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News sentiment and foreign portfolio investment in Brazil

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Abstract

This paper aims to investigate the influence of news sentiment on foreign portfolio investment, as well as its disaggregated components (equity and debt securities) in Brazil. We construct a news sentiment index, based on the sentiment analysis of news stories published by the *Wall Street Journal*, from January 1999 to May 2018. The resulting index is consistent with national and international events during the period. There is evidence for the influence of news sentiment on these flows. This influence occurs in both contemporaneous and lagged values, in a way that an improvement in news sentiment leads to an increase in these flows in the next period. Additionally, the volatility of the flows responds asymmetrically to changes in news sentiment.

KEYWORDS

Brazil, capital flows, foreign portfolio investment, GMM, news sentiment, VAR-GARCH-DCC

1 | INTRODUCTION

Since capital flow waves are harmful to the economy, international capital flows can be quite important for emerging economies, as foreign investors tend to react to the perception of risk concerning those economies. Because the media has influence on the expectations of economic agents through the tone and the volume of its news coverage (Doms & Morin, 2004), including news stories in empirical analysis can be useful for financial markets and monetary policy decisions, as they provide information that has not been captured by hard data. An often used alternative for this is the sentiment analysis of those news stories, which is called news sentiment.[1]

The most used determinants in the literature to explain international capital flows are economic and financial variables. However, as shown in Lucas (1990), Papaioannou (2009), Evans and Hnatkovska (2014), and Gerlach and Yook (2016), among others, capital flows cannot be fully explained by those determinants. Additionally, there is empirical evidence for the influence of news sentiment on the economy (Fraiberger, 2016; Shapiro et al., 2018, among others) and on the stock market (Boudoukh et al., 2013; Heston & Sinha, 2017; Tetlock, 2007; Tetlock et al., 2008). Therefore, it is possible that news sentiment also has an effect on international capital flows.

To answer whether news sentiment affects foreign portfolio investment in Brazil, we develop a monthly news sentiment index, with the sentiment analysis of news stories published by the *Wall Street Journal* between January 1999 and May 2018. To our knowledge, this is the first time such an analysis is carried out for Brazil. Controlling for the economic and financial determinants most used in the literature, we find evidence for the influence of news sentiment on foreign portfolio flows to Brazil. With vector autoregressive (VAR) and dynamic conditional correlation (DCC) models, we conclude that an improvement in news sentiment leads to an increase in flows in the next period, and that changes in news sentiment generate asymmetric responses in the volatility of flows, in a way that suggests that news sentiment has a bigger impact when it worsens

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than when it improves. When we estimate models with contemporaneous values using the generalized method of moments (GMM) estimator, we find a significant positive coefficient for news sentiment. While we also confirm the importance of the other determinants, our results suggest that, unlike the usual conclusion found in the literature, domestic factors are critically important for international portfolio investment in Brazil.

Between 1999 and 2018, not only Brazil, but also the whole world went through economic, financial, and political crises, while international financial integration deepened. In 2001, when the international investment position (IIP) series was first compiled by the Central Bank of Brazil (BCB), the stock of liabilities in portfolio investment was equal to 27% of Brazilian Gross Domestic Product (GDP). Since then, as can be seen in Figure 1, the composition of portfolio investment has changed over time. Equity investment became more important than debt investment in 2005. In 2007, before the global financial crisis, equity investment peaked at 26% of GDP, while portfolio investment peaked at 35% of GDP. In the following year, the stock of equity and portfolio investment was reduced to less than half of its value. An additional drop occurred from 2010 to 2016. These two dates coincide with the election of Dilma Rousseff as president and her impeachment trial 6 years later. In the third quarter of 2018, according to the most recent data published by the BCB, portfolio investment was 32.73% of GDP: 19.21% was in equity investment and 13.52% was in debt investment. During the whole period, with 2014 being an exception, derivatives investment did not even account for 1% of GDP.

In the external accounts, equity and debt liabilities are divided between those that are issued in Brazil and those that are issued abroad. Because these two markets are very distinct, our analysis focuses on securities issued in Brazil only. Figure 2 shows how the importance of securities issued in the country has been growing over time. In 2001, the stock of securities issued abroad, of both equity and debt, was higher than the stock of securities issued in the country. This changed in 2009 for equity securities, and in 2013 for debt securities. In the third quarter of 2018, the stock of equity issued in Brazil was 13.50% of GDP, the stock of equity issued abroad was 5.60% of GDP, the stock of debt issued in Brazil was 7.46% of GDP, and the stock of debt issued abroad was 6.06% of GDP. Looking at monthly net flows, one can notice that the volatility of those flows is higher for equity issued in the country than for equity issued abroad. This also happens for debt securities since 2013.

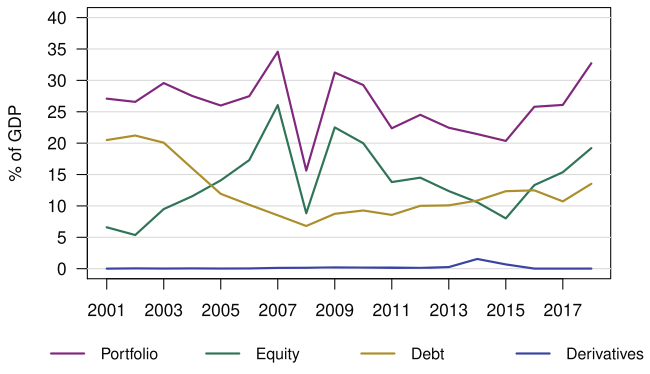

FIGURE 1 Brazilian international investment position liabilities, as a percentage of GDP, from 2001 to 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

Following this introduction, Section 2 reviews the literature, while Section 3 presents the news sentiment index within a contextualisation about the period of study, and discusses the methodology for the econometric analysis. Section 4 discusses the results of the analysis, and is followed by the conclusion in Section 5.

2 | LITERATURE REVIEW

Since the seminal works of Calvo et al. (1993) and Fernandez-Arias (1996), the literature about the determinants of capital flows usually employs what is known as 'push-pull' analysis. In this analysis, the variables that have the potential to influence the decision of international investors are considered to be determinants. The external variables that may lead investors to increase their position in a country are the 'push' factors, while the 'pull' factors are represented by domestic variables which affect the risk and return of investments made inside the country (Hannan, 2017).

It is a recurring result in the literature that the push factors are more important than the pull factors; among the examples of this are: Calvo et al. (1993), Fernandez-Arias (1996), Lo Duca (2012), Forbes and Warnock (2012) for capital waves, and Broto et al. (2011) and Pagliari and Hannan (2017) for the volatility of flows. Another repeating result is the changing relative importance of each factor, as world conditions change: Lo Duca (2012) highlights that the greatest changes occurred alongside important events in the international economy, Evans and Hnatkovska (2014) associate those types of changes with international financial integration, and Broto et al. (2011) conclude that the importance of global factors increased in the recent years.

