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Ibovespa's Response to the Behavior of Oil and Ore Prices During the International Crisis Caused by COVID-19

Jorge Luis Sánchez Arévalo[*], *Alisson Maxwell Ferreira de Andrade*[**], *Elisabeth de Oliveira Vendramin*[***]

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Research article

[*] Doctor in Administration. Professor at the Federal University of Mato Grosso do Sul, Campo Grande (Brazil). E-mail: jorge.sanchez@ufms.br.
https://orcid.org/0000-0002-8426-2096

[**] Doctor in Administration. Professor at the Federal University of Mato Grosso do Sul, Três Lagoas (Brazil). E-mail: alisson.andrade@ufms.br.
https://orcid.org/0000-0001-9460-2018

[***] Doctor in Accounting. Professor at the Federal University of Mato Grosso do Sul, Campo Grande (Brazil). E-mail: elisabeth.vendramin@ufms.br.
https://orcid.org/0000-0002-9082-2256

Abstract

The systemic risk caused by COVID-19 affected all sectors of the economy, thus showing the vulnerability of some sectors in comparison to others. In this context, the supply shock experienced by the iron ore sector has drawn attention and resulted in a price increase. Linked to this, and in a negative way, oil prices fell due, among other factors, to the price war between producing countries. In this sense, this study analyses the volatility of the Brazilian stock market indicator in relation to the prices of the aforementioned products and the price of the dollar. The results show the importance of the price formation in these markets for the variation of the indicator. The appreciation of Brent oil and iron ore prices on the Dalian Commodity Exchange (DCE), in China, caused the Ibovespa indicator to move in the same direction. In addition, in statistical terms, the study highlights the great importance of the exchange rate as a determinant in the variation of the indicator and, consequently, affecting the intention to invest.

Keywords: Supply and demand shock, Brazilian market, ARDL Model, Financial markets, Econometrics.

JEL Classification: C58, G11, G15.

La respuesta de Ibovespa al comportamiento de los precios del petróleo y del mineral de hierro durante la crisis internacional causada por el COVID-19

Resumen

El riesgo sistémico causado por el COVID-19 afectó a todos los sectores de la economía y con ello se denotó la vulnerabilidad de algunos sectores en comparación con otros. En este contexto, llamó la atención el choque de oferta experimentado por el sector minero, que, en consecuencia, se tradujo en una alta apreciación de los precios. Vinculado a esto, y con efectos negativos, se produjo en este periodo la devaluación de los precios del petróleo, explicada, entre otros factores, por la guerra de precios entre los países productores. En este sentido, el presente estudio analiza la volatilidad del indicador bursátil brasileño considerando los precios de los productos antes mencionados y la cotización del dólar. Los resultados muestran la importancia de la formación de precios de estos mercados en la variación del indicador de la Bolsa de Brasil, y la apreciación de los precios del petróleo y el mineral Brent cotizados en el mercado de minerales básicos de Dalian (China) deriva en que el indicador Ibovespa vaya en la misma dirección. Además, en términos estadísticos, el estudio destaca la gran importancia del precio de la moneda extranjera como determinante en la variación del indicador de Ibovespa y, consecuentemente, con efectos en la intención de inversión.

Palabras clave: Choque de oferta y demanda, mercado brasileño, modelo ARDL, mercado financiero, econometría.

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INTRODUCTION

Systemic risk events, such as the health crisis experienced since the World Health Organization (WHO) declared the COVID-19 pandemic in March 2020, affect the financial markets and the overall business environment. In that period, the shares of all publicly-traded companies listed on B3 (Brazilian Stock Exchange in São Paulo) suffered devaluation. Also, sectors such as trade, tourism and leisure were more sensitive when compared to others, such as the electricity, mining, and steel sectors (Economatica, 2021).

The crisis was of great magnitude, to the point that almost all the world's economies went into recession, with China standing out as one of the largest economies experiencing growth (Banco Mundial, 2021). According to data from the Brazilian Ministry of Industry, Foreign Trade and Services (MDIC, 2021), China has become Brazil's main trade partner with a trade volume exceeding US$ 100 billion. In addition, Brazil is one of the few economies in the world that maintains a surplus trade balance, which in 2020 registered a value of approximately US$ 34 billion.

During the 2020 crisis, the price appreciation of iron ore in the international market drew attention, and it was attributed to the strong demand registered by China. As a result of the positive demand shock, and due to a signaling effect, the stock prices of companies in this sector appreciated. Synchronously, the Ibovespa indicator (Brazil Stock Exchange Indicator) appreciated in the three months after March by approximately 30%. The shares of Vale S. A., the most important company in this sector in Brazil, experienced an accumulated appreciation of approximately 100% between March 2021 and October 2021 (Economatica, 2021).

