(0,2117)		
BBAS3	0,0003*	1,201*	0,0108	-0,2244	0,5934	520,6*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
BBDC3	0,0002*	1,0497*	0,0285	-0,0653	0,6482	659,8*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
BBDC4	0,0002*	1,0936*	0,0369	-0,0649	0,6869	723,6*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
BEES3	0,0004*	0,3996*	-0,0036	-0,0575	0,0750	76,8*
	(0,0017)	(0,1174)	(0,1101)	(0,2026)		
BEES4	0,0009*	0,333*	0,0112	-0,1732	0,0324	87,0*
	(0,002)	(0,1299)	(0,115)	(0,227)		
BGIP3	0,0073*	0,1476*	-0,0161	-0,1413	-0,0044	7,9
	(0,0048)	(0,295)	(0,157)	(0,5545)		
BGIP4	0,0013*	0,2689*	-0,0314	-0,3568	0,0406	80,1*
	(0,0021)	(0,1357)	(0,1197)	(0,2372)		
BMEB3	0,0021*	0,0237*	-0,0324	-0,3055	0,0028	30,6*
	(0,0024)	(0,1619)	(0,1271)	(0,2919)		
BMEB4	0,0010*	0,223*	0,0205	-0,0791	0,0204	455,5*
	(0,0019)	(0,1269)	(0,1125)	(0,222)		
BMIN4	0,0014*	0,4477*	0,0634	-0,1938	0,0187	5,9
	(0,002)	(0,139)	(0,1269)	(0,2423)		
BNBR3	0,0024*	0,2721*	0,0658	-0,3530	0,0220	94,0*
	(0,003)	(0,1819)	(0,1935)	(0,3237)		
BPAC11	0,0015*	1,1974*	-0,0361	-0,2066	0,4531	453,1*

	(0,0029)	(0,1785)	(0,1197)	(0,3224)		
BPAN4	0,0007*	0,7718*	-0,0469	-0,2319	0,1577	718,9*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
BRIV3	0,0009*	0,139*	0,0604	0,0693	0,0006	3,1
	(0,0024)	(0,1676)	(0,1853)	(0,2909)		
BRIV4	0,0008*	0,2043*	-0,0134	-0,1693	0,0192	75,1*
	(0,002)	(0,1359)	(0,119)	(0,2349)		
BRSR3	0,0019*	0,3459*	0,0312	-0,1894	0,0130	48,5*
	(0,0023)	(0,1504)	(0,1181)	(0,2595)		
BRSR5	0,0047*	0,4695*	0,0434	-0,0859	0,0047	94,2*
	(0,0037)	(0,2441)	(0,1652)	(0,4178)		
BRSR6	0,0004*	0,8972*	-0,0138	-0,2684	0,3416	257,3*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
BSLI3	0,0149*	0,2472*	-0,0499	1,3486**	0,0017	137,4*
	(0,0052)	(0,3846)	(0,1583)	(0,5846)		
BSLI4	0,0170*	1,1106*	0,0603	2,0053*	0,0089	103,4*
	(0,0051)	(0,3502)	(0,1628)	(0,5627)		
CRIV3	0,0170*	-0,4980*	0,0041	0,7383*	-0,0015	0,0
	(0,0024)	(0,158)	(0,124)	(0,2796)		
CRIV4	0,0009*	0,2353*	-0,0412	-0,0879	0,0244	2357,5*
	(0,0014)	(0,0969)	(0,0831)	(0,1687)		
ITUB3	0,0003*	0,8535*	-0,0061	-0,0960	0,5694	386,7*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
ITUB4	0,0002*	1,0312*	0,0005	-0,0402	0,6676	371,4*
	(0,0017)	(0,1167)	(0,11)	(0,202)		
MERC4	0,0049*	-0,0476*	0,0658	-0,3462	-0,0032	2,4
	(0,004)	(0,2231)	(0,1502)	(0,4451)		
PINE4	0,0002*	0,5150*	0,0216	-0,0751	0,0898	6332,7*
	(0,001)	(0,0674)	(0,0635)	(0,1167)		
SANB11	0,0003*	0,9758*	0,0381	-0,0458	0,4808	335,8*
	(0,0018)	(0,1209)	(0,1122)	(0,2078)		
SANB3	0,0008*	0,9095*	0,0228	-0,0319	0,1471	245,4*
	(0,0017)	(0,1183)	(0,1101)	(0,2044)		
SANB4	0,0009*	0,8100*	0,0139	-0,1322	0,1423	182,2*
	(0,0017)	(0,1174)	(0,1101)	(0,2036)		
Nº significant	31/31	31/31	0/31	3/31	-	26/31

Source: Elaborated by authors.