Economic and financial factors are important determinants of capital flows and, therefore, are the most commonly used variables for this analysis. Koepke (2015) reviews the empirical literature regarding these determinants for emerging economies. More specifically, the author's focus is on flows from non-residents, because this usually is the focus of the literature. This happens because

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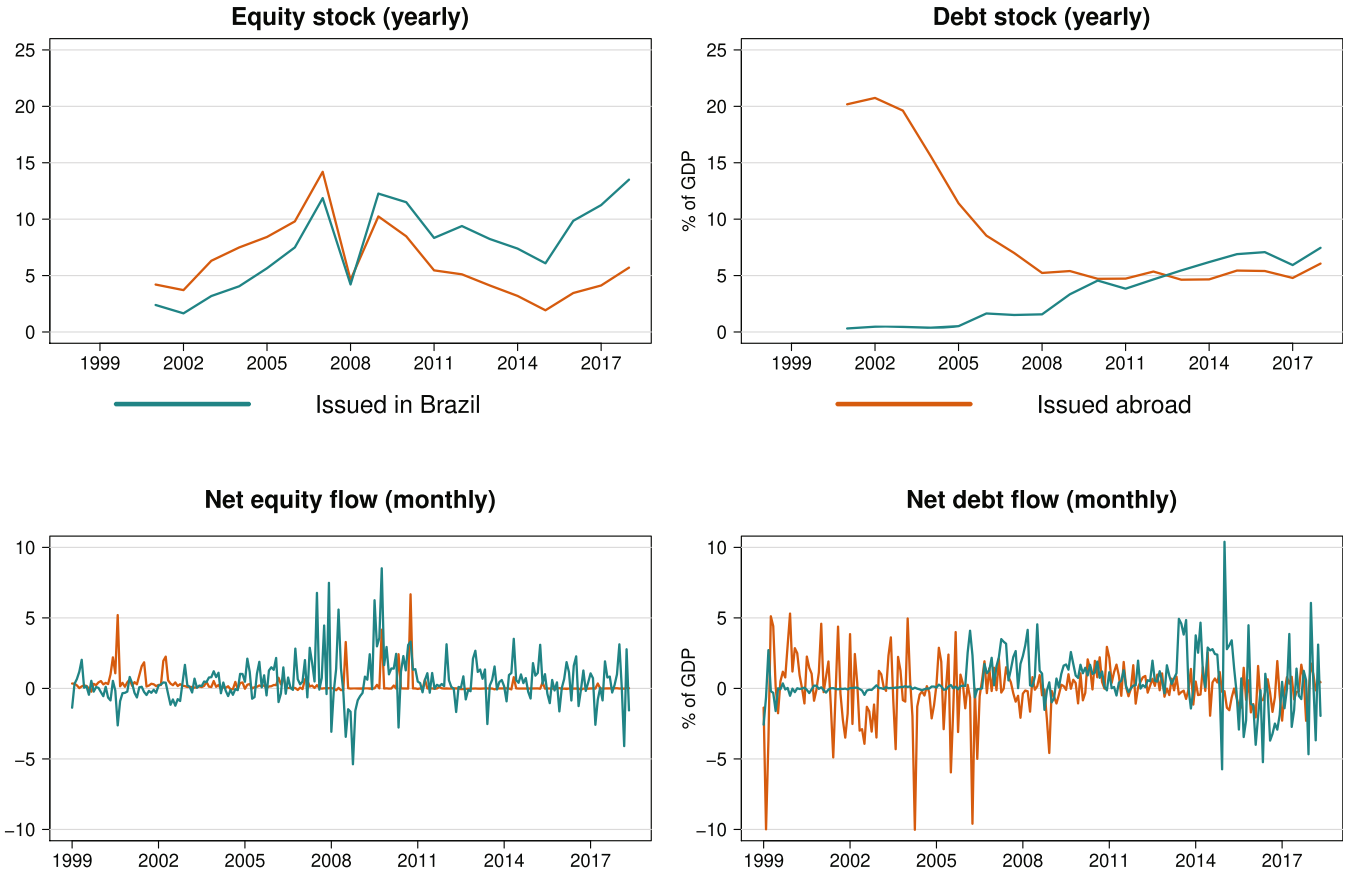

FIGURE 2 Equity and debt stocks and flows, as a percentage of GDP, from 1999 to 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

emerging economies are generally more affected by the actions of foreign investors in their territories than by the actions of domestic investors abroad. The author argues that non-resident flows are more volatile than resident flows, especially during crises, and, therefore, are important determinants of exchange rates, domestic interest rates, and the financial conditions inside the country.

Among the most widely used determinants, Koepke (2015) highlights the three most common push factors (global risk aversion, the interest rate, and output growth) and three pull factors (output growth, stock market returns, and an index of country risk). For the push factors, it is usual to use data from the U.S. economy, thus the interest rate usually is a short-term U.S. Treasury rate. Global risk aversion usually is represented by the VIX index, created by the Chicago Board Options Exchange (CBOE). As a volatility index of the price options of the S&P500, the VIX incorporates both risk aversion and economic uncertainty.

Methodologically, the papers reviewed by Koepke (2015) use very diverse econometric approaches, including, for example, VAR, vector error correction (VEC), and state-space models, whether with constant parameters, or with endogenous changes, or even with dummy variables chosen by the researchers. The author finds evidence for a negative relationship between these flows with global risk aversion, the external interest rate, and country risk. On the other hand, the flows have a positive relationship with internal and external output growth, and the stock market returns.

In the Brazilian literature about the topic, Meurer (2006), with monthly data and a VEC model, Sanvicente (2014), with daily data and simultaneous equations models, and Loncan and Caldeira (2015), with monthly data and an asset pricing model, find evidence for the influence of international capital flows on the Brazilian stock market. Regarding the determinants of those flows, Franzen et al. (2009), with monthly data and a VEC model, find a positive relationship between the flows with the contemporaneous Ibovespa returns and the Selic rate, which is the base interest rate of the Brazilian economy, and a negative relationship between country risk and portfolio investment flows to Brazil, in addition to the influence of the lagged returns. Furthermore, the authors conclude that changes in the exchange rate indirectly affect these flows, because of the resulting changes in the relative prices of assets. Additionally, Barbosa and Meurer (2015) with monthly data and a structural VAR

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(SVAR) model, investigate the relationship between foreign portfolio investment and domestic market returns, both from debt and equity securities, and conclude that changes in the exchange rate are important for assets issued in the country.

There is also evidence that international capital flows can be affected by other factors. Lucas (1990) observes that capital does not flow from developed countries to the developing ones, as predicted by classical economic theory. Tesar and Werner (1995), Obstfeld and Rogoff (2000), Sørensen et al. (2007), and Bai and Zhang (2012) identify and try to explain the 'home bias' which is the preference for national assets over international diversification. Evans and Hnatkovska (2014) observe an increase in the volatility of capital flows to France, Germany, and the United Kingdom, associated with the introduction of the Euro, and an increase in flows to Canada, which coincides with the North American Free Trade Agreement (NAFTA). Furthermore, Gerlach and Yook (2016) conclude that political conflicts with North Korea affect foreign portfolio investment in South Korea.

Those other factors can also affect flows indirectly, as they have an effect on variables that are important for investment decisions. For example, Santa-Clara and Valkanov (2003), Jensen and Schmith (2005), Siokis and Kapopoulos (2007), and Mukherjee and Leblang (2007) find evidence for the influence of political events on the stock market. Moreover, investor sentiment affects the stock market as well, as concluded by Lee et al. (2002) for the United States, and Schmeling (2009) for 18 industrialised countries. Chau et al. (2016) argue that sentiment may rapidly spread among the market and affect the risk tolerance of investors, and conclude that investors negotiate more aggressively when sentiment is worsening than when it is improving by the same magnitude. Tsai (2017), looking at the Taiwanese stock market, concludes that sentiment contagion is asymmetric: pessimistic sentiment is more contagious than optimistic sentiment. Baker et al. (2012) conclude that investor sentiment plays an important role in the volatility of the international market. Their results also suggest that capital flows are one of the mechanisms, together with word of mouth and the media, for the propagation of global sentiment.

Fraiberger (2016) uses the sentiment analysis of news stories published by Reuters to create a news sentiment index for 12 countries, including Brazil, for the period between 1987 and 2013, and finds that news sentiment is an important indicator of output growth. In addition to this, the index reduces in-sample forecast errors by 19% on average. Shapiro et al. (2018) developed another news sentiment index, which is highly correlated with U.S. economic business cycles indicators. An important part of the papers with news sentiment analysis look into the relationship between news and asset prices and returns. Tetlock et al. (2008), Boudoukh et al. (2013), and Heston and Sinha (2017) are examples that find evidence for that. Tetlock (2007) is one of the best known papers about the topic (Loughran & McDonald, 2011). With the Harvard-IV 4 dictionary, Tetlock (2007) associates a popular column of the *Wall Street Journal* to stock market returns and the trading volume, and concludes that a column with a large number of pessimistic words in 1 day precedes lower returns in the next day.