At the same time, the international oil price fell as a result of the negotiations failure between Russia and OPEC related to production. This supply shock was secondary to the effects caused by the pandemic and the consequent global drop in demand. In this context, the question was what effects these two events would have in the dynamics of the economy as well as in the financial sector in the short term. Empirical studies that incorporate events of a similar nature have found that in this scenario it is common to observe high volatility and asymmetric effects among exchanges, in addition to the chance of prices with abnormal returns (Chowdhury et al., 2021; Ozkan, 2021; Yang et al., 2021; Maciel et al. 2012).

Thus, with the gradual reopening of borders in the months after March 2020, and supported by expansive monetary policies, the financial markets were driven

by a broad sense of optimism. Therefore, this study incorporates these events and the response of the Ibovespa indicator, which can be understood as a *proxy* for the economy's income.

All these events and the demand and supply shocks linked to iron ore and oil can have a domino effect, affecting several companies and/or segments of the economy. And this behavior, consequently, can be reflected in investment intentions through the stock prices. These relationships with their effect on the structure of the Ibovespa indicator can be summarized in the hypothetical model that supports the research problem (See Figure 1), in which an overall composition of 31%, approximately, of the portfolio is observed. Thus, based on Figure 1, the main objective of this study was to verify the Ibovespa's response to the behavior of the international ore and Brent oil prices as listed in the Chicago, London, and China exchanges, while considering the effect of the exchange rate. Consequently, the purpose is to analyze the effect of the possible shocks that the so-called determinant variables have on the Ibovespa.

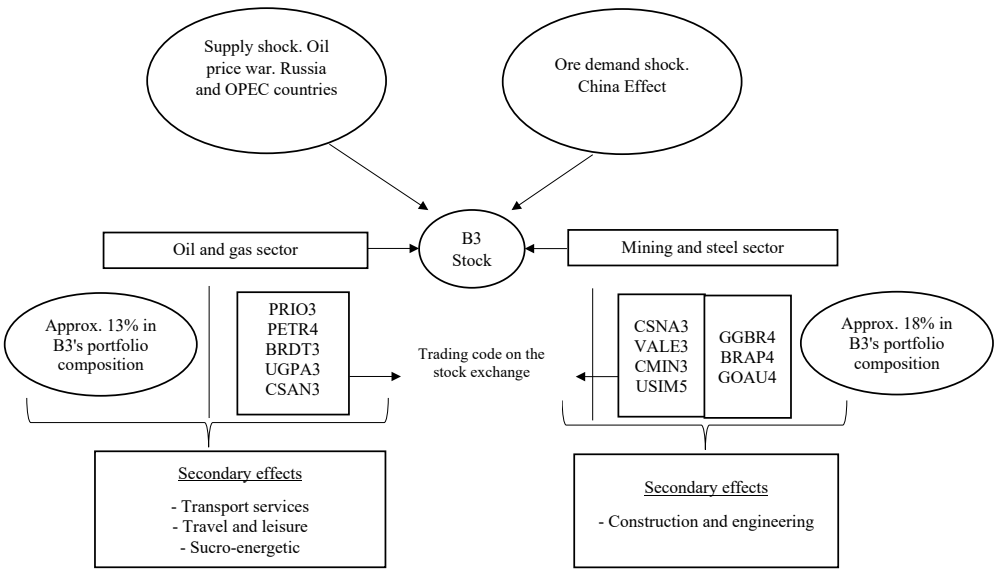
There is no denying the importance of oil and minerals as essential raw materials in every economy. In the case of iron ore, it's an essential product for the industry and construction sectors. In the case of petroleum, it's used as raw material for alcohol (sugar-energy sector) and diesel, and is, in general, a raw material of great economic importance. In view of this, changes observed in these commodities have an impact on the price of transport, freight, food, and, consequently, on inflation. We can also think of inflation as an increase in the exchange rate since it implies a loss of purchasing power of the domestic currency.

Along these lines, it is worth noting the crucial importance of the dollar and the exchange rate policy adopted by a country to maintain a balance in the economy. In the Brazilian case, the adoption of the policy in question is part of the so-called macroeconomic tripod. In addition, when the domestic currency depreciates, the capital structure and value of companies are affected because of the effect that this variable has on assets. Due to the existence of a causal relationship between the exchange rate and the market index, and depending on the appreciation/devaluation of the domestic currency, the investment intentions become suitable or not. In the case of Brazil, its currency has lost a lot of purchasing power to the dollar since 2018 (Bacen, 2021), and with an economy growing below potential, the Central Bank responded with expansive monetary policies seeking to stimulate growth.

On the commodities' side, the appreciation of the dollar has had another effect for developing countries, such as Brazil. The rise of the price reflects not only the new commodities' price, which has become more expensive, but also of the dollar, which has also risen (Arevalo et al., 2020).

Figure 1.