The coefficients related to the Market Index proved to be statistically significant, pointing to a considerable impact of market risk on asset returns. It is noteworthy that in almost all cases this impact was positive, except for the MERC4 and CRIV3 assets. This suggests that, in virtually all situations, an increase in the return of the Market Index is associated with an increase in daily stock returns. This conclusion indicates the presence of a systemic component in the market that exerts influence on the returns of bank stocks, highlighting the interconnection and dependence of stocks on the behavior of the market as a whole.

On the other hand, the coefficients related to the Interest Rate did not demonstrate statistical significance, indicating the absence of influence of the interest rate on asset returns. This relationship is indeed ambiguous since arguments can be made both for and against the idea that increases in interest rates would affect banks' bottom lines. On the one hand, an increase in interest rates can increase the profitability of banks, since the remuneration of their loans is linked to interest rates. On the other hand, if a bank has a significant and leveraged liability, the costs of its debts can hurt its financial results.

Regarding the coefficients associated with exchange rates, although they were negative, they were statistically significant only for three assets, which indicates a relatively weak effect of the Exchange Rate on daily returns. This observation suggests that, in the context of the analysis, fluctuations in exchange rates have a limited impact on banks' stock returns, affecting only a limited number of assets in a notable way.

The first coefficient, representing the intercept of the models, was statistically significant in all scenarios. This implies that these results can be considered as estimates of the average population returns of the stocks, controlling for the effect of the explanatory variables.

As previously mentioned, these models are applied under the premise of homoscedasticity and normality of the residuals. In the last column of Table 3, a test is presented to verify the presence of heteroscedasticity and autocorrelation of errors, concluding that the null hypothesis of the test is rejected, indicating heteroscedasticity. It is observed that most of the models show signs of heteroscedasticity, covering 26 of the 31 analyzed models. This suggests that OLS estimates are biased in cases of heteroscedasticity.

Therefore, GARCH models are more appropriate for modeling returns, as they incorporate other characteristics of financial series, such as volatility clusters, allowing more accurate estimates of the effects of explanatory variables on stock returns of banks on the stock exchange and, consequently, a better inference statistic. The results of the estimated models are shown in Table 4.

