

Impacts of investors' rational and irrational sentiment on the Brazilian market

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Received on 08/09/2022 – Desk acceptance on 08/29/2022 – 3rd version approved on 05/22/2023

Editor-in-Chief: approved by Fábio Frezatti, published by Andson Braga de Aguiar

Associate Editor: Andrea Maria Accioly Fonseca Minardi

ABSTRACT

This article aimed to determine how rational and irrational investor sentiments impact the return and volatility of the Brazilian market. The role of sentiment in financial markets is still a recent, controversial and limited subject, and this study explores this relationship in the Brazilian market. The evidence from this research adds to the limited number of studies on investor sentiment in emerging markets and extends the evidence already documented in Brazil. Our results are expected to have an impact on investors, policymakers and monetary authorities. Investors must be aware of economic fundamentals when formulating their investment strategies and also when choosing the stocks that will make up their portfolios. Policymakers and monetary authorities should take sentiment into account when formulating political, economic and monetary strategies, as economic changes can affect investor psychology and be reflected in their stock market trading. Consumer and business confidence indexes were used as proxies for investor sentiment and were regressed against a set of economic fundamentals to isolate their rational and irrational components. Then, autoregressive vector models were estimated and impulse response functions and variance decompositions were generated to verify the impact of sentiment on the return and volatility of the Ibovespa. There are three main results. First, investor sentiment impacts both returns and volatility in the Brazilian market. Second, economic fundamentals were important determinants of returns and volatility in the Brazilian market, indicating that fundamental trading induced by rational sentiment had a greater effect than trading induced by irrational sentiment. Third, in terms of magnitude, consumer-based sentiment had a greater impact than business-based sentiment.

Keywords: investor sentiment, stock market, Ibovespa.

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This is a bilingual text. This article has also been translated into Portuguese and published under the DOI <https://doi.org/10.1590/1808-057x20231760.pt>

Study presented at the 21st USP International Conference on Accounting, São Paulo, SP, Brazil, July 2021.



Impactos dos sentimentos racionais e irracionais dos investidores no mercado brasileiro

RESUMO

O objetivo deste artigo foi determinar como os sentimentos racionais e irracionais dos investidores afetam o retorno e a volatilidade do mercado brasileiro. O papel do sentimento nos mercados financeiros ainda é um assunto recente, controverso e limitado, e este estudo explora essa relação no mercado brasileiro. As evidências dessa pesquisa se somam ao número limitado de estudos sobre o sentimento do investidor em mercados emergentes e ampliam as evidências já documentadas no Brasil. Espera-se que nossos resultados tenham impacto sobre investidores, formuladores de políticas e autoridades monetárias. Os investidores devem estar cientes dos fundamentos econômicos ao formularem suas estratégias de investimento e também ao escolherem as ações que irão compor seus portfólios. Os formuladores de políticas e as autoridades monetárias devem levar em conta o sentimento ao formular estratégias políticas, econômicas e monetárias, pois as mudanças econômicas podem afetar a psicologia do investidor e se refletir em suas negociações no mercado de ações. Os índices de confiança do consumidor e empresarial foram usados como proxies para o sentimento do investidor e foram regredidos em relação a um conjunto de fundamentos econômicos para isolar seus componentes racionais e irracionais. Em seguida, modelos vetoriais autorregressivos foram estimados e funções de resposta a impulsos e decomposições de variância foram geradas para verificar o impacto do sentimento sobre o retorno e a volatilidade do Ibovespa. Há três resultados principais. Primeiro, o sentimento do investidor afeta tanto o retorno quanto a volatilidade do mercado brasileiro. Segundo, os fundamentos econômicos foram importantes determinantes dos retornos e da volatilidade no mercado brasileiro, indicando que a negociação fundamental induzida pelo sentimento racional teve um efeito maior do que a negociação induzida pelo sentimento irracional. Terceiro, em termos de magnitude, o sentimento baseado no consumidor teve um impacto maior do que o sentimento baseado nos negócios.

Palavras-chave: sentimento do investidor, mercado de ações, Ibovespa.

1. INTRODUCTION

Financial asset prices are believed to be affected by both fundamental risk factors and investor sentiment (Baur, Quintero & Stevens, 1996). The first aspect involves factors that have been shown in the asset pricing literature to contain non-redundant information and are therefore rational risk factors. These factors include, but are not limited to, the growth rate of the economy, interest rates, inflation, business conditions, terms of trade and exchange rate fluctuations. All of these contain essential information about the general economy and generate expectations about future returns (Bayram, 2017).

The second perspective focuses on the stock market's reaction to investor sentiment, which, according to Baker and Wurgler (2006), is defined as investors' optimism or pessimism about future stock prices that cannot be explained by existing facts and thus is not rationally justified. The connection between the stock market and sentiment-driven trading has long been established by behavioral models (Black, 1986; De Long, Shleifer, Summers & Waldmann, 1990; Shleifer & Summers, 1990; Barberis, Shleifer & Vishny, 1998; Daniel, Hirshleifer & Subramanyam, 1998). All of these models predict the activity of a group of irrational investors (noise traders)

whose desires, emotions and cognitive errors can affect their preferences for certain stocks (Shefrin & Statman, 1984). Consequently, a higher incidence of noise trading can affect financial market returns and volatility due to unpredictable changes in sentiment.

Clearly, these perspectives provide inconclusive and conflicting results because the rational expectations theory emphasizes fundamentals while the behavioral theories of asset pricing focus on investor sentiment (Bayram, 2017). However, Verma and Soydemir (2006) found that investor sentiment can reflect fully rational expectations based on fundamentals, irrational enthusiasm or a combination of the two. Following Verma and Soydemir (2006), some other studies have been conducted in this respect, including those of Verma, Baklaci and Soydemir (2008), Calafiore, Soydemir and Verma (2009), Verma and Soydemir (2009), Sayim and Rahman (2015a), Sayim and Rahman (2015b) and Bayram (2017), all of which find evidence that investor sentiment has rational and irrational components with potential impacts on the stock market.

However, most of the studies in this literature stream have investigated the financial markets of the United States (U.S.) (Verma & Soydemir, 2006; Verma et al.,

2008; Verma & Soydemir, 2009) and Turkey (Sayim & Rahman, 2015a, 2015b; Bayram, 2017). Only one study, now outdated, investigated the Brazilian market (Calafiore et al., 2009). In addition, these studies have primarily examined the influence of investor sentiment on stock returns. Much less attention has been paid to the volatility of returns. According to Black (1986), the noise resulting from trading activities can affect the level and volatility of financial asset prices. If investors base their trading decisions on their sentiments, extreme shifts in sentiment will temporarily lead to more trading noise, higher pricing errors and excessive volatility, creating uncertainty about future investment returns.

In Brazil, an important emerging economy, there is little evidence about the impact of investor sentiment on the stock market. In addition to the study by Calafiore et al. (2009), a few other papers have been published, including those by Yoshinaga and Castro (2012), Xavier and Machado (2017), Piccoli, Costa Jr., Silva and Cruz (2018) and Souza and Martins (2022). However, they did not address both rational and irrational sentiments and the possible impact on returns and market volatility. In this context, there is clearly room for new research that explores this gap in the literature. In this study, we determined how rational and irrational investor sentiments impact the return and volatility of the Brazilian market.

Consistent with previous literature, we used the Consumer Confidence Index (CCI) and the Business Confidence Index (BCI) as proxies for investor sentiment. Based on a strategy already consolidated in previous research, we isolated the rational and irrational components of investor sentiment and generated impulse

response functions (IRFs) and variance decompositions for return and volatility from two vector autoregressive (VAR) models. We found the following empirical results: (i) an increase in investor sentiment impacts returns and volatility in the Brazilian stock market in early periods; (ii) economic fundamentals play a strong role as determinants of returns and volatility in the Brazilian stock market, indicating that the fundamental trading induced by rational sentiment has a greater effect than the noise trading induced by irrational sentiment; and (iii) in terms of magnitude, consumer sentiment has a much greater impact on returns and volatility than business sentiment. Robustness tests confirm these results.

Our results contribute theoretically by establishing an updated relationship between investor sentiment and the return and volatility of the Brazilian stock market, and add to the limited number of studies on investor sentiment in emerging markets. Our findings also have important implications for investors, policymakers and monetary authorities. Investors should pay close attention to economic fundamentals when formulating their strategies and also when choosing the stocks for their portfolios. Given that sentiment is an important determinant of returns and volatility, investors should be aware of these measures at all times. Policymakers and monetary authorities should also take investor sentiment into account when formulating political, economic and monetary strategies. This is important because the impact of fundamental trading is greater than that of noise trading, so changes in key variables such as foreign exchange rates, interest rates and inflation can affect investor psychology and be reflected in their stock market trading.