3 | DATA AND METHODOLOGY

The news sentiment index was created with the sentiment analysis of news stories published by the *Wall Street Journal* between January 1999 and May 2018. We analysed 26.406 news stories that contained the keyword 'Brazil' and were not published under the rubric of culture, sports, and lifestyle. The sentiment analysis uses semantic criteria, following a semantic dictionary, to conclude something about a text connotation (Louhgran & McDonald, 2016). We used the 'Positiv' and 'Negativ' categories of the Harvard-IV 4 dictionary, which is a much used dictionary in this kind of analysis (Tetlock, 2007 and Tetlock et al., 2008 are a few examples). We also used the 'bag of words method', in which words are considered separated entities, ignoring word order. This may lead to a meaning loss, which is compensated by the simplicity of the method when word order is not highly important for the analysis. This way, news sentiment is given by the proportion of positive and negative words in the text, such that:

$$\text{News sentiment} = \frac{\text{number of positive words} - \text{number of negative words}}{\text{number of positive words} + \text{number of negative words}}.$$

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Therefore, news sentiment can vary between −1 and 1, considering the extreme cases in which the text has only negative or only positive words. While, theoretically, news sentiment can vary between −1 and 1, texts usually have a more balanced proportion between positive and negative words. In the 26,406 news stories analysed, news sentiment ranged from −0.2273 to 0.3516. The resulting monthly index, given by the average of the news stories of the month, multiplied by 100, has an average of 5.4847, varying from 1.8430 to 11.1353. Figure 3 presents the evolution of the news sentiment index between January 1999 and May 2018.

The study period starts at the beginning of the second Fernando Henrique Cardoso government, with the adoption of the floating exchange rate regime by Brazil, and the following devaluation of the domestic currency. In the first 2 years, the index had a sharp increase, peaking during August 2000, when the Brazilian GDP growth was at its highest levels and the country risk index was at its lowest levels, between 1999 and 2004. In 2001, however, the index underwent a sharp decline. Contributing to this was the energy crisis, which resulted in a rationing of electric power in most of the country; the crisis in Argentina; the 9/11 attacks in the United States; the Brazilian agreement with the International Monetary Fund (IMF); and an economic recession that lasted from the second to the fourth quarter of the year. In the following year, the index begun a new rising trajectory, even with the turbulence in the market generated by the fear of the election of Luís Inácio Lula da Silva in 2002.

News sentiment improved until 2007, with August 2006 being the highest point of the series since 2001. The *Mensalão* scandal, the worst political crisis of both Lula governments, began in May 2005; represented by the widest valley on the graph, this did not reverse this trend. The trend reversed, however, with the global financial crisis of 2008. The recovery of news sentiment after the peak of the crisis was interrupted in the electoral year of 2010, when Dilma Roussef was elected to the Presidency of the country. Since then, the index fell considerably, oscillating around the lowest level of the whole series since the reelection of the president in 2014: May of that year was the last point above average of the whole period. The second quarter of 2014 also marked the beginning of the longest recession, dated by the Brazilian Business Cycle Dating Committee (*Comitê de Datação de Ciclos Econômicos* – CODACE), until now. Since 1980, the longest recessions were the ones of 1989–1992 and 2014–2016, which each lasted 11 quarters. The recession that ended in the last quarter of 2016 is the one that had the biggest accumulated loss in those 38 years: 8.5% of GDP.

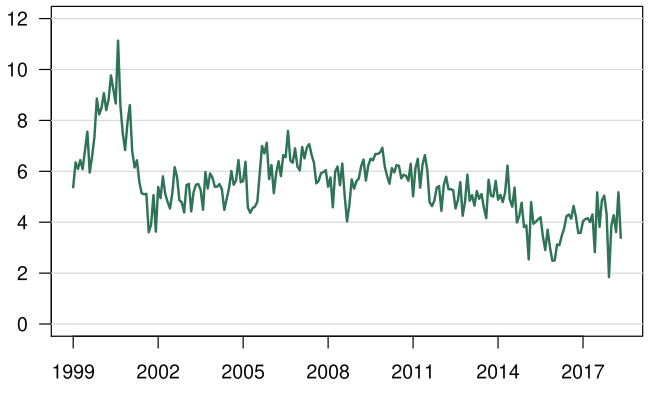

FIGURE 3 News sentiment index, from January 1999 to May 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

In the last few years, the country has been struck by the countless denunciations of corruption, the popular protests especially those of June 2013, and the launch of Operation Car Wash (*Operação Lava Jato*) by the Federal Police in 2014. In 2016, Dilma Rouseff became the second president impeached in 24 years. Her successor, Michel Temer, was accused of corruption by whistle-blower Joesley Batista in May 2017. In the last point of the series, May 2018, the strike by truck drivers was detrimental to the whole Brazilian economy. December 2017, the lowest point of the whole series, witnessed the trial by the justice of the United States of the case of corruption in the International Federation of Association Football (FIFA), which resulted in the conviction of José Maria Marin, former president of the Brazilian Football Confederation (CBF). The case did not reverberate in the Brazilian media, but had an extensive coverage by *Wall Street Journal*, representing more than half of the news with negative news sentiment in that month. Although it is a case that involved a sports entity, the news stories about the scandal were not published under sports categories, and, therefore, were not excluded during the initial filtering by categories.

As the interest of this paper lies in the action of foreign investors in the country, we analyse the monthly net liabilities flows of equity issued in Brazil, of debt issued in Brazil, and of aggregated portfolio investment. We collected the values in millions of dollars from the BCB website and deflated them by the United States Consumer Price Index (CPI). The analysis does not include investment funds, because this account is a complementary subdivision introduced by the sixth edition of the Balance of Payments and International Investment Position Manual (IMF, 2009), and the first observation for the series is January 2010. To control for the economic and financial factors that may affect international investment decisions, we use domestic and external variables. The external variables are the ones identified by Koepke (2015) as the most used by the literature: *TB3M*,

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USGDP, and *VIX*, which represent the external interest rate, external output growth, and global risk aversion, respectively. For the domestic variables, besides the output growth (*BRGDP*), the stock market index (*IBOV*) and country risk (*EMBIBR*), also identified by Koepke (2015) as the most common, we use the domestic interest rate (*SELIC*) and the real exchange rate index (*EXCHANGE*), for which the Brazilian literature about the topic already found evidence for the influence on flows (Barbosa & Meurer, 2015; Franzen et al., 2009). Additionally, we include a variable for the fiscal situation of the country (*FISCAL*), as public sector borrowing requirements may also affect flows, especially those from debt securities. All series are monthly, for the period from January 1999 to May 2018. Table 1 details the data and their source, while Table 2 presents the descriptive statics of the variables. From the review of the empirical literature, we expect that the relationships between the flows and the explanatory variables will have the signs presented in Table 3.

Because the econometric analysis is conducted with a time series approach, it is necessary to check whether the series are stationary, in order to avoid spurious results. For this, we use the Augmented Dickey–Fuller (ADF) test, which tests the null hypothesis of the existence of a unit root against the alternative of stationarity, and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, which tests the null hypothesis of stationarity against the alternative of unit root. The results for both tests are reported in Tables A1 and A2 in the Appendix. Following Kwiatkowski et al. (1992), a failure to reject the unit root in the ADF test and a rejection of stationarity in the KPSS test indicate a nonstationary series, which is the case for *EMBIBR*, *EXCHANGE*, *BRGDP*, *FISCAL*, *IBOV*, *TB3M*, and *USGDP*. On the other hand, a rejection of the unit root in the ADF test and a failure to reject stationarity in the KPSS test indicate a stationary series, which is the case for *EQUITY*, *DEBT*, *PORTFOLIO*, *VIX*, and the first difference of the nonstationary series, represented by *DEMBIBR*, *DEXCHANGE*, *DBRGDP*, *DFISCAL*, *DIBOV*, *DTB3M*, and *DUSGDP*. When there is a rejection of both the unit root in the ADF test and the stationarity in the KPSS test, which is the case for *NEWSSENT* and *SELIC*, the conclusion is not clear, since the tests yield conflicting results. Because the differencing of stationary series may lead to information loss, both series are left in levels. Additionally, Wu and Chen (2001) provide an argument in favour of the stationarity of interest rates, since the low power of the ADF test may be the reason why this test fails on rejecting the null of unit root for those variables.