Table 4: GARCH (1,1) Results

	Intercept	Market	Interest	Exchange	α_0	α_1	β
ABCB4	0,0005***	0,7279*	-0,0317***	-0,2285*	0,0000*	0,0565*	0,9142*
	(0,0003)	(0,0145)	(0,0173)	(0,0334)	(0,0000)	(0,0032)	(0,0056)
BAZA3	0,0005	0,3300*	0,0191	-0,0158*	0,0000*	0,0982*	0,8359*
	(0,0003)	(0,223)	(0,0288)	(0,0499)	(0,0000)	(0,0135)	(0,0219)
BBAS3	0,0003	1,1792*	0,0059	-0,2300*	0,0000*	0,0941*	0,8768*
	(0,0002)	(0,0157)	(0,0235)	(0,0265)	(0,0000)	(0,0106)	(0,0136)
BBDC3	0,0002	1,0505*	0,0251**	-0,0597*	0,0000*	0,0665*	0,8934*
	(0,0002)	(0,0117)	(0,0111)	(0,0219)	(0,0000)	(0,0027)	(0,0074)
BBDC4	0,0003	1,0930*	0,0328*	-0,0565*	0,0000*	0,0707*	0,8893*
	(0,0002)	(0,0101)	(0,0111)	(0,0191)	(0,0000)	(0,0093)	(0,0207)
BEES3	0,0005	0,3443*	-0,0043	-0,026	0,0000*	0,0947*	0,9042*
	(0,0004)	(0,0226)	(0,0458)	(0,0405)	(0,0000)	(0,0075)	(0,0089)
BEES4	0,0016*	0,3235*	0,0067	-0,0305	0,0000*	0,1049*	0,8940*
	(0,0005)	(0,0317)	(0,07104)	(0,0499)	(0,0000)	(0,0134)	(0,0103)
BGIP3	0,0071***	0,1520	-0,0132	-0,0944	0,0000*	0,0054*	0,9902*
	(0,0039)	(0,2144)	(0,2913)	(0,4750)	(0,0000)	(0,0028)	(0,0028)
BGIP4	0,0013**	0,2615*	-0,0258	-0,3269*	0,0000*	0,1258*	0,8203*
	(0,0006)	(0,0309)	(0,0370)	(0,0684)	(0,0000)	(0,0222)	(0,0292)
BMEB3	0,0020**	-0,0044	-0,0528	-0,3622*	0,0000*	0,0988*	0,8742*
	(0,0010)	(0,0624)	(0,0908)	(0,1194)	(0,0000)	(0,0175)	(0,0201)
BMEB4	0,0005	0,1944*	0,0092	-0,1137**	0,0000*	0,1350*	0,8120*
	(0,0003)	(0,0239)	(0,0293)	(0,0463)	(0,0000)	(0,0201)	(0,0284)
BMIN4	0,0014	0,4538*	0,0627	-0,1623	0,0000*	0,0000*	0,0000*
	(0,0014)	(0,0788)	(0,0958)	(0,1214)	(0,0000)	(0,0000)	(0,0000)
BNBR3	0,0015	0,2710*	0,0852	-0,3726*	0,0000*	0,1049*	0,8646*
	(0,0013)	(0,0710)	(0,1181)	(0,0013)	(0,0000)	(0,0298)	(0,0474)
BPAC11	0,0016*	1,1030*	-0,0542*	-0,1876*	0,0000*	0,1291*	0,8219*
	(0,0006)	(0,0360)	(0,0185)	(0,0609)	(0,0000)	(0,0242)	(0,0357)
BPAN4	0,0004	0,5900*	-0,0240	-0,2433*	0,0000*	0,2567*	0,7141*
	(0,0004)	(0,0241)	(0,0191)	(0,0417)	(0,0000)	(0,0286)	(0,0298)
BRIV3	0,0017	0,1345***	0,0165	-0,0343	0,0000*	0,0000*	0,0000*
	(0,0010)	(0,0763)	(0,0957)	(0,1056)	(0,0000)	(0,0000)	(0,0000)
BRIV4	0,0008	0,2093*	-0,0232	-0,1620*	0,0000*	0,2445*	0,5311*
	(0,0005)	(0,0347)	(0,0377)	(0,0620)	(0,0000)	(0,0444)	(0,0737)
BRSR3	-0,0007	0,2739*	0,0153	-0,2168**	0,0000*	0,0440*	0,9549*
	(0,0009)	(0,0725)	(0,1272)	(0,1129)	(0,0000)	(0,0046)	(0,0043)
BRSR5	0,0038	0,4221**	0,0202	-0,1973	0,0000*	0,0551*	0,9386*
	(0,0033)	(0,1974)	(0,2329)	(0,3683)	(0,0000)	(0,0094)	(0,0086)
BRSR6	0,0005	0,8797*	-0,0169	-0,2640*	0,0000*	0,0945*	0,8511*
	(0,0003)	(0,0217)	(0,0293)	(0,0337)	(0,0000)	(0,0160)	(0,0268)
BSLI3	0,0084	0,4642	-0,0086	1,8840*	0,0000*	0,1294*	0,8695*
	(0,0109)	(0,5445)	(0,2945)	(0,5976)	(0,0000)	(0,0142)	(0,0109)
BSLI4	0,0001	0,7046**	0,1933	-0,7807**	0,0000*	0,7950*	0,2039*

	(0,0043)	(0,3139)	(0,1255)	(0,4135)	(0,0000)	(0,0964)	(0,0778)
CRIV3	-0,0017	0,3624**	0,0278	-0,0328	0,0000*	0,4564*	0,1749*
	(0,0024)	(0,1838)	(1,6021)	(0,3631)	(0,0000)	(0,0642)	(0,0714)
CRIV4	0,0008***	0,1996*	-0,0648*	-0,1495*	0,0000*	0,0194*	0,9781*
	(0,0004)	(0,0292)	(0,0223)	(0,0533)	(0,0000)	(0,0004)	(0,0003)
ITUB3	0,0003***	0,8554*	0,0005	-0,0937*	0,0000*	0,0713*	0,8821*
	(0,0002)	(0,0103)	(0,0110)	(0,0223)	(0,0000)	(0,0044)	(0,0073)
ITUB4	0,0002	1,0346*	-0,0042	-0,0420**	0,0000*	0,0634*	0,9020*
	(0,0002)	(0,0087)	(0,0093)	(0,0200)	(0,0000)	(0,0034)	(0,0060)
MERC4	0,0014	0,2105	0,0890	0,0563	0,0000*	0,0517*	0,9000*
	(0,0033)	(0,1734)	(0,0830)	(0,3359)	(0,0000)	(0,0011)	(0,0062)
PINE4	-0,0003	0,5217*	0,0678*	-0,0347	0,0000*	0,1039*	0,8850*
	(0,0004)	(0,0110)	(0,0106)	(0,0435)	(0,0000)	(0,0049)	(0,0029)
SANB11	0,0003	0,9753*	0,0382**	-0,0489***	0,0000*	0,0557*	0,9094*
	(0,0002)	(0,0158)	(0,0151)	(0,0295)	(0,0000)	(0,0031)	(0,0059)
SANB3	0,0008	0,9628*	0,0155	-0,0296	0,0000*	0,0626*	0,9257*
	(0,0005)	(0,0372)	(0,0393)	(0,0658)	(0,0000)	(0,0104)	(0,0109)
SANB4	0,0008***	0,8540*	0,0087	-0,1182***	0,0000*	0,0861*	0,8940*
	(0,0005)	(0,0357)	(0,0416)	(0,0626)	(0,0000)	(0,0114)	(0,0135)
Nº Significants	9/31	27/31	7/31	21/31	31/31	31/31	31/31