2. LITERATURE REVIEW

Behavioral finance challenges traditional financial models based on the idealized “rational investor” and argues that some financial phenomena can be better explained using models that assume some degree of investor irrationality (De Long et al., 1990). According to these authors, the presence of irrational investors in financial markets limits the trading of rational investors who pay attention to economic fundamentals, because although rational investors are able to react to fundamental risks, they are still subject to the irrational risk of investor sentiment. According to Sayim and Rahman (2015b), phenomena such as herding behavior, bubbles and crashes are motivated to a greater extent by investor sentiments

than by market fundamentals. Another consequence of noise traders is their joint trading, which leads to a rapid increase in trading volumes, resulting in increased market volatility (Blasco, Corredor & Ferrer, 2018; Economou, Hassapis & Philippas, 2018).

While some studies have focused on one type of trading or the other, a more recent stream of research in the financial literature seeks to understand the joint impact of rational and irrational sentiment on stock market performance. Verma and Soydemir (2006) analyzed the degree to which the rational and irrational sentiments of individual and institutional investors in the U.S. are propagated abroad. The IRFs from the estimates of a VAR

model showed that the rational and irrational sentiments of the two classes of investors impacted the returns of the domestic and foreign stock markets in different ways. Specifically, in the U.S., both classes of investors were shown to have a strong and significant effect on stock market returns. In the international context, U.S. institutional investor sentiment affected the markets in Brazil, Mexico and the United Kingdom (UK) to varying degrees, but had no effect in Chile. The effect of individual investor sentiment was statistically significant only for the UK stock market.

Verma et al. (2008) examined the effects of rational and irrational investor sentiments on the returns of the Dow Jones Industrial Average (DJIA) and Standard & Poor's 500 (S&P 500) indexes. The main results indicated that the impact of rational sentiment was greater than that of irrational sentiment for both individual and institutional investors. However, irrational sentiment had a quicker and more pronounced effect than rational sentiment. Calafiore et al. (2009) investigated the effects of rational and irrational investor sentiments on the returns of the Brazilian market and found the following results: (i) the effect of rational business and consumer sentiments on Ibovespa returns was positive and significant in the first month and insignificant thereafter; (ii) the impact of rational sentiment was greater than that of irrational sentiment; and (iii) business sentiment had a much greater impact than consumer sentiment. In another related study, Verma and Soydemir (2009) investigated the effects of the rational and irrational sentiment of individual and institutional investors on the market price of risk for the DJIA and S&P 500 indexes. The results indicated that for both individual and institutional investors, an increase in irrational optimism led to a significant downward movement, but an increase in rational sentiment did not lead to a significant change in the market price of risk for either market index.

The emerging market of Turkey has also been extensively studied. Sayim and Rahman (2015b) examined the impact of individual investors' sentiment on the return and volatility of the Istanbul Stock Exchange (ISE). Supported by the IRFs from the estimates of a VAR model, the authors showed that unexpected changes in rational and irrational investor sentiment had a positive and significant impact on stock returns. They also showed that an unexpected increase in rational investor sentiment had a significant and negative effect on market volatility. In addition, Sayim and Rahman (2015a) presented evidence that the returns and volatility of the Turkish market also

appear to have been affected by the rational and irrational sentiments of individual and institutional investors in the U.S. They found that the impact of institutional investors was greater than that of individual investors; and that the effect of rational sentiment on the return of the ISE was faster, although not necessarily greater, than that of irrational sentiment.

In another study in Turkey, Bayram (2017) analyzed the effects of the rational and irrational sentiments of two classes of investors on the returns of the ISE. The IRFs from the estimates of a VAR model showed that the impact generated by rational sentiment was greater than that generated by irrational sentiment. In addition, the immediate reactions of the Turkish market to sudden increases in the sentiment component driven by fundamentals were positive and significant in the first three months, unlike the reactions to the irrational component, which were insignificant at both the consumer and business levels.

PH and Rishad (2020) constructed an irrational sentiment index from sentimental market-oriented factors (trading volume, market turnover, stock turnover, number of initial public offerings, among others) using principal component analysis and explored the role of irrational investor sentiment on Indian market volatility. Based on causality tests, the results showed that irrational sentiment significantly causes excess volatility. Wang, Su and Duxbury (2021) assessed the impact of investor sentiment on future stock returns in 50 global stock markets. Using the CCI as a sentiment proxy, they found a negative relationship between investor sentiment and stock returns over two to 12 month horizons. Splitting the sample into developed and emerging markets did not affect the negative relationship.

This evidence suggests that financial markets tend to be affected, at least to some degree, by rational and irrational investor sentiments. Studies have suggested that the Brazilian stock market appears to be affected by behavioral biases and investor psychology. Yoshinaga and Castro (2012) found evidence of a significant and negative relationship between investor sentiment and stock returns. Xavier and Machado (2017) showed that value anomalies may be impacted by investor sentiment. Piccoli et al. (2018) found that the risk-return relationship is positive (negative) in periods of pessimistic (optimistic) sentiment, and that the deterioration of this relationship is related to the growth of less sophisticated investors in the Brazilian market. Souza and Martins (2022) found that investor sentiment is positively correlated with returns,

but negatively correlated with trading volume, and that although there is a dynamic relationship between the variables, sentiment explains the return of the Brazilian stock market only at moments of lower returns. However, these studies did not consider both rational and irrational

sentiments and their possible impact on returns and market volatility together. These characteristics imply the need for a better understanding of the effects of investor sentiment on the Brazilian market. This is the gap we aim to fill here.

3. DATA AND METHOD

Investor sentiment is shaped by rational expectations based on risk factors as well as irrational expectations (Verma et al., 2006; Verma et al., 2008; Sayim & Rahman, 2015a, 2015b; Bayram, 2017). Consistent with this literature, investor sentiment can be broken down into (i) the rational (fundamental) component and (ii) the irrational (residual) component. Although there are several measures of sentiment, such as liquidity, the dividend premium, the number of initial public offerings and their average return on the first day of trading (Baker & Wurgler, 2006), and sentiment indexes such as those created by Baker and Wurgler (2006) and Brown and Cliff (2005), we use the CCI and BCI as proxies for sentiment. The choice of these indexes is similar to that of Verma et al. (2008), Calafiore et al. (2009), Schmeling (2009), Sayim and Rahman (2015a; 2015b), Bayram (2017) and Piccoli et al. (2018), who also used the scores of opinion indexes. As highlighted by Baker and Wurgler (2006), there are no undisputed or definitive measures of investor sentiment.

Zhou (2018) highlights that opinion surveys are limited in terms of scope and frequency, and tend to be based on a small group of respondents. Furthermore, the answers are approximate estimates and are highly dependent on how the survey was designed (written and interpreted) and on the respondents' willingness to tell the truth. Nevertheless, survey data provide a unique perspective on how investors form their beliefs and may contain important information about future stock returns.

To extract the rational and irrational components, we regress each sentiment measure against a set of economic factors. The residuals from the regression equation are then used as irrational sentiment and the predicted value of the equation as rational sentiment. For this, we adapted equations (1) and (2) from previous works (Verma & Soydemir, 2006; Verma et al., 2008; Calafiore et al., 2009; Verma & Soydemir, 2009; Sayim & Rahman, 2015a, 2015b; Bayram, 2017):

$$Sent_{1t} = \gamma_0 + \gamma_j \sum_{j=1}^J Fund_{jt} + \xi_t \quad \boxed{1}$$

$$Sent_{2t} = \theta_0 + \theta_j \sum_{j=1}^J Fund_{jt} + \vartheta_t \quad \boxed{2}$$

We included several variables as economic factors that are representative of the fundamentals of the Brazilian market. The choice of these variables was supported by their use in previous research (Verma et al., 2008; Calafiore et al., 2009; Verma & Soydemir, 2009; Sayim & Rahman, 2015a, 2015b; Bayram, 2017), the availability of monthly data for Brazil, and the inclusion of non-redundant information in the asset pricing literature. The variables included were: (i) economic growth, represented by the industrial production index; (ii) interest rate, represented by the benchmark rate of the Brazilian Central Bank (SELIC); (iii) inflation, represented by the Comprehensive Consumer Price Index (IPCA); (iv) exchange rate fluctuations, represented by changes in the exchange rate of the Brazilian real and the US dollar; (v) terms of trade, represented by the monthly ratio between trade-weighted export and import prices; and (vi) economic uncertainty, represented by the Economic Uncertainty Index in Brazil. Data on industrial production, interest rate, inflation, exchange rate and terms of trade were obtained from the Instituto de Pesquisa Econômica Aplicada (IPEA). The series on sentiment and economic uncertainty were obtained from the Fundação Getúlio Vargas (FGV). After estimating equations 1 and 2, we isolated the rational components ($Fund_{1t}$ and $Fund_{2t}$ – effects induced by economic fundamentals) and the irrational components (ξ_t and ϑ_t – the portion not explained [error] by fundamentals).