All the stationary variables are used to estimate a VAR model with exogenous variables. This way, it is possible to make inferences about the behaviour of the endogenous variables, without knowing the structural relationship between them. Therefore, we estimate the following model:

$$y_t = A_1 y_{t-1} + B_0 x_t + B_1 x_{t-1} + u_t, \quad (1)$$

such that y is a vector for the domestic variables, or pull factors, which are endogenous. Since Brazilian domestic variables do not directly affect external variables, the push factors are considered exogenous to the system, being represented by the vector x. The model includes

TABLE 1 Collected series

Series	Unit	Source (code)
Net liabilities of portfolio investment	$ millions	BCB (22924)
Net liabilities of equity issued in the country	$ millions	BCB (22930)
Net liabilities of debt issued in the country	$ millions	BCB (22942)
EMBI+Br, country-risk index by J. P. Morgan Chase	Basis points	Ipeadata (40940)
Real exchange rate index (IPCA)—US Dollar	Index	BCB (11753)
Interest rate—Selic accumulated in the month in annual terms (basis 252)	% p.a.	BCB (4189)
Brazilian Gross Domestic Product	$ millions	BCB (4385)
PSBR—Flows accumulated in 12 months—Primary fiscal result—Total—Federal Government and Central Bank	% of GDP	BCB (5783)
Ibovespa index	Points	B3
3-Month Treasury Bill: secondary market rate	% p.a.	Federal Reserve Bank of St. Louis (TB3MS)
U.S. monthly real GDP index	Index	Macroeconomic Advisers
VIX, end of period	Points	CBOE

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TABLE 2 Descriptive statistics of the variables

Variable	Num. of observations	Mean	Standard deviation	Minimum	Maximum
PORTFOLIO	233	0.9336	2.8380	−9.9528	11.4317
EQUITY	233	0.3860	1.2317	−4.0815	6.4787
DEBT	233	0.3769	1.3079	−3.9979	7.2902
NEWSSENT	233	5.4757	1.3415	1.8430	11.1353
EMBIBR	233	0.0446	0.0343	0.0141	0.2147
EXCHANGE	233	−0.0108	0.2615	−0.4852	0.7232
SELIC	233	0.1328	0.0464	0.0620	0.3594
BRGDP	233	0.5835	0.4731	−0.2643	1.2828
FISCAL	233	−1.2699	1.5917	−2.9900	3.0700
IBOV	233	1.4627	0.6562	0.0000	2.3551
TB3M	233	0.3507	0.4719	0.0001	1.0617
USGDP	233	0.2116	0.1008	0.0000	0.4002
VIX	233	20.0463	7.9329	9.5100	59.8900

Note: *PORTFOLIO* is the net liabilities flow of portfolio investment as a percentage of Brazilian GDP, *EQUITY* is the net liabilities flow of equity issued in the country as a percentage of Brazilian GDP, *DEBT* is the net liabilities flow of debt issued in the country as a percentage of Brazilian GDP, *NEWSSENT* is the news sentiment index created by authors, *EMBIBR* is the natural logarithm of (1 + EMBI+Br divided by 10,000), *EXCHANGE* is the natural logarithm of (real exchange rate index, Jan/99 = 1), *SELIC* is the natural logarithm of (1 + Selic), *BRGDP* is the natural logarithm of (Brazilian GDP as index, deflated by CPI and seasonally adjusted by X-13ARIMA-SEATS, Jan/99 = 1), *FISCAL* is the PSBR series without transformation, *IBOV* is the natural logarithm of (Ibovespa index, Jan/99 = 1), *TB3M* is the natural logarithm of (1 + 3-month Treasury Bill: secondary market rate), *USGDP* is the natural logarithm of (U.S. monthly real GDP index, Jan/99 = 1), and *VIX* is the VIX series without transformation.

TABLE 3 Expected relationships between explaining variables and the flows

	EQUITY	DEBT	PORTFOLIO
NEWSSENT	+	+	+
BRGDP	+	+	+
EXCHANGE	−	−	−
SELIC	−	+	+
EMBIBR	−	−	−
IBOV	+	+	+
FISCAL	?	+	?
USGDP	+	+	+
TB3M	−	−	−
VIX	−	−	−

Note: positive relationships are represented by '+', and negative relationships by '−'. When there is no information about the expected behaviour of the variable, it was used '?'

the contemporaneous values and the first lag of the exogenous variables. We estimate one model for portfolio flows and another model with both equity and debt flows as endogenous variables, in order to capture portfolio rebalancing effects, if they exist. We refer to such models as PORTFOLIO model and EQUITY & DEBT model, respectively, from now on.

For the selection of the optimal lag, we use the Bayesian information criterion (BIC), which tends to select more parsimonious models than does the Akaike information criterion (AIC). The results are not shown, but are available upon request. The criterion selects one lag for the EQUITY & DEBT model, and two lags for the PORTFOLIO model. In the last case, however, the difference between the results for one and two lags is quite small (about 0.01). Therefore, we choose the more parsimonious model of one lag, due to the number of variables included in the analysis and the total number of observations. As the models are estimated through ordinary least squares (OLS), which results in inefficient estimators in the case of heteroskedasticity and autocorrelation in the residuals, the standard errors are corrected as in Andrews (1991) and Long and Ervin (2000), when it is necessary.

To investigate the joint dynamics of the conditional variance, we employ a DCC-GARCH(1,1) model as proposed by Engle (2002). The DCC is a model of time-varying conditional correlations. With the resulting matrices, it is possible to analyse how the correlations changed throughout the period of study, and, with this, to identify characteristics of the dynamics between variables. In addition to this, the DCC is a model of low parameterisation, which allows for simple modelling, even in the case of processes with many variables. Its

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estimation is done in two stages. In the first, an univariate model for conditional variance, more specifically a GARCH(1,1), is estimated for each variable with the residuals of the VAR model. The GARCH process models the volatility dynamics of the series that only depends on itself. In the second, and multivariate, stage, the DCC estimation is conducted with the standardised residuals extracted from each estimated model from the previous stage.

The VAR estimation, however, does not account for contemporaneous effects that probably exist between variables. Since it is also quite possible that endogeneity between the variables exists, OLS cannot be the estimation method, because, in this case, it results in biased, inconsistent, and inefficient estimators. Therefore, we use the two-step GMMs estimator from Hansen (1982) as an alternative. More general than OLS, GMM only depends on moment conditions to generate consistent, efficient, and non-biased estimators, which depend on the choice of instruments. These instruments should be correlated with the endogenous variables, as well as orthogonal to errors (Hamilton, 1995). Since the variables used are time series, their lags are natural candidates for instruments, as those series usually are autocorrelated. In this paper, the first two lags of the variables that were considered to be endogenous after testing were chosen as instruments.