Source: Elaborated by authors.

From the GARCH model, it is possible to see that the effect of market risk is significant in 92% of assets. In addition, this effect was positive in 96% of the cases, which is in agreement with the result observed in the OLS model. This result is well consolidated and expected and incorporates how the systemic risk ratio affects banking sector stocks.

In the case of the exchange rate, after refining the model to better control the error, it was possible to observe a significant effect on the daily return of 81% of the assets. This effect, in turn, proved negative in 95% of cases, indicating that an increase in exchange rate returns is associated with a decrease in daily stock returns. This inverse relationship between exchange rates and stock returns is influenced by several characteristics of economic-financial dynamics.

In general, an appreciation of the local currency, in this case the real, is often explained by flows of dollars entering the country, being directed mainly to financial assets. This means that a scenario of appreciation of the national currency is often linked to an increase in demand for local bonds and investments, leading to an increase in the value of shares. In addition, the fall of the dollar is often associated with a lower perception of risk in financial markets, which tends to favor assets considered riskier, such as stocks in general. Therefore, the identification of this negative effect of exchange rates on stock returns is a relevant finding that helps to better understand the dynamics of interactions between the foreign currency and equity markets.

As evidenced, the interest rate presented statistical significance in only 33% of the cases analyzed. This suggests that, based on the data obtained, the effect of the interest rate on daily asset returns appears to be relatively weak, despite the possible theoretical relationships. This finding indicates that other factors may have a more substantial influence on the returns of bank stocks on the stock exchange compared to the interest rate measured by the CDI.

Alternatively, when we examine the conditional variance equation, we note that the constant term (term 0) is positive and statistically significant in all scenarios, which points to the existence of a constant and significant component in time in the process of generating asset returns. In addition, the parameters ARCH and GARCH meet the condition of non-negativity. Most importantly, the GARCH parameters are significantly higher than the ARCH parameters, suggesting that the volatility of each asset's returns is more sensitive to its own lagged values than to external factors. This result emphasizes the importance of considering past volatility in modeling future volatilities of asset returns, contributing to a better understanding and prediction of price movements in the financial market.

5. Conclusion

The present work sought to verify the influences of the interest rate, the exchange rate, and the main stock index of the Brazilian stock exchange on the stock returns of Brazilian banks. Our analysis focused on the evaluation of the impact of the Market Index like Ibovespa, interest rates like CDI, and Exchange Rate like currency fluctuations in the daily returns of shares of financial institutions, as measured by PTAX, with daily data for the period from January 2009 to December 2021.

The econometric analysis used two statistical models: the Ordinary Least Squares (OLS) model and the GARCH time series model. In this way, it was evaluated how the market, interest rates, and exchange rate fluctuations affect the daily returns of the shares of financial institutions. The results indicated that, due to the characteristics of the data, the GARCH model was more adequate to analyze the context of this work.

In addition, we identified that the distribution of stock returns presents an asymmetry, with an elongated tail on the right. By applying the model, we found that daily stock returns are significantly influenced by the behavior of the Ibovespa and exchange rates, while the interest rate exerts a relatively minor impact on these returns, which was also evidenced in the study conducted by Andrade et Al. (2022) on the influence of macroeconomic indicators on the behavior of shares of financial institutions listed on the Brazilian stock exchange. These results contribute to a deeper understanding of the factors that affect stock returns in the financial sector, providing valuable insights for investors, market analysts, and financial regulators. These findings have relevance both for the scientific community investigating finance and banking, as well as for decision-making by financial industry leaders, market analysts, investors, regulatory authorities, and society at large. Contributions from future research could bring an evaluation of the impact of these indicators in other sectors of the economy, seeking possible comparisons and relationships with the results of this work.

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