We also used Ibovespa (Ibov) returns and volatility. The Ibovespa is the most important indicator of the average performance of stocks traded on the [B]³. The return variable is obtained by calculating the log-return of the

monthly closing prices of the stocks that make up this index. For volatility, we used the standard deviation of continuously compounded returns. The monthly closing data used to calculate these variables were collected from the Economática database. It is important to note that, although the standard deviation has limitations as a measure of volatility, the number of observations in the period ($n = 133$) makes it impossible to use autoregressive conditional heteroscedasticity (ARCH) models or their variants. Hwang and Pereira (2010) proposed that at least 250 observations are required for ARCH (1) models and 500 observations for GARCH (1,1) models because smaller samples rarely explain the volatility of the financial series with accuracy.

In possession of the data series, we estimated VAR models to verify the impact of rational and irrational sentiments on the return and volatility of the Brazilian market. The VAR model was originally proposed by Sims (1980), and is a multiple equation system in which each variable is a function of its lagged values, the current and lagged values of the other variables included in the system, and the error term (Sims, 1980). In general terms, the VAR model can be represented as follows:

$$x_t = \sum_{i=1}^p \Phi_i x_{t-i} + \Psi w_t + \varepsilon_t, \quad t = 1, 2, \dots, T, \quad \boxed{3}$$

where $x_t = (x_{1t}, x_{2t}, \dots, x_{mt})$ is an $m \times 1$ vector of jointly determined dependent variables, p is the number of lags, w_t is a $q \times 1$ vector of exogenous variables; and Φ_i ($m \times m$ vectors) and Ψ ($m \times q$ vectors) are matrices of coefficients. The VAR model is only stable if the included variables are stationary (Senna & Souza, 2016). This requirement is met because the procedure for extracting the rational and irrational components of sentiment produces stationary series. In addition, it is necessary to define the minimum number of lags, p , that guarantees the absence of autocorrelation. For this, an auxiliary VAR was fitted, with an arbitrary number of lags varying from $p = 1, \dots, p = 8$, and we then applied tests/criteria to select the best model.

VAR modeling requires caution in the decomposition used to generate the vector of autocorrelated innovations. Sims (1980) proposed a triangular method of decomposing the residuals, called the Cholesky decomposition. This

decomposition has wide appeal in the literature because of the dynamic effects provided by the method of orthogonalizing the variables. However, this procedure attributes the entire systemic effect to the first variable in the model, so changes in the order of the variables can influence later analyses (Vartanian, 2012; Senna & Souza, 2016). Because of this, it is recommended to order the variables according to their degree of endogeneity (Vartanian, 2012).

After validating the model, we analyzed the impulse response function and variance decomposition. The first allows the verification of the reaction of a variable in the presence of external disturbances in the system of variables of the model, i.e., it allows the verification of the positive or negative effects that occur in a variable due to changes in the other variables of the system (Chris, 2008). The second allows the verification of the percentage contribution of each variable over time. Through this analysis, it was possible to identify the impact caused by random disturbances on the variance of all variables for n periods ahead according to the VAR model.

We estimated two VAR models, each with five variables. The first included Ibovespa returns and the other sentiment variables. The second included volatility and other sentiment measures. The rational and irrational sentiments of the two classes of investors were included together in the models to avoid specification errors. According to Verma and Soydemir (2009), shocks caused by the sentiment of one class of omitted investors can be misinterpreted as reflecting the sentiment of another class of investors. The models also had two exogenous variables, one dummy for the period of the *Lava Jato* ("Car Wash") corruption investigation and another for the Covid-19 pandemic. These variables were included solely to capture possible external shocks that could affect the system, and therefore are not variables of primary interest in this study.

3.1 Variables and Descriptive Statistics

We used monthly data from July 2009 to August 2020. This period was chosen because it was after the 2008 financial crisis and also after the study by Calafiore et al. (2009). Table 1 shows the descriptive statistics of the variables used in this study.

Table 1
Descriptive statistics (period from July 2009 to August 2020, monthly data)

	SENT ₁	SENT ₂	EXCH	INF	INT	GROWTH	ECUN	TOT	RIBOV	VIBOV
Mean	95.197	93.996	2.851	0.443	0.750	93.618	108.726	113.731	0.002	0.002
Median	98.600	94.650	2.815	0.430	0.770	93.500	105.700	112.540	0.003	0.001

Table 1

Cont.

	SENT ₁	SENT ₂	EXCH	INF	INT	GROWTH	ECUN	TOT	RIBOV	VIBOV
Maximum	112.600	114.900	5.642	1.320	1.220	112.600	210.500	132.650	0.068	0.014
Minimum	57.600	55.700	1.563	-3.380	0.160	60.400	85.100	96.250	-0.154	0.000
Std. Dev.	12.276	13.001	0.998	0.322	0.241	10.171	18.576	8.322	0.028	0.002
Skewness	-1.041	-0.511	0.562	0.349	-1.176	-0.306	2.704	0.211	-1.190	3.017
Kurtosis	3.342	2.618	2.557	3.391	2.389	2.743	12.893	2.577	8.809	20.735

Note: Variables are consumer sentiment ($SENT_1$), business sentiment ($SENT_2$), exchange rate ($EXCH$), inflation (INF), interest rate (INT), economic growth ($GROWTH$), economic uncertainty ($ECUN$), terms of trade (TOT), Ibovespa return ($RIBOV$) and Ibovespa volatility ($VIBOV$). All statistics are based on 133 observations.

Source: Prepared by the authors.

The measures of sentiment behaved in a very similar way. Most of the variables had an asymmetric distribution, either to the left or to the right of the mean. Kurtosis was

also observed in consumer sentiment, inflation, economic uncertainty, Ibovespa returns and volatility.

Table 2

Correlation (period from July 2009 to August 2020, monthly data)

	SENT ₁	SENT ₂	EXCH	INF	INT	GROWTH	ECUN	TOT	RIBOV	VIBOV
SENT₁	1.000									
SENT₂	0.867	1.000								
EXCH	-0.566	-0.710	1.000							
INF	-0.126	-0.025	-0.202	1.000						
INT	-0.333	-0.267	-0.362	0.299	1.000					
GROWTH	0.473	0.588	-0.698	-0.007	0.204	1.000				
ECUN	-0.586	-0.566	0.779	-0.320	-0.311	-0.570	1.000			
TOT	0.669	0.731	-0.683	-0.049	-0.002	0.548	-0.434	1.000		
RIBOV	-0.051	-0.105	0.051	-0.092	-0.020	-0.065	0.039	-0.117	1.000	
VIBOV	-0.221	-0.166	0.177	-0.032	-0.015	-0.174	0.323	-0.117	-0.236	1.000

Note: Variables are consumer sentiment ($SENT_1$), business sentiment ($SENT_2$), exchange rate ($EXCH$), inflation (INF), interest rate (INT), economic growth ($GROWTH$), economic uncertainty ($ECUN$), terms of trade (TOT), Ibovespa return ($RIBOV$) and Ibovespa volatility ($VIBOV$). All correlations are significant at the 5% level. All statistics are based on 133 observations.

Source: Prepared by the authors.

Table 2 shows that the correlation between the sentiment measures was 0.86. This correlation was greater than that found by Calafiore et al. (2009) for the period 1997-2007 (0.14). However, it is close to that found by Bayram (2017) in Turkey (0.85), suggesting possible feedback effects between consumer and business

sentiment. Most of the pairwise correlations between the fundamental variables were at acceptable levels, suggesting that each variable represents a unique risk factor and that multicollinearity would not be a problem in subsequent regressions.

4. RESULTS AND DISCUSSION

First, we checked for the presence of a unit root in the time series of each variable. For that purpose, we applied the augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1981) and Phillips-Perron (PP) (Phillips & Perron, 1988) tests. The results of these tests (Appendix A) showed that only the variables INF, RIBOV and VIBOV were stationary; the others met the condition of stationarity

only in the first difference. To extract the rational and irrational components of the sentiment measures, we estimated two Ordinary Least Squares (OLS) regression models based on equations (1) and (2). The results of the first estimates (not shown here) indicated problems of heteroscedasticity. Model 2 also showed a value for the Durbin-Watson statistic in the zone of indecision

regarding the first-order serial correlation problem. To overcome these problems, the models were robustly re-estimated.