To identify which variables may be considered endogenous, we follow the procedure in Hausman (1978), for each of the flows and each of the domestic variables. Each of these variables is regressed on the other explanatory variables. The significance of the residuals of this regression in the regression of the flows on the determinants indicates that the variable is endogenous. The results of the tests, which are not shown but are available upon request, indicate that, at the 10% significance level, *NEWSSENT*, *DEXCHANGE*, *SELIC*, and *DIBOV* are endogenous for *EQUITY*, and *DEXCHANGE*, *SELIC* and *DIBOV* are endogenous for *PORTFOLIO*. None of the variables is endogenous for *DEBT*. Therefore, we estimate Equations (2) and (3) through GMM and Equation (4) through OLS:

$$\begin{aligned}\mathrm{PORTFOLIO}_t = {} & \beta_1 \mathrm{NEWSSENT}_t + \beta_2 \mathrm{DBRGDP}_t + \beta_3 \mathrm{DEXCHANGE}_t \\ & + \beta_4 \mathrm{SELIC}_t + \beta_5 \mathrm{DEMBIBR}_t + \beta_6 \mathrm{DIBOV}_t \\ & + \beta_7 \mathrm{DFISCAL}_t + \beta_8 \mathrm{DUSGDP}_t + \beta_9 \mathrm{DTB3M}_t \\ & + \beta_{10} \mathrm{VIX}_t + \varepsilon_t. \end{aligned} \tag{2}$$

$$\begin{aligned}\mathrm{EQUITY}_t = {} & \beta_0 \mathrm{DEBT}_t + \beta_1 \mathrm{NEWSSENT}_t + \beta_2 \mathrm{DBRGDP}_t \\ & + \beta_3 \mathrm{DEXCHANGE}_t + \beta_4 \mathrm{SELIC}_t + \beta_4 \mathrm{DEMBIBR}_t \\ & + \beta_6 \mathrm{DIBOV}_t + \beta_7 \mathrm{DFISCAL}_t + \beta_8 \mathrm{DUSGDP}_t + \beta_9 \mathrm{DTB3} \\ & \times \mathrm{M}_t + \beta_{10} \mathrm{VIX}_t + \varepsilon_t, \end{aligned} \tag{3}$$

$$\begin{aligned}\mathrm{DEBT}_t = {} & \beta_0 \mathrm{EQUITY}_t + \beta_1 \mathrm{NEWSSENT}_t + \beta_2 \mathrm{DBRGDP}_t \\ & + \beta_3 \mathrm{DEXCHANGE}_t + \beta_4 \mathrm{SELIC}_t + \beta_4 \mathrm{DEMBIBR}_t \\ & + \beta_6 \mathrm{DIBOV}_t + \beta_7 \mathrm{DFISCAL}_t + \beta_8 \mathrm{DUSGDP}_t + \beta_9 \mathrm{DTB3M}_t \\ & + \beta_{10} \mathrm{VIX}_t + \varepsilon_t, \end{aligned} \tag{4}$$

We also repeat the estimation of the models in Equations (1), (2), (3), and (4), replacing news sentiment with uncertainty indices based on the volume of news coverage. Baker et al. (2016) created the Economic Policy Uncertainty (*EPU*) index, which counts the number of times that newspapers published news stories containing one or more of the selected uncertainty keywords. With the U.S. version of the index, Baker et al. (2016) concluded that uncertainty increases the volatility on the stock market, decreases investment and employment in sensible sectors (defence, health, and construction of infrastructure), and helps to forecast changes in investment, output, and employment in the United States and in other 12 countries. Since its creation, the index has been used in a large amount of research. The index is published on its own website, and is periodically updated for more than 20 countries. The index also has a global version, which is a weighted average of the national indices, as well as regional and thematic versions. In addition to the Economic Policy Uncertainty index for Brazil (*EPUBR*), we also estimate the models with Global Economic Policy Uncertainty (*GEPU*), due to the recurring result found in the literature regarding the importance of external factors as determinants of international capital flows. Another alternative is the Brazilian Economic Uncertainty Indicator (*IIE*), created by the Getulio Vargas Foundation, inspired by the EPU. Beside the frequency of news stories containing uncertainty keywords, the index also includes the volatility of the financial market and the dispersion of expectations for the exchange rate and for inflation among the respondents of the survey conducted by the BCB. Because the index was created for the period that begins in January 2000, we repeat the unit root tests for this period, and make adjustments in the estimation when necessary.

Analysing the uncertainty indices EPUBR and GEPU, we notice that the global index was higher than the Brazilian index only in a few occasions: in 2001, with the 09/11 attacks; in 2003, with the beginning of the Second Gulf War; and between 2011 and 2013 with the European debt crisis, the United States fiscal cliff, and the power transition in China. This means that uncertainty in Brazil is higher than the international average over time. The correlation between them is 0.6167. Compared with those indices, the news sentiment index has a correlation of

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−0.5256 with EPUBR, and of −0.5407 with GEPU: both of them are significant at the 1% level. In its turn, the correlation of the news sentiment index with the IIE index is −0.52: this is also significant at the 1% level. As expected, the news sentiment index has negative correlations with the uncertainty indices.

4 | RESULTS

To answer the main research question of this paper, news sentiment is included among the other explanatory variables in the analysis. The estimation results are shown in Table 4. News sentiment has a significantly positive

TABLE 4 VAR estimation results from March 1999 to May 2018

Dependent variable	EQUITY	DEBT	PORTFOLIO
$EQUITY_{t-1}$	0.0715	0.0211	
	(0.1028)	(0.0634)	
$DEBT_{t-1}$	0.0615	0.2077	
	(0.0748)	(0.1331)	
$PORTFOLIO_{t-1}$			0.0869
		(0.0738)	
$NEWSSENT_{t-1}$	0.0970**	0.1933***	0.4497***
	(0.0504)	(0.0459)	(0.1130)
$DBRGDP_{t-1}$	3.0526*	1.7005	5.0537
	(1.6266)	(1.4923)	(3.7262)
$DEXCHANGE_{t-1}$	−3.8498	−0.8099	−11.8057 **
	(2.6268)	(2.2726)	(5.2756)
$SELIC_{t-1}$	−2.8438	−4.8073***	−10.9520***
	(1.8899)	(1.3474)	(3.9011)
$DEMBIBR_{t-1}$	−1.6293	−8.0304	−25.5835
	(6.3484)	(6.1804)	(19.8053)
$DIBOV_{t-1}$	2.4715*	−1.5810	3.6663
	(1.3965)	(1.6679)	(3.0782)
$DFISCAL_{t-1}$	0.0781	0.2313	0.0587
	(0.3941)	(0.4552)	(0.7538)
$DUSGDP_t$	28.8452	−0.4907	59.8419 *
	(18.3234)	(15.0960)	(33.5070)
$DUSGDP_{t-1}$	12.7181	6.1135	−7.4759
	(14.8724)	(13.6510)	(34.3684)
$DTB3M_t$	129.8283**	−103.9800**	−124.8359
	(58.2281)	(50.4320)	(119.1463)
$DTB3M_{t-1}$	−197.0845**	7.2335	−25.1304
	(91.2881)	(45.4410)	(120.1652)
VIX_t	−0.0307	−0.0053	−0.0526
	(0.0308)	(0.0157)	(0.0417)
VIX_{t-1}	0.0323	−0.0040	0.0377
	(0.0248)	(0.0141)	(0.0409)
R^2	0.2599	0.2019	0.3083
R^2 adjust	0.2083	0.1462	0.2635

Note: Standard errors are in parentheses. For EQUITY, they are heteroskedasticity robust, as in Long and Ervin (2000), and, for DEBT, they are heteroskedasticity and autocorrelation robust, as in Andrews (1991). Results (*p*-value) of the ARCH-LM test: EQUITY: 0.0113; DEBT: 0.0064; PORTFOLIO: 0.8686. Significance levels: *10%, **5%, ***1%.

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coefficient for the three flows. The response of these flows to an impulse to news sentiment, generated by the coefficient matrix of the moving average representation of the VAR, is shown in Figure 4, with the 95% confidence bands calculated using bootstrap methods. For the three flows, an improvement in news sentiment, represented by an increase of one percentage point in the index, results in an increase in flows in the next period. However, the response of equity flows to an impulse to news sentiment is not significant. The effect dissipates approximately 2 years later.