Hypothetical Conceptual Model



Source: compiled by the authors.

BIBLIOGRAPHIC REVIEW AND HYPOTHESIS

Temporal Behavior of the Variables Under Study

Ibovespa is the main stock exchange indicator in Brazil and includes companies with the highest volume of trading (B3, 2021). From a theoretical point of view, it is understood that the financial markets reflect the reality of economy. Therefore, the stock exchange indicator of a given country reflects the economic and political reality,

that is, the financial markets measured by the stock exchange indicator can serve as a proxy for political and economic variables.

Thus, changes in macroeconomic variables such as the exchange rate, interest rate, or fiscal policy affect companies in different ways, and in turn also the market indicator (Montes & Tiberto, 2012; Santana et al., 2018). The political environment is an important aspect that complements the effect of macroeconomic variables, as it is a key factor in attracting capital. In the financial field, it is possible to affirm that political noises in the internal environment create great uncertainty for investors, which is reflected in the pricing of company value (Arevalo & Meurer, 2020).

Linked to this, the period under analysis experienced several events that affected the indicator behavior. Since 2018, the truck drivers' strike, the Joesley Day, and the Car Wash operation were considered systemic risk events, and in some cases, corruption was involved, such as in the Car Wash case (Padula & Albuquerque, 2018). Additionally, since 2016 the Weak Meat Operation (adulterated meat), which is still under investigation, greatly affected the meat exporting sector.

Figure 2.

Behavior of the Ibovespa Indicator (January 2, 2018, to September 19, 2021)

Source: built with data from Economatica.

The most striking systemic event in the period under study was the crisis linked to the COVID-19 pandemic. In the indicator series (see Figure 2) it is possible

to verify its impact on March 2020. This crisis caused a retraction of the Brazilian Gross Domestic Product – GDP of approximately 4.1%, compared to the previous year (IBGE, 2020). In cases like this, it is common to see in developing countries the implementation of expansive monetary policies (Falato, 2021; Resende et al., 2021; Debata & Mahakud, 2018). However, in the short term, these policies usually don't produce increases in the investment intention, because, at a time of global crisis, foreign investors tend to be cautious (Ghazali, Lean & Bahari, 2020; Zavadska et al., 2020). On the other hand, it is possible to notice high volatility in the stock market, which in many cases can be observed as an opportunity for trades. Arévalo et al. (2020) point out that in cases like this it is possible to observe a distortion between the stock market indicator and the economy's income, since the short-term series tend to walk in the opposite way.

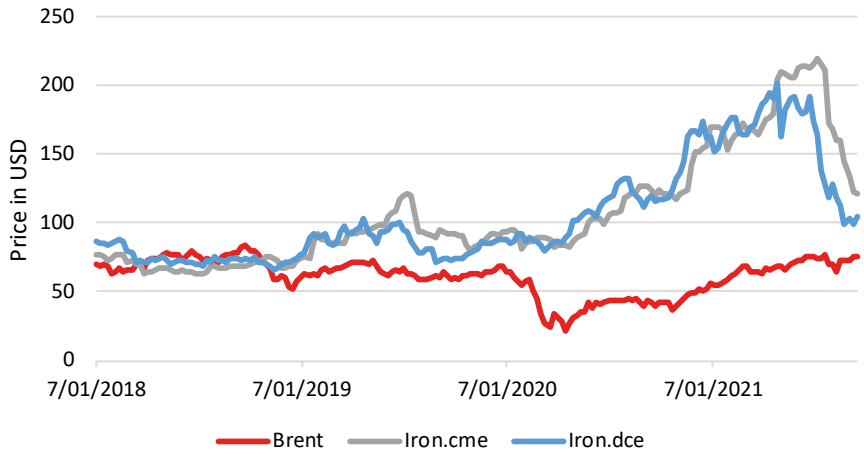
In 2020, in a context of uncertainty, the recovery of the Chinese economy gained prominence and, in the Brazilian case, ore exports to this market tried to alleviate the crisis. Of the total amount of iron ore exported to the world, China was the destination of approximately 72% (Ibram, 2021). In Figure 3, it is evident how ore prices on the Chicago (CME) and China (DCE) stock exchanges followed this demand shock. Iron ore is essential to sectors such as construction, engineering, and others. In the financial markets, these price variations can be observed by investors as trades or opportunities, whether for investment or speculation.

Additionally, oil also gained prominence, but in a negative way, due to the price war between OPEC countries and Russia. Given oil's importance in the production chains, it is expected that a significant variations in the price of shares in the oil sector will cause volatility in the financial markets. In this way, for this period, as shown in Figure 3, Brent oil prices fell sharply, returning to pre-pandemic levels only at the beginning of 2021.