Table 3 summarizes the results of the estimation of Equation (1) and suggests that consumer sentiment is negatively and significantly affected by exchange rate

fluctuations and economic uncertainty, and positively affected by economic growth. The R^2 of the regression is 0.42, indicating that almost half of the variation in the dependent variable was explained by the fundamentals of the Brazilian market in the period analyzed here.

Table 3

Effect of economic fundamentals on consumer sentiment (period from July 2009 to August 2020, monthly data)

Dependent variable: $SENT_1$				
Variable	Coefficient	Std. Error	t statistic	Prob.
EXCH	-6.157	2.399	-2.57	0.011
INF	-1.424	1.333	-1.07	0.287
INT	-2.522	4.215	-0.60	0.551
ECUN	-0.246	0.076	-3.24	0.002
GROWTH	0.219	0.066	3.29	0.001
TOT	-0.050	0.151	-0.34	0.737
Constant	0.792	0.724	1.09	0.276
R-squared	0.42			
F-statistic (6, 126)	7.87			
Prob(F-statistic)	0.000			
Root MSE	3.718			

Note: Variables are consumer sentiment ($SENT_1$), exchange rate (EXCH), inflation (INF), interest rate (INT), economic uncertainty (ECUN), economic growth (GROWTH), and terms of trade (TOT). All statistics are based on 133 observations. The reference period is the current month for all variables.

Source: Prepared by the authors.

Table 4 shows the estimation of Equation (2), which indicates that business sentiment was negatively affected by economic uncertainty and positively affected by economic

growth. The R^2 of the regression was 0.49, which indicates that almost half of the variation in investor sentiment was explained by market fundamentals.

Table 4

Effect of economic fundamentals on business sentiment (period from July 2009 to August 2020, monthly data)

Dependent variable: $SENT_2$				
Variable	Coefficient	Std. error	t statistic	Prob.
EXCH	-4.139	2.741	-1.51	0.133
INF	-0.154	1.167	-0.13	0.895
INT	-0.819	2.356	-0.35	0.729
ECUN	-0.259	0.097	-2.65	0.009
GROWTH	0.110	0.059	1.94	0.049
TOT	-0.222	0.164	-1.35	0.179
Constant	0.271	0.642	0.42	0.673
R-squared	0.49			
F-statistic (6, 126)	4.04			
Prob(F-statistic)	0.001			
Root MSE	2.674			

Note: Variables are business sentiment ($SENT_2$), exchange rate (EXCH), inflation (INF), interest rate (INT), economic uncertainty (ECUN), economic growth (GROWTH), and terms of trade (TOT). All statistics are based on 133 observations. The reference period is the current month for all variables.

Source: Prepared by the authors.

These results suggest that investor sentiment contains a combination of rational and irrational components, since it is affected by economic fundamentals in different ways and to different degrees, as highlighted by Brown and Cliff (2005) and confirmed in previous works. It is important to note that consumer sentiment was more affected by economic factors than business sentiment, similar to what Calafiore et al. (2009) found. This evidence contradicts the commonly held view that consumers or individual investors do not employ market fundamentals as much as institutional or business investors in their stock trading decisions (De Long et al., 1990; Brown & Cliff, 2004, 2005; Verma & Soydemir, 2009). After this step, we generated adjusted and residual values from each regression to calculate the rational and irrational components of the

sentiment measures ($SENT_{1RA}$ and $SENT_{1IR}$ and $SENT_{2RA}$ and $SENT_{2IR}$, respectively).

After this stage, a VAR(5) model was estimated to analyze the impact of rational and irrational sentiment on Ibovespa returns. This lag order was defined by two (LR and AIC) of the five criteria tested (AIC, SC, LR, HQ, FPE). This model was ordered according to the endogeneity of the variables and had as a criterion the χ^2 of the block causality test, which indicated the following order to be used in the Cholesky decomposition: $SENT_{2IR}$ ($\chi^2 = 72.286$), $SENT_{1RA}$ ($\chi^2 = 65.023$), $SENT_{2RA}$ ($\chi^2 = 54.379$), $SENT_{1IR}$ ($\chi^2 = 36.586$), RIBOV ($\chi^2 = 30.021$). After fitting this model (Appendix B), a shock of one standard deviation was transmitted to the other variables at different time intervals.

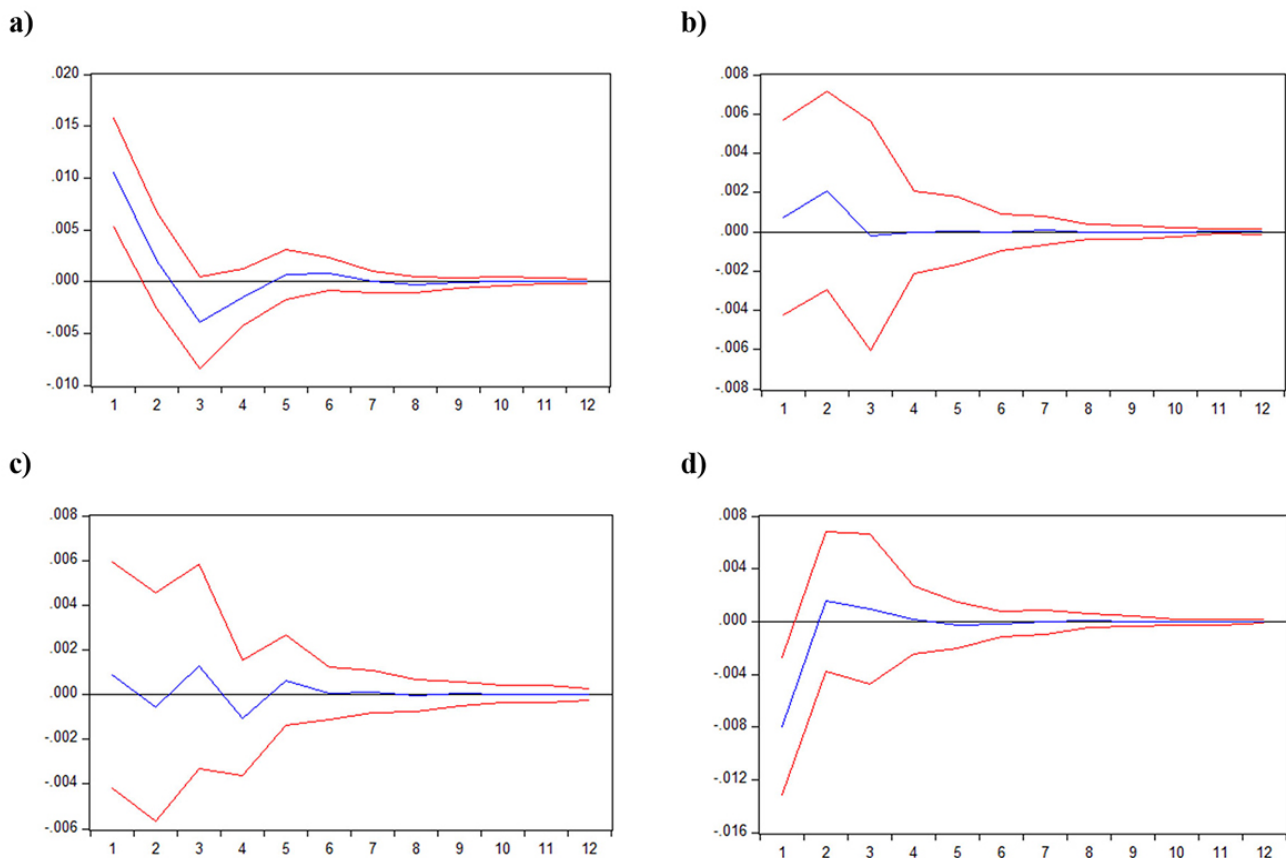


Figure 1 Response of Ibovespa returns to investor sentiment

Note: (a) Response of Ibovespa returns to rational consumer sentiment; (b) Response of Ibovespa returns to irrational consumer sentiment; (c) Response of Ibovespa returns to rational business sentiment; (d) Response of Ibovespa returns to irrational business sentiment. The red lines in each graph represent the upper and lower 95% confidence bands. When the upper and lower bounds have the same sign, the response is statistically significant. In each graph, "percentage returns" are on the vertical axis and "horizon" is on the horizontal axis.

Source: Prepared by the authors.