In addition to news sentiment, the following variables are significant at the 5% level: the first lag of *DEXCHANGE* for *PORTFOLIO*; *SELIC* for *DEBT* and *PORTFOLIO*; and *DTB3M* for *EQUITY*, in addition to the contemporaneous values of *DTB3M* for *EQUITY* and *DEBT*. However, the coefficients for the interest rates have a different sign than the expected. The domestic interest rate has a negative relationship with all three flows, while the external interest rate has a positive coefficient for *EQUITY*. This may have happened because the base interest rate of the Brazilian economy reacts with lags to the exchange rate, as a consequence of the monetary policy decisions by the monetary authority, while the positive relationship of the external interest rate with equity flows may be due to portfolio rebalancing, with an increase in equity flows after an increase in the external interest rate. In addition to this, the exchange rate may react to the risk perception of investors. On the other hand, the lagged values of *DEBT* for *EQUITY*, and of *EQUITY* for *DEBT*, are not significant, suggesting that, in this case, the investors who trade equity securities are not the same ones who trade debt securities. Otherwise, it would probably be rebalancing effects from one period to the next. Other variables also have a non-expected sign coefficient, but they are not significant.

Although the hypothesis of heteroskedasticity is rejected for *PORTFOLIO*, this is not the case for *EQUITY* and *DEBT*. This may indicate that the volatility of the last two flows cancels out when the flows are aggregated. Additionally, the hypothesis of heteroskedasticity is not rejected for *NEWSSENT*, *SELIC*, *DEMBIBR*, *DIBOV*, and *FISCAL*. Therefore, we estimate a GARCH(1,1) for each one of those variables, as well as for equity and debt flows. The conditional volatility estimated by the GARCH(1,1) models for *EQUITY* and *DEBT* are presented in Figure 5. For most of the period, the volatility of equity flows is higher than the volatility of debt flows. This is the case except for between March and October 2006, briefly in 2007, and since July 2013.

It is possible to see shocks in the volatility of debt flows on a few occasions. The first is in March and April 2006. On February 16, 2006, the Brazilian government exempted foreign investors from income tax on gains on public debt securities, which may explain this shock. Additionally, March 2006 coincides with the resignation of Antonio Palocci from the Ministry of the Economy. The shock in July 2013 happened after the 2013 protests in Brazil, also known as the '*Jornadas de Junho*' (Journeys of June); the shock in February 2015 happened before the protests that occurred during the following month, assembled by a movement called '*Vem Pra Rua*' (Come to the Streets). Other shocks can be seen in May 2017, the month of the denunciations by Joesley Batista; and in February 2018. On the other hand, one can notice shocks in the volatility of equity flows in August 2007, the month of the beginning of the global financial crisis and of the reduction of the U.S. base interest rate by the Federal Open Market Committee (FOMC); in February 2008, the month of the launch of a stimulus package by the U.S. government, as an attempt to avoid a crisis; and in November 2009, the month of the beginning of the European debt crisis. These results might indicate that the volatility of equity flows reacts more to what happens in the world (the push factors) than to what happens in the country (the pull factors). This result is in accordance with the results found in the literature, which stress the importance of external factors over domestic ones for capital flows. This corresponds particularly strongly to Pagliari and Hannan (2017), who analysed the volatility of those flows. In its turn, the volatility of debt flows seems to react more to what happens in the country, or to the pull factors.

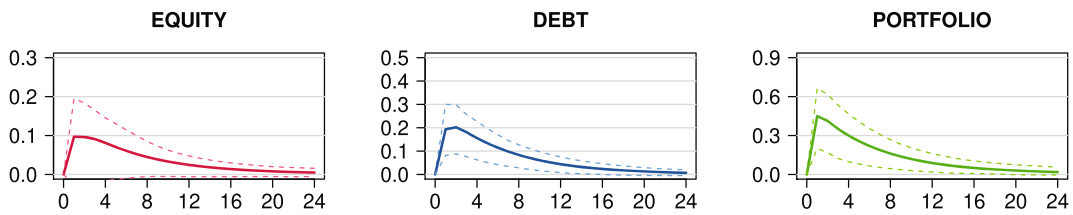

FIGURE 4 Response of the flows to an impulse to news sentiment. The figure shows the response of the three flows, as a percentage of GDP, up to 24 months ahead, to an impulse of one percentage point to news sentiment, with the 95% confidence bands, estimated using bootstrap methods, represented by the dashed lines [Colour figure can be viewed at wileyonlinelibrary.com]

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The DCC results are shown in Table 5. The model is stationary, since $\alpha+\beta<1$, and only the autoregressive coefficient, given by α, is statistically significant. The estimated conditional correlations of the flows with the explanatory variables can be seen in Figure 6. Comparing those values, it is possible to notice that news sentiment is not the most important variable for explaining the volatility of the flows. In other words, news sentiment is not the variable with the strongest correlation with the flows. The Ibovespa, a financial variable that better captures market expectations, is the most important variable for equity flows. With the exception of the fiscal variable, the other variables have a similar importance for *EQUITY*. For *DEBT*, all explanatory variables have a similar importance. The conditional correlation of news sentiment with the flows, which can be seen in more detail in Figure 7, have particularly interesting dynamics.

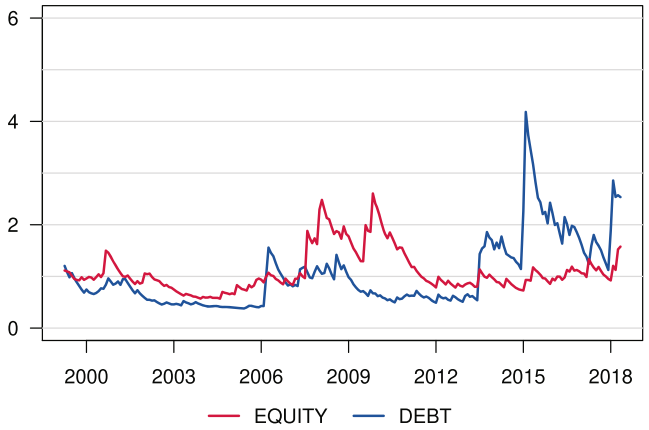

FIGURE 5 Estimated conditional volatility for EQUITY and DEBT flows from January 1999 to May 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 5 DCC estimation results, March 1999 to May 2018

α	β
0.7756 ***	0.0087
(0.1558)	(0.0095)

Note: The estimated model is $Q_t=(1-\alpha-\beta)\rho_0+\alpha Q_{t-1}+\beta\varepsilon^2_{t-1}$, such that ε_t are the standardized residuals from GARCH(1,1) and $\rho_t=J_tQ_tJ_t$ is the conditional correlations matrix, such that J_t is the diagonal matrix, whose elements are the main diagonal of Q_t. Standard errors are in parentheses. Significance levels: *10%, **5%, ***1%. *p*-Value of a Portmanteau diagnosis test, with 10 lags and as in Tsay (2013): rank-based = 0.1304; multivariate = 0.7336; robust multivariate = 0.6689.
Abbreviation: DCC, dynamic conditional correlation.