The initial hypothesis of this study is to prove that iron ore prices on the Chinese market have greater influence on the Ibovespa when compared to the Chicago stock exchange price. In this regard, the information of this market must be channeled to the Brazilian market. Additionally, Brent appreciation should also be linked to an Ibovespa appreciation as this product is considered essential for the economy, in view of which, if the economy is doing well, the prices of this commodity should price this good performance.

Figure 3.

Brent Oil and Iron Ore Prices Behavior (January 2 to September 19, 2021)



Source: built with data from Economatica.

Iron.cme = future ore quote on the CME Chicago stock exchange.

Brent = international oil quote on the London stock exchange.

Iron.dce = future ore quote on the DCE China stock exchange.

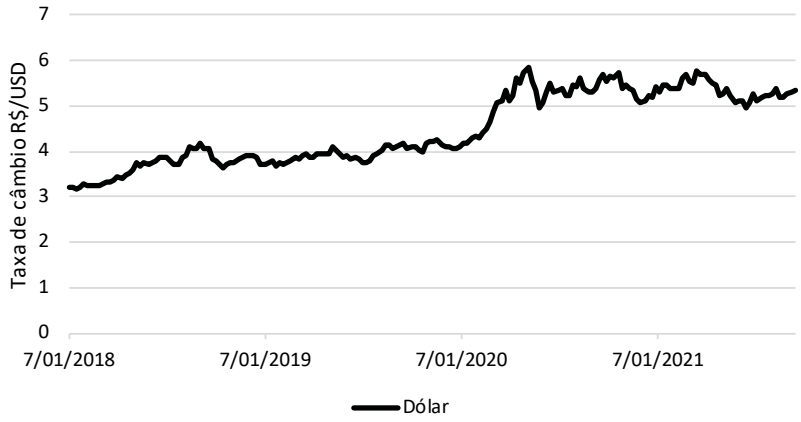
Regarding the dollar, its price is the result of a combination of several factors, such as the commodities prices, the interest rates in the United States and internal or external political noises (such as the tax reform), all of which makes it difficult to predict its future price. In the Brazilian case, the political context and the measures adopted by the Central Bank, such as swap operations, play a fundamental role in this context. Also, it is worth mentioning the importance given by the literature to the volatility of the foreign currency in the pricing of the Stock Exchange indicator. In view of this, policies aimed at price stability are of paramount importance (Mroua & Trabelsi, 2020; Khan & Ali, 2015).

An aspect that tends to soften the high dollar value in the domestic scenario is the trade balance surplus, something that was notorious between 2003 and 2011 when Brazil experienced an effect called "demand shock" for soy and ore by China (MDIC, 2021). In general, during this period most countries in South America experienced a similar pattern (UNCTAD, 2021).

Therefore, the Chinese economy plays a fundamental role and, when it reported a slowdown in 2019, for example, the raw materials price in the world fell. This was also linked to the trade war with the United States, which discouraged international trade. In similar situations, the lack of trade stimulus implies less exports and less inflow of foreign currency, increasing its price. In 2020, this behavior became more remarkable, and with the global crisis caused by the COVID-19 pandemic, the dollar was traded at an average of R$ 5.30 (see Figure 4).

Figure 4.

Commercial Dollar Price Behavior (January 2, 2018 - September 19, 2021)



Source: built with data from Economatica.

On the interest rates side, after the 2008 crisis an expansive monetary policy has been applied in the United States to stimulate economic recovery (Milan & Quadros, 2016; Dathein, 2011). After the 2020 crisis, monetary policy has also been expansive in many countries, including Brazil, where the economy's basic interest rate was 2%, the lowest in history (Bacen, 2021). The referred policy tends to alleviate the problem of high exchange rates in the short term, as it is necessary to increase a country's productivity, as well as to stimulate the inflows of international capital (Drenik & Perez, 2021; Saraç & Karagoz, 2016). Therefore, the second hypothesis oh this study is that there exists an inverse relationship between the increase in the price of foreign currency and the appreciation of the Ibovespa, which is more evident in crisis periods, where expansive monetary policies tend to be relevant.

METHODOLOGY

Model, Procedures, and Source

In any analysis of time series, it is necessary, first, to verify the order of integration of the series and, based on this information, to identify whether the series has a unit root or if it is stationary. Among the various tests used to assess the stationarity of a time series, there is the Dickey-Fuller, a procedure proposed by Fuller (1976) and complemented by Dickey and Fuller (1979, 1981) which is known as the Augmented Dickey–Fuller (ADF) test, which is widely used in the literature to test the presence of a unit root, which constitutes a situation of non-stationarity [1]

$$\Delta Y_t = \alpha + \beta T + \delta Y_{t-1} + \sum_{i=1}^{n} \Delta Y_{t-i} + \varepsilon_t \qquad [1]$$

Where Δ is the first difference operator ($\Delta Y_t = Y_t - Y_{t-1}$); α, an intercept term; T, the trend; $\delta(=\rho-1)$, the test coefficient for the presence or absence of a unit root; ΔY_{t-1}, the dependent variable itself, differentiated and lagged, whose objective is to eliminate the possibility of autocorrelation of the residues; ρ is the initial process of the unit root test, so that: $H_0:\rho-1, H_1:|\rho| < 1$, under H_0 the process has a stochastic tendency; and ε_t is the error structure, which is assumed to have zero mean, constant variance and absence of autocorrelation.