Rational consumer sentiment had a positive and significant impact on returns in the first month (Figure 1a). This result is similar to those found in Brazil (Calafiore et al., 2009), Turkey (Sayim & Rahman,

2015b; Bayram, 2017) and the U.S. (Verma et al., 2008), suggesting that an increase in rational consumer sentiment tends to increase Ibovespa returns. As observed in previous studies in Brazil (Calafiore et

al., 2009) and Turkey (Bayram, 2017), the irrational component did not have a significant impact (Figure 1b), indicating that irrational consumer sentiment does not lead to a statistically significant response of Ibovespa market returns. This result also suggests that investor sentiment is not solely based on irrationality, as there is a portion that is driven by fundamentals (Verma & Soydemir, 2006; Verma et al., 2008; Calafiore et al., 2009; Verma & Soydemir, 2009; Sayim & Rahman, 2015a, 2015b; Bayram, 2017).

In contrast to rational consumer sentiment, rational business sentiment had no effect on the Ibovespa (Figure 1c). This result is the opposite of that found by Calafiore et al. (2009) and may be due to two factors. The first is the rise in the number of individual positions in the Brazilian stock exchange from just over 0.5 million in 2011 to over 5 million in 2022 (B3, 2022). In addition, Li and Li (2021) found that the dispersion of household beliefs is more informative in explaining returns than the dispersion of professional analysts. Although each consumer's information is potentially biased or incomplete, household investors may collectively have richer and more diverse information than professional analysts, as the consumer population is more heterogeneous in terms of income level,

geographic location, occupation and financial experience. Therefore, the collective wisdom of these investors can be a powerful factor affecting the broader stock market. In light of this sharp increase, and given that rational consumer sentiment appears to be informative, it is plausible to assume that consumer sentiment has now become more relevant.

The response of the Bovespa index return to irrational business sentiment (Figure 1d) is negative and significant in the first month and insignificant thereafter. This result is similar to that previously observed for Brazil (Calafiore et al., 2009). According to these authors, this behavior is consistent with the view that irrational sentiment has the potential to influence stock market returns. This behavior can be amplified in emerging markets, where there is potential for insufficient information dissemination among agents (Martins & Barros, 2021). After analyzing the IRF, we verified the participation of each of the sentiment measures in explaining the variance of Ibovespa returns. Table 5 shows that most of the variance in Ibovespa returns can be explained by innovations (impacts) from the market itself. The components of $SENT_1$ explained to a greater extent the variance of stock returns.

Table 5

Estimates of the percentages of variance decomposition using the VAR(5) model

Period	S.E.	$SENT_{2IR}$	$SENT_{1RA}$	$SENT_{2RA}$	$SENT_{1IR}$	RIBOV
1	2.184	6.913	14.468	0.190	0.051	78.374
6	2.860	10.661	25.183	4.618	4.466	55.069
12	3.208	13.296	30.021	5.314	4.639	46.727

Note: The variables are rational consumer sentiment ($SENT_{1RA}$), irrational consumer sentiment ($SENT_{1IR}$), rational business sentiment ($SENT_{2RA}$), irrational business sentiment ($SENT_{2IR}$) and Ibovespa return (RIBOV). S.E. is the standard error.

Source: Prepared by the authors.

According to the results presented in Table 5, the participation of rational sentiment in explaining the variance of Ibovespa returns was greater than that of irrational sentiment. This result is also supported by the existing literature. According to Verma et al. (2008) and Calafiore et al. (2009), sentiment-driven trading based on fundamentals has a much greater effect than noise trading. Because of this, we speculate that the rational response may have been based on sound economic fundamentals, processed for a reasonable amount of time, and only then put into practice.

To verify the impacts of rational and irrational sentiments on the volatility of the Ibovespa, a VAR(3) model was estimated based on most information criteria (FPE, AIC and SBIC) and ordered as follows: $SENT_{2IR}$ ($\chi^2 = 75.164$), $SENT_{2RA}$ ($\chi^2 = 42.380$), $SENT_{1RA}$ ($\chi^2 = 37.427$), RIBOV ($\chi^2 = 33.490$), $SENT_{1IR}$ ($\chi^2 = 32.669$). After fitting the model (Appendix C), a shock of one standard deviation was transmitted to the other variables at different time intervals.

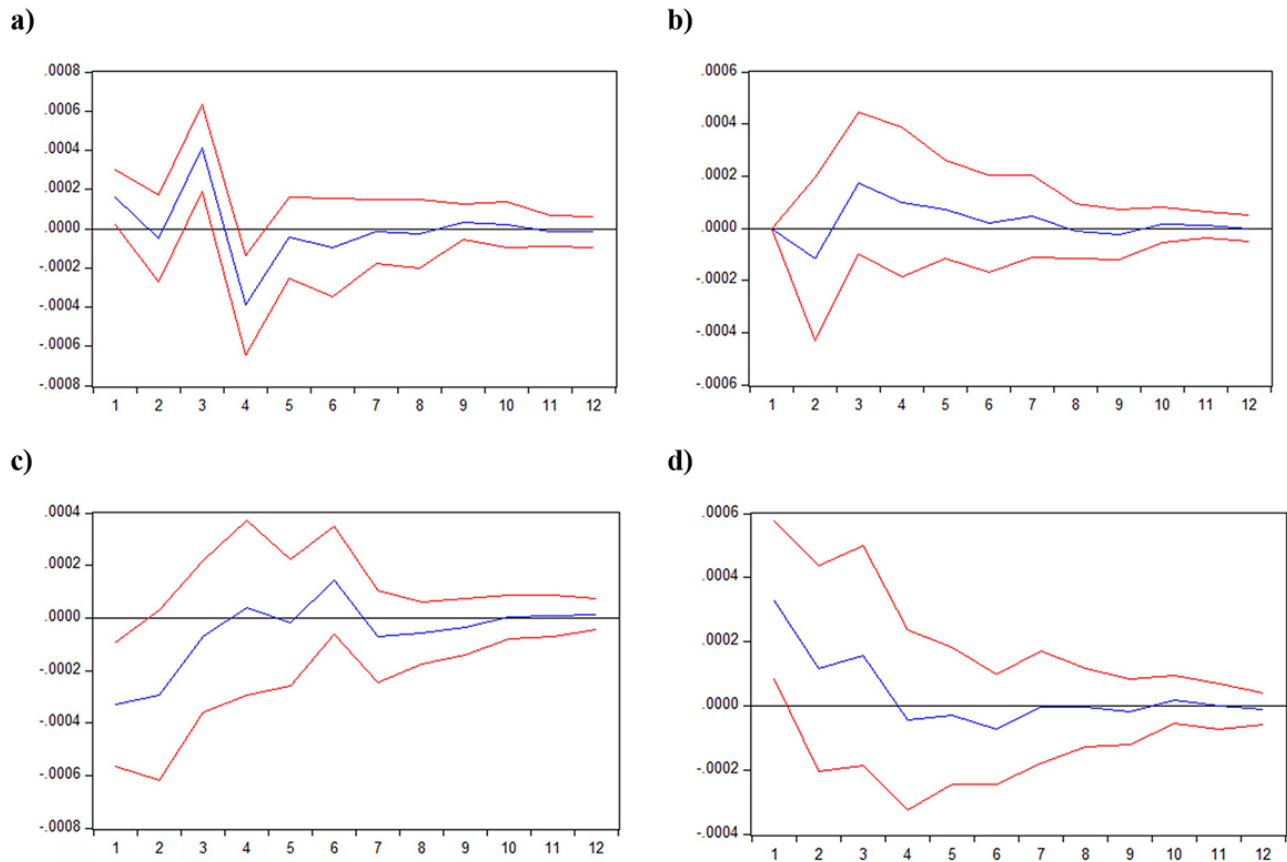


Figure 2 Ibovespa volatility response to investor sentiment

Note: (a) Ibovespa volatility response to rational consumer sentiment; (b) Ibovespa volatility response to irrational consumer sentiment; (c) Ibovespa volatility response to rational business sentiment; (d) Ibovespa volatility response to irrational business sentiment. The red lines in each graph represent the upper and lower 95% confidence bands. When the upper and lower bounds have the same sign, the response is statistically significant. In each graph, “volatility” is on the vertical axis and “horizon” is on the horizontal axis.

Source: Prepared by the authors.

Figure 2a shows that a one standard deviation increase in rational consumer sentiment had a positive and significant effect on Ibovespa volatility in the first month. This impact was still significantly positive in the third month, negative in the fourth, and insignificant in the following months. This result is different from the Turkish emerging market (Sayim & Rahman, 2015b) and may indicate a lack of investor optimism about the economy and market fundamentals, which increases uncertainty and volatility of returns due to noise trading. According to PH and Rishad (2020), when investors are more optimistic about the market, their extreme optimism can lead them to engage in more speculative activities that generate greater volatility. Irrational consumer sentiment did not have a significant impact on volatility (Figure 2b), as observed in the Turkish market (Sayim & Rahman, 2015b).