On the other hand, the conditional correlations of news sentiment with flows also come close to zero in March 2006, without a known international event: the correlations for both flows reached an inflection point, getting to the lowest point of the series for *DEBT*, and one of the lowest points for *EQUITY*. Similarly to what happened in 2000, those correlations series are at one of its lowest points when the news sentiment index is in one of its highest points. This behaviour of the

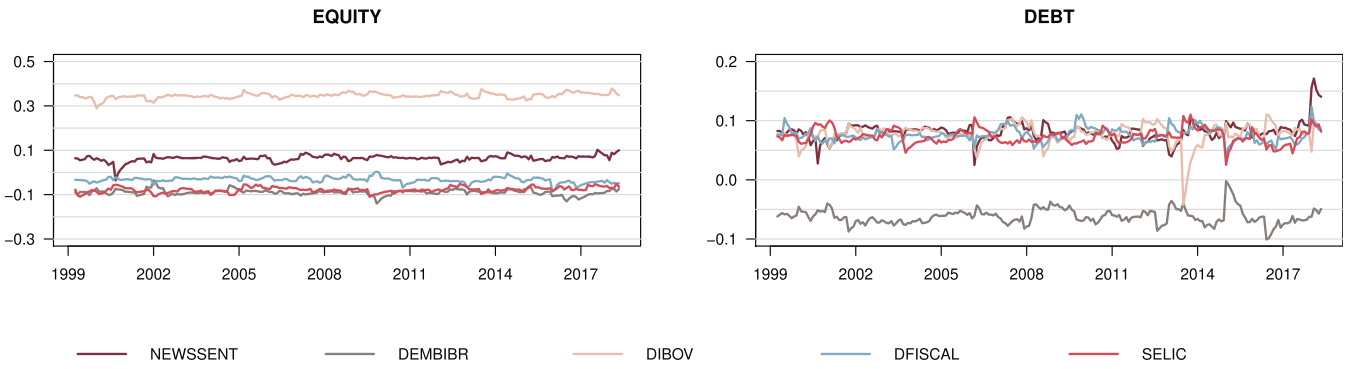

FIGURE 6 Conditional correlations of the explanatory variables with capital flows, April 1999 to May 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

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conditional correlations perhaps can be explained by domestic factors. As mentioned earlier, in February 2006, there was a change on the legislation that was favourable for foreign investors interested in buying Brazilian debt securities, which may explain the volatility shock and the increase on the volume of debt flows in February and March 2006. Additionally, the resignation of Antonio Palocci from the Ministry of the Economy may have caused a stronger reaction by the market than the effect caused by news sentiment on that month.

As suggested by a graphical analysis, the conditional correlations of news sentiment with the flows are negatively correlated with news sentiment itself: −0.3275 for *EQUITY* and −0.2803 for *DEBT*, which are significant at the 1% level. Therefore, in general, those conditional correlations increase when news sentiment worsens and decrease when it improves. In other words, news sentiment becomes more important when it worsens and less important when it improves. The impact of a positive change on the index is smaller than the impact of a negative change, which characterises an asymmetric response of the variance of the flows.

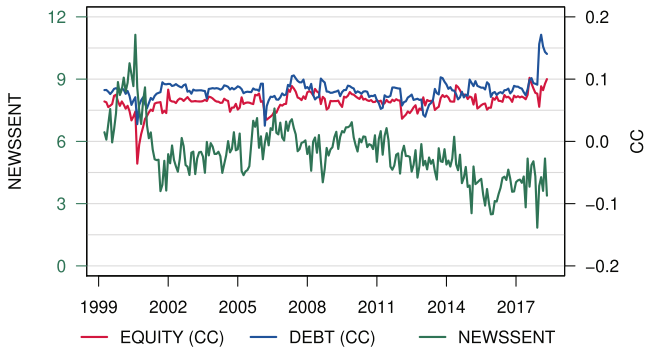

FIGURE 7 News sentiment index and conditional correlations of news sentiment with capital flows, April 1999 to May 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 6 Contemporaneous values estimation results, March 1999 to May 2018

Dependent variable	EQUITY	DEBT	PORTFOLIO
$EQUITY_t$	—	0.1801**	—
		(0.0779)	
$DEBT_t$	0.0907	—	—
	(0.0876)		
$PORTFOLIO_t$	—	—	—
$NEWSSENT_t$	0.1438**	0.2610***	0.6088***
	(0.0731)	(0.0655)	(0.1013)
$DBRGDP_t$	−0.5303	−3.7340**	−4.4077***
	(0.6707)	(1.5381)	(1.3439)
$DEXCHANGE_t$	−15.9860***	−1.1643	−54.8440***
	(3.9023)	(2.8413)	(10.5440)
$SELIC_t$	−4.2442*	−6.1951***	−18.5280***
	(2.4283)	(1.8381)	(4.6614)
$DEMBIBR_t$	−0.1504	−0.8428	12.2790
	(25.3320)	(3.9637)	(22.6240)
$DIBOV_t$	−1.5145*	−0.7915	−4.4767
	(6.1479)	(1.2409)	(3.7643)
$DFISCAL_t$	−0.4322*	0.3565	−0.4737
	(0.2470)	(0.2773)	(0.6603)
$DUSGDP_t$	15.8090	−4.8615	52.7210*
	(14.5020)	(11.6233)	(28.5750)
$DTB3M_t$	36.7800	−141.4100**	−184.8400*
	(36.9140)	(69.5577)	(104.3100)
VIX_t	0.0016	−0.0160	0.0002
	(0.0148)	(0.0116)	(0.0329)

Note: Standard errors are in parentheses. For DEBT, they are heteroskedasticity and autocorrelation robust, as in Andrews (1991). Significance levels: *10%, **5%, ***1%. Results (*p*-value) of the *J* test for over-identifying restrictions for the models estimated through GMM: EQUITY: 0.2223; PORTFOLIO: 0.8161.

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TABLE 7 Coefficients from estimation results for the uncertainty index IIE, March 2000 to May 2018

Dependent variable	EQUITY	DEBT	PORTFOLIO
IIE_{t-1}	0.0107***	0.0072*	0.0159**
	(0.0033)	(0.0043)	(0.0079)
$NEWSSENT_{t-1}$	0.0868	0.1788***	0.5152***
	(0.0557)	(0.0589)	(0.1266)
IIE_{t-1}	0.0089**	0.0036	0.0057
	(0.0036)	(0.0046)	(0.0079)
IIE_t	0.0090*	−0.0008	0.0183*
	(0.0051)	(0.0056)	(0.0103)
$NEWSSENT_t$	0.1176	0.2766***	0.6316***
	(0.0962)	(0.0554)	(0.1125)
IIE_t	0.0074*	0.0010	0.0017
	(0.0039)	(0.0038)	(0.0069)

Note: standard errors are in parentheses. Significance levels: *10%, **5%, ***1%. Models estimated: VAR with IIE (first panel in table), VAR with NEWSSENT and IIE (second panel in table), model estimated with contemporaneous values and IIE (third panel in table), and model estimated with contemporaneous values, NEWSSENT and IIE (fourth panel in table).

The results for the estimation of Equations (2), (3), and (4) are presented in Table 6. We confirm the existence of contemporaneous effects, not only for news sentiment, but also for the majority of the variables considered endogenous in the VAR estimation. Again, the coefficient for news sentiment is significant and positive for the three flows. In addition to news sentiment, the following variables are significant: *DEXCHANGE* at the 1% level for *EQUITY*; *SELIC* at the 1% level, and *EQUITY*, *DBRGDP*, and *DTB3M* at the 5% level for *DEBT*; and *DBRGDP*, *DEXCHANGE*, and *SELIC* at the 1% level for *PORTFOLIO*. As before, the coefficients for the interest rates, *SELIC* and *DTB3M*, do not have the expected signs. Additionally, the coefficient for *DBRGDP*, which now is in contemporaneous values, has an unexpected negative sign, which perhaps may be explained by the fact that real variables, like the variables for economic activity, have a slower adjustment when compared to financial variables, such as capital flows. For investors, GDP expectations are more important than GDP itself, because what has happened is already priced in. Lastly, the significance of *EQUITY* for *DEBT* suggests that, while there are not rebalancing effects from one period to the next, the investors who buy/sell equity securities also buy/sell debt securities in the same period, but the opposite is not true.