If a series is non-stationary, the stochastic tendency can be eliminated through differentiation. For the cases of ARDL estimation (Autoregressive Distributed Lag) containing non-stationary variables, it is possible that there are stationary linear combinations for integrated variables of the same order, that is, long-term balance relations that must be included in the model to avoid specification errors (Shakil, 2018; Solarin & Eric, 2015; Enders, 2014).

To know the number of cointegrating vectors, it is important to emphasize the significance of the characteristic roots of π. The π rank is equal to the number of cointegrating vectors. Assuming that π = 0, there are no linear combinations of $\{x_{it}\}$ that are stationary, and, in this way, the variables are not cointegrated. Therefore, the test to verify the number of characteristic roots that are significantly different from zero is performed using the statistic λ_{traco}:

$$\lambda_{traco}(r) = -T \sum_{i=r+1}^{n} ln(1-\hat{\lambda}_i) \qquad [2]$$

Where T is the number of observations used in the adjustment and $\hat{\lambda}$ are the estimated values of the characteristic roots obtained by estimating the π matrix. To verify the number of lags necessary in the multi-equational model, the Schwarz Information Criterion (SIC) is used. Thus, to summarize this first part, the unit root tests were initially applied in the series at the levels and in the first difference, as well as the number of lags to consider in the methodology. Next, the ARDL model was estimated considering the specifications based on the SIC.

The empirical model of the study can be described as:

$$LnIbov_t = \beta_0 + \beta_1 Lnbrent_t + \beta_2 LnIron.cme_t + \beta_3 LnIron.dce_t + \beta_4 Lndólar_t + \mu_t \qquad [3]$$

Where:

$Ibov_t$ = Ibovespa indicator points in period t,

$Lbrent_t$ = International oil quotation at time t,

$LIron.cme_t$ = Ore quotation on the Chicago-US stock exchange at time t,

$LIron.dce_t$ = Ore quotation on the Dalian-China stock exchange at time t,

$Ldólar_t$ = Dollar value against the Brazilian real at time t,

μ_t = is the stochastic error term, also named impulses, innovations, or shocks.

The period of analysis goes from January 2, 2018, to September 19, 2021, considering a series of weekly data. The data collected are sourced from Economatica and the Investing website, and, for the model estimation, the data were transformed to logarithms. Based on equation 3, and following the ARDL estimation procedure, it is possible to determine the causal relationship between the study variables and, thus, verify the short-term response of the Ibovespa to unexpected shocks in the independent variables. In general, we consider that the futures quotation prices of the spot market are quickly passed on to the price-taking markets (Tu & Zhang, 2020; Peersman et al., 2021; Mandaci & Kirkpinar, 2022). In this way, the quotations of the commodities mentioned in Equation 3 are information from the futures markets.

RESULTS

Unit Root, Lags Number and Cointegration

When working with time series data, it is important to analyze the stationarity to ensure an adequate equation estimation. Specifically, sometimes economic series have structural breaks which cause them to present a unit root at the analysis time. Therefore, initially, the unit root test was performed for each of the variables used in the defined model to explain the effects on the Brazilian stock exchange indicator.

On Table 1, the results obtained for the unit root test using the Dickey-Fuller and Phillip and Perron procedures are shown. The results show that the variables are stationary and integrated in the first difference I(1), which is, a priori, a requirement for an ARDL estimation (Greaves, 2018). For analysis purposes, the data from each series were changed into logarithms to reduce the variance and facilitate its interpretation in terms of elasticity.

Table 1.

Result of Augmented Dickey Fuller and Phillips and Perron Unit Root Tests

Variables	Level		First difference		Result
	Intercept	Intercept and trend	Intercept	Intercept and trend	
Augmented Dickey-Fuller					
Ibov	-1.7321	-2.3708	-12.8814***	-12.8489***	I(1)
Brent	-1.6271	-1.4334	-12.2037***	-12.2056***	I(1)
Dollar	-1.4822	-2.1297	-13.7767***	-13.7777***	I(1)
Iron.cme	-1.1556	-2.1163	-10.6112***	-10.5877***	I(1)
Iron.dce	-1.1665	-1.5249	-13.1293***	-13.1118***	I(1)
Phillip Perron					
Ibov	-1.9641	-2.8601	-12.9735***	-12.9436***	I(1)
Brent	-1.7423	-1.5671	-12.2099***	-12.2119***	I(1)
Dollar	-1.4838	-2.1569	-13.7782***	-13.7787***	I(1)
Iron.cme	-1.1619	-2.2257	-10.7031***	-10.6801***	I(1)
Iron.dce	-1.2882	-1.9929	-13.2041***	-13.1848***	I(1)

Source: search result.