Rational business sentiment had a negative and significant impact on Ibovespa volatility in the contemporary period (Figure 2c). A possible explanation

for this could be investors’ optimistic expectations about the economy in general and market fundamentals. This optimism can result in the spread of positive market expectations, which can reduce uncertainty and volatility of returns (Brown & Cliff, 2004; Verma & Soydemir, 2006; Sayim & Rahman, 2015a). The reduction in volatility may also be due to the behavior of more sophisticated investors who carefully analyze market fundamentals when making their decisions, thereby reducing uncertainty and the risk of noise in the stock market (Verma & Soydemir, 2006; Sayim & Rahman, 2015a).

Irrational business sentiment had a positive and significant impact on Ibovespa volatility in the first month and became insignificant in the remaining months. Because of this, we speculate that the positive impact may indicate a pessimistic expectation of these investors in relation to the fundamentals, causing an increase in volatility. In addition, we found evidence (regression of Equation 2) that business sentiment is less affected by

fundamentals, and therefore the increase in volatility may have been the result of a misperception of fundamentals. The low ability of fundamentals to explain business sentiment may occur because emerging markets have a more fragile information environment and greater

problems of information asymmetry, which can contribute to excess volatility (PH & Rishad, 2020; Martins & Barros, 2021). After analyzing the impulse response function, we verified the relative participation of each of the sentiment measures in explaining the variance in Ibovespa volatility.

Table 6
Estimates of the percentages of variance decomposition using the VAR(3) model

Period	S.E.	SENT _{2IR}	SENT _{2RA}	SENT _{1RA}	VIBOV	SENT _{1IR}
1	2.150	4.824	4.808	1.176	89.189	0.000
6	2.805	5.361	7.629	12.510	72.465	2.032
12	2.818	5.349	7.909	12.511	72.098	2.129

Note: The variables are rational consumer sentiment (SENT_{1RA}), irrational consumer sentiment (SENT_{1IR}), rational business sentiment (SENT_{2RA}), irrational business sentiment (SENT_{2IR}) and Ibovespa volatility (VIBOV). S.E. is the standard error.

Source: Prepared by the authors.

Table 6 shows that most of the variance in volatility is explained by innovations (impacts) in its own trajectory. The two measures of sentiment were important in explaining volatility, and the sum of rational components was also more pronounced for volatility.

4.1 Robustness Test

We verified the robustness of our results by re-estimating our models without the period from

August 2019 to August 2020, a period that includes the Covid-19 pandemic, previously controlled as an exogenous variable. To check the impact of investor sentiment on returns, we estimated a VAR(5) model defined by most information criteria (LR, FPE and AIC) and ordered as follows: SENT_{2IR} ($\chi^2 = 56.582$), SENT_{1RA} ($\chi^2 = 43.913$), RIBOV ($\chi^2 = 35.418$), SENT_{2RA} ($\chi^2 = 34.932$), SENT_{1IR} ($\chi^2 = 25.599$). After the estimation, we generated the following IRFs:

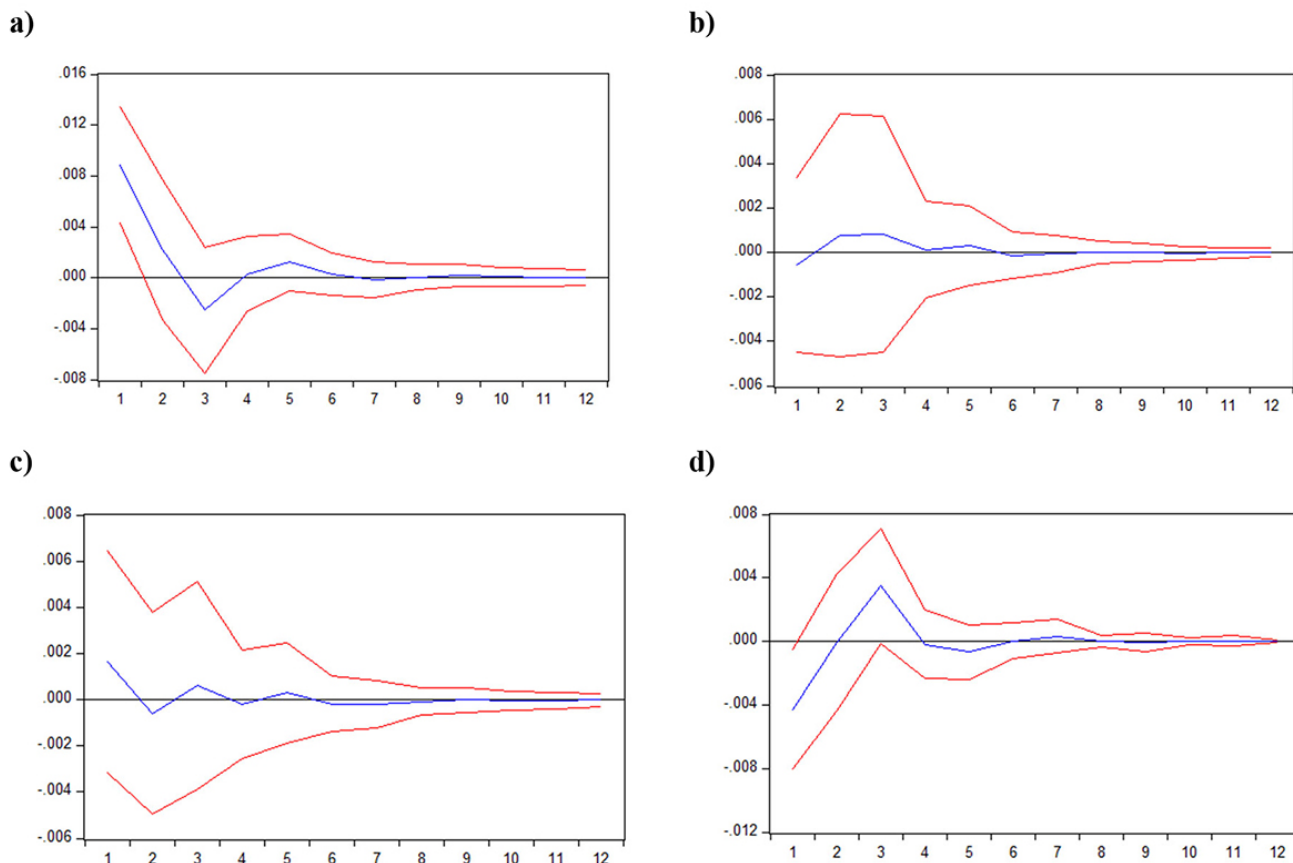


Figure 3 Response of Ibovespa returns to investor sentiment

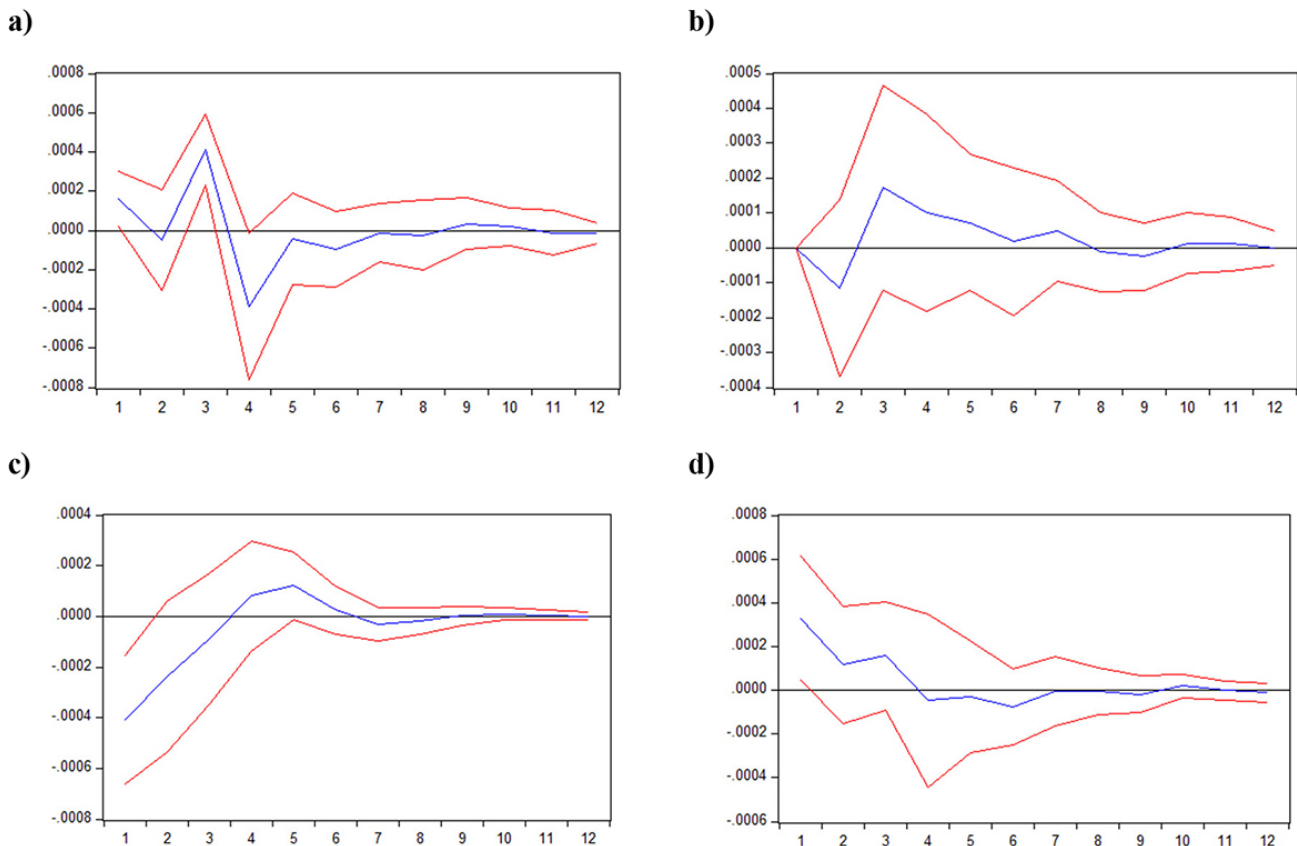
Figure 3 Cont.