The results for news sentiment correspond to those of the literature reviewed above, even though the contexts are a little different. As Fraiberger (2016), Shapiro et al. (2018), Tetlock (2007), Tetlock et al. (2008), Boudoukh et al. (2013), and Heston and Sinha (2017) found evidence for the influence of news sentiment in different situations, we find evidence for the influence of news sentiment on international capital flows to Brazil. Furthermore, the dynamics of the conditional correlations of news sentiment with flows are in line with the asymmetries found in the literature. News sentiment has a greater impact on the variance of the flows when it worsens than when it improves; likewise investors trade more aggressively when sentiment is worsening (Chau et al., 2016), and pessimistic sentiment is more contagious than optimistic sentiment (Tsai, 2017).

The results also confirm the importance of the commonly used variables to explain international capital flows. As in Franzen et al. (2009), we find evidence for the influence of the Selic rate on these flows, both in lagged and in contemporaneous values. The results of the Ibovespa index for the volatility of equity flows, of the real exchange rate for equity and portfolio flows, and of country risk for portfolio flows highlight the importance of those variables, agreeing with the results of Barbosa and Meurer (2015), Franzen et al. (2009), and Koepke (2015). However, the external factors, constantly stressed in the international literature, are not as important in this case. Only the external interest rate,[2] in lagged and contemporaneous values, is significant in different occasions for the three flows, as it was found by Koepke (2015).

Although uncertainty might be important in some situations (Baker et al., 2016), this does not happen for international capital flows in this analysis. The coefficients for *EPUBR* and *GEPU* are not statistically significant for the three flows, both for the first lag and for contemporaneous values. On the other hand, as it is possible to see in the summarised results in Table 7, the coefficients for *IIE* are significant in almost every situation.

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When we control for news sentiment, however, the *IIE* remains significant only for equity flows, which might be explained by the index itself, as it includes the volatility of the financial market. Therefore, depending on the definition of uncertainty, news sentiment and uncertainty can be substitutes on certain occasions and complementary on others, as they do not always capture the same information.

5 | CONCLUSIONS

The sentiment analysis of selected news stories results in an index that is coherent with the national and international events of the studied period. With such an index, we find evidence for the influence of news sentiment on international capital flows to Brazil, in line with the literature that examines other factors that may help to explain that type of flow, and with the literature that finds evidence for the influence of news sentiment on the economy.

News sentiment has positive and significant coefficients for the three flows. The conditional correlations of the flows with news sentiment have particularly interesting dynamics. These correlations are negatively correlated with news sentiment itself, characterising an asymmetric response of the variance of the flows to changes in news sentiment. Uncertainty, in its turn, despite being an important factor in other situations, is not significant for international capital flows to Brazil. Of the three tested indices, only the IIE is significant for equity flows, when controlling for news sentiment. This may be explained by the IIE index itself, as it includes, among other factors, the volatility of the stock market. Agreeing with the literature about the determinants of international capital flows, the results also confirm the importance of the economic and financial variables, for which news sentiment is an additional explanatory variable. This means that economic policy is important for international capital flows.

The results are important because they indicate that economic and financial fundamentals do not fully explain the movement of capital around the world. Because it captures information that are still not shown in the data, news sentiment provides additional information to financial markets and to monetary policy, which is relevant because abrupt inflows and outflows of international capital may have negative effects on the economy. The importance of this paper can also be stressed by its contribution to the literature, as we use a methodology that still can be further explored, in general, and that, to our knowledge, has not been previously explored within the context of the determinants of international capital flows.

ACKNOWLEDGEMENTS

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ENDNOTES

[1] The sentiment analysis is a textual analysis based exclusively on semantic criteria. It should be noticed that the words 'news' and 'sentiment' do not have their traditional economic meaning here.

[2] We also estimate the models with the short shadow rate (SSR), as estimated by Krippner (2013), to account for the unconventional monetary policy period, but the SSR is not statistically significant.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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TABLE A1 Results for the augmented dickey-fuller unit root test, January 1999 to May 2018

Variable	Exogenous variables	Num. of obs.	Test statistic	Critical values		
				1%	5%	10%
EQUITY	Drift	233	−7.5721	−3.46	−2.88	−2.57
DEBT	Drift	233	−7.9516	−3.46	−2.88	−2.57
PORTFOLIO	Drift	233	−8.2637	−3.46	−2.88	−2.57
NEWSSENT	Drift and trend	233	−4.3992	−3.99	−3.43	−3.13
EMBIBR	Drift and trend	233	−2.8609	−3.99	−3.43	−3.13
DEMBIBR	Drift	232	−9.6857	−3.46	−2.88	−2.57
EXCHANGE	Drift and trend	233	−1.4710	−3.99	−3.43	−3.13
DEXCHANGE	Drift	232	−9.8231	−3.46	−2.88	−2.57
SELIC	Drift and trend	233	−8.0263	−3.99	−3.43	−3.13
BRGDP	Drift and trend	233	−0.6122	−3.99	−3.43	−3.13
DBRGDP	Drift	232	−10.8723	−3.46	−2.88	−2.57
FISCAL	Drift	233	−0.4804	−3.46	−2.88	−2.57
DFISCAL	Drift	232	−10.9704	−3.46	−2.88	−2.57
IBOV	Drift and trend	233	−2.0727	−3.99	−3.43	−3.13
DIBOV	Drift	232	−10.5234	−3.46	−2.88	−2.57
TB3M	Drift and trend	233	−1.2568	−3.99	−3.43	−3.13
DTB3M	Drift	232	−6.9835	−3.46	−2.88	−2.57
USGDP	Drift and trend	233	−1.9170	−3.99	−3.43	−3.13
DUSGDP	Drift	232	−12.7059	−3.46	−2.88	−2.57
VIX	Drift	233	−4.2858	−3.46	−2.88	−2.57

Note: *DEMBIBR*, *DEXCHANGE*, *DBRGDP*, *DFISCAL*, *DIBOV*, *DTB3M*, and *DUSGDP* are the first difference of *EMBIBR*, *EXCHANGE*, *BRGDP*, *FISCAL*, *IBOV*, *TB3M*, and *USGDP*, respectively.

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TABLE A2 Results for the Kwiatkowski–Phillips–Schmidt–Shin unit root test, January 1999 to May 2018

Variable	Exogenous variables	Num. of obs.	Test statistic	Critical values		
				1%	5%	10%
EQUITY	Drift	233	0.3034	0.739	0.463	0.347
DEBT	Drift	233	0.3978	0.739	0.463	0.347
PORTFOLIO	Drift	233	0.2151	0.739	0.463	0.347
NEWSSENT	Drift and trend	233	0.2349	0.216	0.146	0.119
EMBIBR	Drift and trend	233	0.5557	0.216	0.146	0.119
DEMBIBR	Drift	232	0.1026	0.739	0.463	0.347
EXCHANGE	Drift and trend	233	0.6611	0.216	0.146	0.119
DEXCHANGE	Drift	232	0.1294	0.739	0.463	0.347
SELIC	Drift and trend	233	0.3661	0.216	0.146	0.119
BRGDP	Drift and trend	233	0.7648	0.216	0.146	0.119
DBRGDP	Drift	232	0.2959	0.739	0.463	0.347
FISCAL	Drift	233	2.6047	0.739	0.463	0.347
DFISCAL	Drift	232	0.3375	0.739	0.463	0.347
IBOV	Drift and trend	233	0.8085	0.216	0.146	0.119
DIBOV	Drift	232	0.1562	0.739	0.463	0.347
TB3M	Drift and trend	233	0.2479	0.216	0.146	0.119
DTB3M	Drift	232	0.2238	0.739	0.463	0.347
USGDP	Drift and trend	233	0.4967	0.216	0.146	0.119
DUSGDP	Drift	232	0.2039	0.739	0.463	0.347
VIX	Drift	233	0.7215	0.739	0.463	0.347

Note: *DEMBIBR*, *DEXCHANGE*, *DBRGDP*, *DFISCAL*, *DIBOV*, *DTB3M*, and *DUSGDP* are the first difference of *EMBIBR*, *EXCHANGE*, *BRGDP*, *FISCAL*, *IBOV*, *TB3M*, and *USGDP*, respectively.

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