Note: *** significant at 1%.

To obtain the number of *lags* for the cointegration analysis and considering the integrated series of order I(1), the Johansen procedure was used (Johansen 1988, 1995), from the specification of an ARDL model. To find the number

of *lags* in the model, the Schwarz criterion was used, which, according to Enders (2014), is the most parsimonious. In Table 2 it is shown that the Schwarz criterion identifies the existence of only one lag.

Table 2.

Definition of the Number of Lags of the VAR Model Based on the Schwarz and Hannan-Quinn Criterion

Lags	Akaike	Hannan-Quinn	Schwarz
0	-7.1837	-7.14896	-7.09794
1	-18.6398	-18.4314*	-18.1253*
2	-18.5684	-18.1863	-17.6251
3	-18.6951*	-18.1392	-17.3229
4	-18.6180	-17.8884	-16.8170

* Minimum value of each criterion used in choosing the number of lags.

Source: Search result.

The next step was to estimate the ARDL model to analyze the effect and intensity of each of the variables on the behavior of the Brazilian Stock Exchange indicator. The long-term relationship was verified through the cointegration test and focusing the discussion on short-term events. Regarding the cointegration, the approach used was the one proposed by Pesaran et al. (2001). According to these authors, the significance of the lagged levels of the regressors is tested using the F statistic where there are two sets of critical values that define two limits, the lower and upper. The first (lower) assumes that all variables are I(0), while the upper assumes that all variables are I(1). If the F statistic calculated for all lagged levels of the regressors is above the critical value for the upper limit, we conclude that the regressors are cointegrated, otherwise, if the F value is below the critical value, they are not cointegrated.

Diagnosis of the Long-term Relationship and Estimation of the ARDL Model

Table 3 shows the estimated results of the cointegration relationship of the variables in the ARDL equation. Because the value of the F statistic is higher than the critical limits considering the series in level and in the first difference, we reject H0 = inexistence of a long-term cointegration relationship. Thus, the results observed in Table 3 reveal that there is a long-term relationship in the variables. This can be considered

as a finding, avoiding possible biases involved in the unit root or cointegration tests, as well as the exclusion of a possible spurious relationship between the variables. In addition, this result reinforces the importance of the determinant variables in the variation of the Ibovespa indicator. In fact, eventual market behavior can influence the indicator in several directions, considering the market dynamics, since we cannot always analyze this situation in a static way, or even in a ceteris paribus condition. Considering this premise, we analyze the short-term effects estimating the ARDL model.

Table 3.

Result of the Sample size Cointegration Test for Equation 3

Signif. K=4	**I(0)**	**I(1)**
10%	2.45	3.52
5%	2.86	4.01
2.50%	3.25	4.49
1%	3.74	5.06
F-statistic M1	51.3585	
F-statistic M2	40.3950	
F-statistic M3	23.9442	

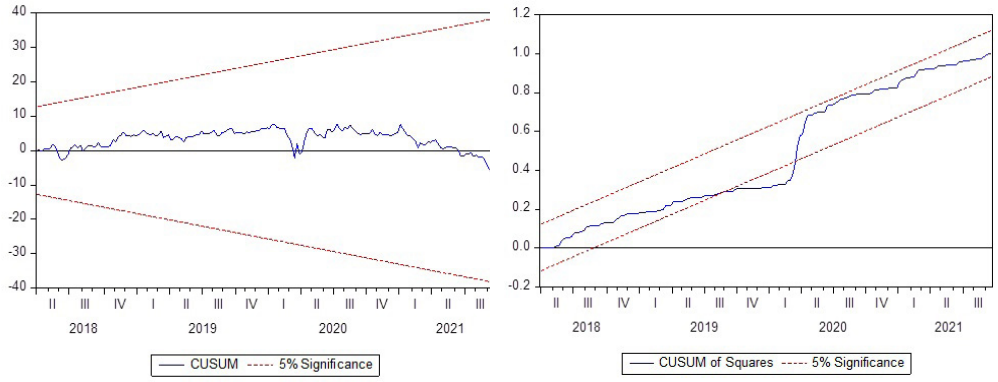
Source: search result.

The result is based on the 5% significance level. The test using the Wald statistic was implemented in Eviews 10.