Note: (a) Response of Ibovespa returns to rational consumer sentiment; (b) Response of Ibovespa returns to irrational consumer sentiment; (c) Response of Ibovespa returns to rational business sentiment; (d) Response of Ibovespa returns to irrational business sentiment. The red lines in each graph represent the upper and lower 95% confidence bands. When the upper and lower bounds have the same sign, the response is statistically significant. In each graph, “percentage returns” are on the vertical axis and “horizon” is on the horizontal axis.

Source: Prepared by the authors.

The IRFs showed that the results are immune to the pandemic period. The variance decompositions showed the following results in the first/twelfth month: $SENT_{2IR} = (2.979/6.823)$, $SENT_{1RA} = (13.577/20.536)$, $RIBOV = (83.419/64.822)$, $SENT_{2RA} = (0.023/3.750)$, $SENT_{1IR} = (0/4.068)$. To check the impact of investor

sentiment on volatility, we estimated a VAR(2) model defined by most information criteria (LR, FPE and AIC), ordered as follows: $SENT_{2IR} (\chi^2 = 36.137)$, $VIBOV (\chi^2 = 20.471)$, $SENT_{1IR} (\chi^2 = 15.783)$, $SENT_{1RA} (\chi^2 = 14.907)$, $SENT_{2RA} (\chi^2 = 7.471)$. After the estimation, we generated the following IRFs:

**Figure 4** Ibovespa volatility response to investor sentiment

Note: (a) Ibovespa volatility response to rational consumer sentiment; (b) Ibovespa volatility response to irrational consumer sentiment; (c) Ibovespa volatility response to rational business sentiment; (d) Ibovespa volatility response to irrational business sentiment. The red lines in each graph represent the upper and lower 95% confidence bands. When the upper and lower bounds have the same sign, the response is statistically significant. In each graph, “volatility” is on the vertical axis and “horizon” is on the horizontal axis.

Source: Prepared by the authors.

The IRFs showed that the impacts of sentiment on Brazilian market volatility are similar to the full sample estimates. The variance decompositions showed the following results in the first/twelfth month:

$SENT_{2IR} = (0.289/1.588)$, $VIBOV = (99.710/83.987)$, $SENT_{1IR} = (0/2.214)$, $SENT_{1RA} = (0/9.877)$, $SENT_{2RA} = (0/2.332)$. These results confirm that the Brazilian market is impacted by investor sentiment.

5. FINAL REMARKS

In this study, we analyzed the impact of investor sentiment on the return and volatility of the Brazilian stock market. Consistent with previous studies (Verma et al., 2008; Verma & Soydemir, 2009; Sayim & Rahman, 2015a, 2015b; Bayram, 2017), our results support the evidence that sentiment was driven by both rational and irrational factors. Based on two VAR models, we also found that rational and irrational sentiments played a significant role in the returns and also in the volatility of the Brazilian market in the period studied. This evidence adds to the limited number of studies on investor sentiment in emerging markets and extends the evidence already documented for Brazil (Calafiore et al., 2009; Yoshinaga & Castro, 2012; Xavier & Machado, 2017; Piccoli et al., 2018; Souza & Martins, 2022).

The main results presented here indicate that an increase in investor sentiment tends to impact the Brazilian market in the initial periods and to reverse in subsequent periods. In addition, we found strong support for the role of economic fundamentals as determinants of Ibovespa returns and volatility. This indicates that fundamental trading induced by rational sentiment seems to have a greater effect than trading induced by irrational sentiment. Economic fundamentals also seem to be carefully analyzed and may have been important in generating optimistic market expectations on the part of investors. This could explain the negative impact of rational sentiment on volatility in the early periods, due to the behavior of investors who carefully analyze market

fundamentals when making their decisions, thus reducing the uncertainty and noise risk of the stock exchange (Verma & Soydemir, 2006; Sayim & Rahman, 2015a). Finally, we highlight that in terms of magnitude, consumer sentiment had a much greater impact on Ibovespa returns and volatility than business sentiment.

These findings have important implications for investors, policymakers and monetary authorities. Investors should pay close attention to economic fundamentals when formulating their investment strategies and also when choosing the stocks that will make up their portfolios. By taking sentiment into account as an important determinant of volatility, investors can improve the performance of their portfolios and support the timing of investment entry and exit. Policymakers and monetary authorities should also consider investor sentiment when formulating political, economic and monetary strategies. This is important because the impact of fundamental-based trading is greater than that of noise trading, so changes in key variables such as foreign exchange rates, interest rates and inflation can affect investor psychology and be reflected in their stock market trading. Although the measures of consumer and business sentiment are correlated, they must be viewed by investors in different and complementary ways because they have different natures and represent distinct groups with different roles in the capital market. Therefore, the right changes at the right time can be useful to stabilize or reduce stock market volatility in order to protect wealth and attract more investors.

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FUNDING

The authors thank the Coordination for the Improvement of Higher Education Personnel (Capes) for funding this research project.

ACKNOWLEDGEMENTS

The authors thank the editorial team and the blind reviewers for their great contributions, which improved the writing and quality of this research.

APPENDIX A

Unit root tests

	ADF (t stat)		PP (t stat)	
	In level	$d = 1$	In level	$d = 1$
SENT ₁	-2.644	-9.910	-2.530	-9.910
SENT ₂	-1.962	-7.132	-1.765	-8.543
INF	-5.672	-	-5.690	-
INT	-0.201	-5.642	-0.714	-20.585
EXCH	1.071	-8.509	1.086	-8.581
ECUN	-1.554	-9.590	-1.990	-9.243
GROWTH	-0.200	-4.916	-0.164	-3.654
TOT	-2.008	-12.539	-2.050	-12.539
RBOV	-10.637	-	-10.637	-
VIBOV	-10.117	-	-10.117	-

Note: The appropriate choice of lag lengths in the ADF tests is determined by the Akaike information criterion. Andrew's procedure was used to calculate the ranges for the PP test. ADF (t stat) critical value 5% = -2,883; PP (t stat) critical value 5% = -2,883.

Source: Prepared by the authors.