Before estimating the model and establishing the cointegration of the series, the Cusum test was carried out to verify the existence of a structural break (see Figure 5). Figure 5 shows the result of the normal Cusum test and the square at 5% significance. This Figure shows a structural break between 2019 and 2020. Specifically, with the Wald test the interruption date was defined as the 12th week of 2020, that is, the week of March 22nd. Thus, the analysis incorporates three study moments. The first, defined as pre-pandemic (Model 2), comprises the interval between 01/02/2018 and 02/22/2020. The second covers the pandemic period from 03/29/2020 to 09/19/2021 (Model 3). The idea is to analyze the changes between these two periods. Finally, the third covers the study as a whole, analyzing the period from January 2018 to September 2021 (Model 1 = cumulative).

Figure 5.

Cusum and Cusum Squared Test Result



Source: search result.

Given the existence of a structural break, which was expected, we analyze the short-term dynamics. Table 4 explores the asymmetric interaction of the variables through the ARDL model. ARDL models are regression models that include not only current values, but also lagged values of explanatory variables. In this case, the model was used to explain the asymmetric fluctuation in the quotation of the Ibovespa indicator from the variations of the series considered decisive for the business environment.

In terms of value and statistical significance, it is observed that the price of iron ore on the Chinese futures exchange (DCE) is the most relevant. For the pre-pandemic and accumulated period, it is observed that a 1% increase in the iron.dce price would have a positive effect and, therefore, be associated with an increase in the Ibovespa indicator of 0.09% and 0.1225%, respectively. It is noteworthy that while the value of futures quotes on the Chicago stock exchange (iron.cme) exerts an effect in the same direction, is less relevant in percentage terms. Therefore, we verified the relevance of the future ore quote in the Chinese market for the appreciation of the Brazilian stock exchange. A priori, it can be stated that domestic companies react positively to news from China and market events that facilitate investments in Brazil, which are channeled into the companies' quotations listed in Figure 1.

Another significant aspect is the effect of the coefficient of Brent oil during the accumulated period, with a positive and significant impact on the Ibovespa indicator.

Given a 1% increase in the Brent oil price, the expected effect on the Ibovespa would be an average of 0.19% in the short term, considering the three moments of analysis. This result reveals that the crisis and the effects of the price war, and the consequent devaluation of corporate shares focused on this sector, were not relevant to incite a negative effect on the Ibovespa. What is observed is that the positive value of the coefficient reinforces the importance of this product in the production agenda composition of the various sectors of an economy, which is passed on in the appreciation of the market indicator, serving in this case as a proxy for the economy's income.

Table 4.

Results of the ARDL Model for the Asymmetric Impact of the Variables in the Ibovespa Indicator

Variable	M1: ARDL (1,1,1,0,0)	M2: ARDL (1,0,0,0,0)	M3: ARDL (1,1,1,0,0)
	Coefficient	Coefficient	Coefficient
Constant	0.0041**	0.0055**	0.0011
	(0.0021)	(0.0022)	(0.0039)
Ibov (t-1)	-0.1541**	-0.0865	-0.2192**
	(0.0727	(0.0848)	(0.1136)
Dollar	-0.6773***	-0.7625***	-0.6169***
	(0.0909	(0.1242)	(0.1419)
Dollar(t-1)	-0.2126**	-	-0.2865*
	(0.1032)		(0.1603)
Brent	0.1923***	0.1971***	0.2019***
	(0.0335)	(0.0517)	(0.0497)
Brent (t-1)	0.0684**	-	0.1025**
	(0.0355)		(0.0521)
CME	-0.0231	-0.1019*	0.0449
	(0.0512)	(0.0604)	(0.0861)
DCE	0.0921**	0.0686	0.1225**
	(0.0434)	(0.0543)	(0.0697)
F-Statistic	19.3632	11.1903	10.2192
Autocorrelation	DW=1.9898	DW=1.9847	DW=1.9974
Serial correlation	Prob. F = 0.9878	Prob. F = 0.6425	Prob. F = 0.9946
Heteroscedasticity	Prob. F = 0.0745	Prob. F = 0.4031	Prob. F = 0.0931
Ramsey reset test	Prob. 0.1218	Prob. 0.1370	Prob. 0.4683
R-square value	0.6742	0.5981	0.6215

Source: Own elaboration.

Note: M1 = Model 1, M2 = Model 2, M3 = Model 3.

Values in ( ) are Std. Error. The symbols ***, ** and * indicate that the parameter is significant at 1%, 5% and 10% level of significance, respectively.

Regarding the dollar, the results observed are expected and noticeable for the three moments of analysis. An increasingly high exchange rate denotes the scarcity of foreign currency, indicating the outflow of capital, which contributes to the fall of the Ibovespa indicator. Thus, given a 1% increase in the price of the dollar, the devaluation of the stock indicator would be approximately 0.69%. Additionally, with the political crisis that has become common in recent years, the successive drops in interest rates to historic lows have had repercussions on the investment intentions in Brazil. In the common case, the gross formation of fixed capital fell considerably between 2016 and 2021, compared to the period between 2010 and 2015. And in June 2021 the value was of 73.704 billion dollars, approximately 58% of the amount observed between 2010 and 2015 (Ibge, 2021).