APPENDIX B

VAR(5) model presented in order from exogenous to endogenous

	SENT _{2IR}	SENT _{1RA}	SENT _{2RA}	SENT _{1IR}	RIBOV
SENT _{2IR} (-1)	-0.236 (-2.068)	0.142 (1.091)	0.029 (0.274)	-0.317 (-1.75)	-0.001 (-0.994)
SENT _{2IR} (-2)	-0.136 (-1.152)	-0.004 (-0.030)	-0.059 (-0.527)	0.090 (0.482)	-0.000 (-0.553)
SENT _{2IR} (-3)	0.014 (0.115)	-0.025 (-0.181)	-0.016 (-0.140)	-0.129 (-0.671)	-0.000 (-0.586)
SENT _{2IR} (-4)	-0.055 (-0.444)	-0.116 (-0.817)	-0.108 (-0.911)	0.078 (0.396)	0.000 (0.157)
SENT _{2IR} (-5)	-0.067 (-0.393)	0.294 (1.494)	0.159 (0.973)	-0.560 (-2.057)	0.003 (1.642)
SENT _{1RA} (-1)	-0.020 (-0.076)	-0.113 (-0.379)	-0.161 (-0.645)	-0.178 (-0.428)	0.004 (1.314)
SENT _{1RA} (-2)	0.571 (2.230)	-0.060 (-0.207)	-0.372 (-1.523)	0.741 (1.831)	-0.007 (-2.239)
SENT _{1RA} (-3)	-0.167 (-0.607)	0.156 (0.498)	0.145 (0.553)	0.136 (0.313)	0.001 (0.341)
SENT _{1RA} (-4)	-0.048 (-0.187)	0.432 (1.468)	0.583 (2.370)	-0.065 (-0.160)	0.005 (1.791)
SENT _{1RA} (-5)	0.170 (0.633)	0.127 (0.414)	0.295 (1.151)	0.646 (1.521)	0.005 (1.521)
SENT _{2RA} (-1)	0.345 (1.119)	0.124 (0.354)	0.105 (0.357)	0.351 (0.719)	-0.005 (-1.421)

Cont.

	SENT _{2IR}	SENT _{1RA}	SENT _{2RA}	SENT _{1IR}	RIBOV
SENT _{2RA} (-2)	-0.706 (-2.426)	-0.474 (-1.425)	-0.047 (-0.170)	-0.754 (-1.638)	0.005 (1.563)
SENT _{2RA} (-3)	0.116 (0.366)	-0.207 (-0.572)	-0.274 (-0.907)	-0.227 (-0.453)	-0.001 (-0.470)
SENT _{2RA} (-4)	-0.133 (-0.425)	-0.617 (-1.722)	-0.744 (-2.486)	0.146 (0.294)	-0.007 (-2.019)
SENT _{2RA} (-5)	-0.388 (-1.076)	-0.037 (-0.090)	-0.363 (-1.057)	-0.909 (-1.593)	-0.000 (-0.200)
SENT _{1IR} (-1)	-0.014 (-0.219)	-0.007 (-0.096)	0.006 (0.100)	-0.040 (-0.380)	0.001 (1.327)
SENT _{1IR} (-2)	0.105 (1.577)	-0.074 (-0.974)	-0.032 (-0.518)	-0.0350 (-0.332)	-0.000 (-0.174)
SENT _{1IR} (-3)	0.127 (1.892)	-0.202 (-2.628)	-0.150 (-2.347)	-0.011 (-0.112)	0.000 (0.405)
SENT _{1IR} (-4)	-0.050 (-0.709)	0.028 (0.346)	0.0242 (0.358)	-0.129 (-1.150)	0.001 (1.560)
SENT _{1IR} (-5)	0.000 (0.010)	-0.109 (-1.392)	-0.092 (-1.417)	-0.041 (-0.383)	-0.001 (-1.741)
RIBOV(-1)	14.620 (1.604)	48.970 (4.700)	40.259 (4.627)	20.044 (1.389)	-0.032 (-0.294)
RIBOV(-2)	13.653 (1.453)	-0.035 (-0.003)	4.086 (0.455)	21.228 (1.427)	-0.149 (-1.295)
RIBOV(-3)	26.554 (2.792)	1.955 (0.179)	3.681 (0.405)	12.046 (0.800)	0.051 (0.442)
RIBOV(-4)	5.889 (0.610)	-9.187 (-0.833)	-10.453 (-1.135)	7.973 (0.522)	-0.070 (-0.596)
RIBOV(-5)	22.451 (2.293)	-13.533 (-1.209)	-13.072 (-1.398)	-21.172 (-1.366)	-0.312 (-2.601)
C	-0.366 (-1.371)	0.295 (0.969)	0.335 (1.317)	0.082 (0.194)	-0.001 (-0.489)
LAVAJATO	-0.049 (-0.213)	-0.266 (-1.012)	-0.2108 (-0.957)	-0.146 (-0.401)	0.006 (2.453)
COVID	0.709 (2.294)	-1.239 (-3.502)	-1.292 (-4.372)	0.328 (0.670)	-0.006 (-1.599)
R-squared	0.480	0.500	0.533	0.303	0.296
Adj. R-squared	0.340	0.365	0.407	0.115	0.106
Sum sq. resids	477.377	623.793	434.938	1,195.835	0.071
S.E. equation	2.184	2.497	2.085	3.458	0.026
F-statistic	3.428	3.709	4.239	1.616	1.562
Log likelihood	-265.865	-282.987	-259.907	-324.636	297.462
Akaike AIC	4.591	4.859	4.498	5.509	-4.210
Schwarz SC	5.215	5.483	5.122	6.133	-3.586

Note: Coefficients on the first line, t-statistic in parentheses.

Source: Prepared by the authors.

APPENDIX C

VAR(3) model presented in order from exogenous to endogenous

	SENT _{2IR}	SENT _{2RA}	SENT _{1RA}	VIBOV	SENT _{1IR}
SENT _{2IR} (-1)	-0.184 (-1.830)	0.034 (0.328)	0.129 (1.037)	4.13E-05 (0.589)	-0.299 (-1.865)
SENT _{2IR} (-2)	0.057 (0.581)	0.019 (0.192)	0.058 (0.471)	5.59E-05 (0.806)	-0.068 (-0.428)
SENT _{2IR} (-3)	0.052 (0.552)	-0.033 (-0.344)	-0.062 (-0.528)	-6.92E-05 (-1.054)	-0.168 (-1.118)
SENT _{2RA} (-1)	0.264 (0.904)	0.302 (1.004)	0.255 (0.700)	-1.64E-05 (-0.080)	0.924 (1.979)
SENT _{2RA} (-2)	-0.425 (-1.526)	0.232 (0.807)	-0.147 (-0.425)	-0.000 (-3.267)	-0.597 (-1.342)
SENT _{2RA} (-3)	0.070 (0.247)	-0.619 (-2.108)	-0.470 (-1.324)	0.000 (3.274)	-0.195 (-0.429)
SENT _{1RA} (-1)	0.100 (0.423)	-0.115 (-0.471)	-0.007 (-0.025)	-8.93E-05 (-0.538)	-0.386 (-1.016)
SENT _{1RA} (-2)	0.509 (2.216)	-0.491 (-2.074)	-0.215 (-0.752)	0.000 (3.357)	0.773 (2.109)
SENT _{1RA} (-3)	-0.041 (-0.171)	0.518 (2.058)	0.450 (1.478)	-0.000 (-3.778)	0.343 (0.881)
VIBOV(-1)	-382.264 (-2.778)	-591.250 (-4.170)	-523.003 (-3.049)	0.119 (1.244)	79.400 (0.361)
VIBOV(-2)	71.393 (0.460)	468.680 (2.936)	513.392 (2.658)	-0.247 (-2.297)	334.039 (1.350)
VIBOV(-3)	287.282 (1.944)	180.722 (1.186)	214.628 (1.165)	0.093 (0.908)	188.041 (0.796)
SENT _{1IR} (-1)	0.026 (0.400)	0.047 (0.703)	0.007 (0.097)	-3.90E-05 (-0.859)	-0.044 (-0.425)
SENT _{1IR} (-2)	0.067 (1.057)	-0.078 (-1.182)	-0.122 (-1.526)	6.05E-05 (1.352)	0.009 (0.097)
SENT _{1IR} (-3)	0.126 (1.964)	-0.131 (-1.985)	-0.186 (-2.337)	3.34E-05 (0.747)	0.029 (0.291)
C	-0.265 (-0.541)	0.017 (0.035)	-0.292 (-0.479)	0.001 (5.288)	-1.030 (-1.317)
LAVAJATO	0.144 (0.706)	-0.041 (-0.197)	-0.051 (-0.202)	-8.03E-05 (-0.563)	-0.097 (-0.297)
COVID	0.990 (3.675)	-0.727 (-2.618)	-0.746 (-2.221)	0.000 (2.505)	0.440 (1.023)
R-squared	0.447	0.410	0.356	0.294	0.235
Adj. R-squared	0.363	0.321	0.258	0.187	0.119
Sum sq. resids	517.948	550.183	804.950	0.000	1,320.856
S.E. equation	2.150	2.216	2.680	0.001	3.434
F-statistic	5.335	4.593	3.642	2.749	2.025
Log likelihood	-274.314	-278.238	-302.973	670.676	-335.164
Akaike AIC	4.497	4.557	4.938	-10.041	5.433
Schwarz SC	4.894	4.954	5.335	-9.644	5.830

Note: Coefficients on the first line, *t*-statistic in parentheses.

Source: Prepared by the authors.