Thus, given this context, decision makers will monitor the variables that have the greatest impact on the Ibovespa variation. In the short term, there is a supremacy of the exchange rate coefficient in comparison to the other variables mentioned above as determinants in the variation of the market indicator. Evidently, the exchange rate policy has a very strong relationship with the investment intention in the country or abroad. In the case of investment abroad, the exchange rate policy greatly influences this type of operation, which at first would help to price the eventual profit to be earned. At the same time, when considering the exchange rate as a measure of inflation, investments in fixed income can be affected, as the increase in the exchange rate can end up reducing the real gain, which would be undesirable for long-term investments.

In general, the results reveal that the iron ore quotation on the Dalian Commodity Exchange in China is highly relevant to the Ibovespa and is linked to its behavior. In the study, we start from the hypothesis that the iron ore and Brent oil prices are fundamental variables related to the Ibovespa indicator. Also, these products are essential in the economy, especially oil, as it is the main input for many companies.

In addition, this result reinforces the main issue under discussion, namely, the importance of China as a trading partner, as well as the investment intention channeled into a short and long-term analysis. Empirical studies, such as those by Gouvea et al. (2020), Escher & Wilkinson (2019)

and, Bortoluzzo et al. (2013), also reiterate the importance of the Chinese market for the Brazilian market.

FINAL CONSIDERATIONS

This research discusses the iron ore price variations during the global crisis caused by the COVID-19 pandemic and their effect on the Ibovespa indicator. Among other factors, the increase of the international ore price was associated with a supply shock explained by a factor named "China". Linked to this event, there was an oil price war between the OPEC countries and Russia, which are responsible for approximately 50% of the world production (EIA, 2021).

When the World Health Organization (WHO) declared the COVID-19 pandemic on March 11, 2020, all stock market indexes fell. In that moment, the news highlighted the closing of borders as a first measure to contain the advance of the virus, the economic recession, as well as the required time it would take to return to normality.

This study analyzed weekly data in logarithms since January 2018. The data, which are the Ibovespa and the iron ore quotation on the Chicago Stock Exchange (CME) and in China (DCE) and the dollar/real exchange rate, were collected from the Economatica platform. In the analysis, a structural break in week 12 of 2020 was found, which implied an estimation "pre" and "during" the pandemic in order to verify changes in the behavior pattern of the predictor variables on the Ibovespa behavior. Furthermore, through this methodology, it was possible to analyze the short-term relationship and predict the behavior of the Ibovespa, as well as determine the possible statistical and significant effect of the variables in question.

The results support the main hypothesis, which sustains that an increase in iron ore prices in China exert a positive and significant effect on the Ibovespa. Therefore, this study highlights the importance of this market for Brazil and shows that the information that comes through the Chinese market linked to ore is channeled into the Brazilian business environment, which, consequently, is reflected in the Ibovespa. A similar behavior was

expected for iron ore quotations on the Chicago stock exchange, however, short-term relationships, in the general model, denote a negative coefficient, implying a short-term devaluation of the Ibovespa. It should be noted that although this effect is unexpected and not statistically significant, this result should be observed with caution, since the cointegration test denotes the existence of a common long-term stochastic trend.

Regarding the Brent oil, the results indicate a positive variation in the Ibovespa related to the appreciation of Brent for the three moments of analysis. This result allows us to conclude that the Chicago Stock Exchange is an important price formation market. Furthermore, the appreciation or devaluation of oil denotes how essential this product is as an energy source for the normal functioning of the various production chains. It is notorious that the changes observed in the price behavior, depending on the degree of use and/or dependence on the product, have considerable effects on the economy's income, as well as on inflation (Lourenço & Roos, 2015; Sek et al., 2015), which reveals a domino effect on the stock quotes of other companies linked to the sector.

Regarding the dollar, it was verified that an increase in the exchange rate has a negative effect on the Ibovespa, signaling a lack of stimulus in the intention to invest in Brazil, an expected result. It is reasonable to think that the shortage of foreign currency in the domestic market, signaled by the increase in the exchange rate, implies a fall in the stock market indicator. This emphasizes the importance of foreign capital for the better functioning of the business environment. Thus, this result highlights the relevance of the exchange rate policy for the decision makers. In the short term, this relationship should be taken into greater consideration in relation to the price of commodities.

In summary, as a practical contribution, the study can serve as support for the decisions of investors and managers of third-party resources. In addition, the results are relevant to the discussion on the chain effect that such variables exert on the different economy sectors, which are then reflected in the Ibovespa. Additionally, analysts' estimates, as well as investment intent, should incorporate these results into the pricing formation of predictor variables.

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