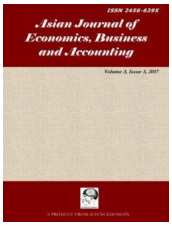

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Asset Pricing and Asymmetric Information

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Authors' contributions

This work was carried out in collaboration between all authors. Author AR designed the study, collected the data, performed the econometric analysis, managed the analysis and discussion of results and wrote the last draft of the manuscript. Authors DRS and EBMN collected data, estimated measures and variables, made the literature review and wrote the first draft of manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This study applies Johansen-Fisher panel cointegration to a sample of the most liquid shares on the Brazilian stock market for 20 years. It finds that stock prices are determined by the asymmetric information of a lagged period, and the dilution of information corrects stock prices in the current period. This shows that rational expectations theory can offer a new price measure in the rational valuation formula, and its main assumptions are met. Uninformed traders can benefit from this paper´s findings by monitoring asymmetric information.

Keywords: Asset pricing; rational valuation formula; asymmetric Information; Corwin-Schultz Bid-Ask spread estimator; Johansen-Fisher Panel Cointegration.

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1. INTRODUCTION

Asset pricing has been one of the most important subjects in finance [1-5], with rational expectations hypothesis being used to predict the present value of a dividend, that is the fundamental value of an asset [1]. Several studies have attempted to uncover the determinants of asset returns [6-8] and the discussion is ongoing [9].

It has been argued that asymmetric information is a relevant aspect of asset pricing [10,11] and the theory of market microstructure has developed asset pricing measures [12-15].

Although asset pricing and asymmetric information appear to be associated, this may lead to a controversial assumption under the rational expectations hypothesis [1], even when assets' returns are time-varying [16], because only dividends should explain the fundamental values in a rational valuation formula (RVF). It seems appropriate to test the significance of asymmetric information measures in present value models considering that they are derived from price data.

In this paper, the asymmetric information and stock prices in Brazil were found to have had a negative long-run relationship for approximately the last two decades, throughout Johansen-Fisher panel cointegration [17], even when controlling for traditional determinants of return and capital structure [18], and for a ten-year moving average of dividend on price ratio [5].

Section 2 of this paper examines the theoretical framework of asset pricing and asymmetric information. Section 3 outlines the methodology. The results are provided in Section 4. Section 5 contains concluding remarks and the main theoretical and practical implications.

1.1 Theoretical Framework

The hypothesis of this paper is aligned to rational expectations theory [1] and therefore the assumption is that stock prices are based only on their dividends. The asymmetric information is included in the specification as well as the growth opportunities set, size, returns, and the ten-year moving average of dividends to price ratio or *delta* δ. There are several debates regarding asset pricing whilst asymmetric information is analysed only in market microstructure debates.

1.1.1 Asset pricing

A significant amount of financial economics literature has focused on various determinants of stock price. Studies include the traditional dividend approach [1], capital asset pricing model – CAPM [7], improvements and different specifications [8], and econometric modelling [16].

Ebrahima, Girmab, Shahc, and Williams [19] observed that asset pricing growth is related to high and low company earnings, whilst Onali [20] showed that delaying dividend announcements negatively influences the dividend per share figures.

Kim, Kim, and Shin [21] tested some competing asset pricing models in South Korea and found Fama and French's [8] five factors performed the best, confirming the relevance of other variables in explaining the asset return in the stock market. The relevance of different factors has been observed in other studies [22-24].

Chianga and Zheng [25] tested the illiquidity of shares and found stock prices can be determined by their fundamentals. Feng, Jung, and Wang [26] compared a pair of asset pricing models and found that liquidity was significant in explaining stock prices. Baaquie, Dua, and Bhanap [27] also found the relevance of liquidity through the association of supply and demand for shares with stock returns.

Chianga, Li, and Zheng [28] found the specification of asset pricing models can be improved and the stock prices also could come from idiosyncratic risk. Bierens and Martins [16] and Ripamonti [29] applied Johansen's [30,31] framework combined with Chebyshev time polynomials and found asset rates of return are time varying for exchange rates and stock prices. Kuo [32] also found that vector error-correction models are better specified for predicting stock prices.

Doblas-Madrid [33] and Lee and Phillips [34] developed and tested finite bubbles models to explain stock prices and returns and found that several factors impact them. Mozumder, Desempsey, Kabir, and Choudhry [35] computed δ and γ from derivatives' average prices, in order to identify better specification for asset pricing models.

1.1.2 Asymmetric information

Market microstructure is the study of intraday price movements and their ability to predict stock prices [36]; asymmetric information is one of the most important areas in this field of research [37]. Roll's [13] model was one of the seminal measures of asymmetric information and other studies have improved it and developed new models [38-46]. The PIN score [47] has become standard in the financial literature, but its implementation requires a large sample of intraday data. Corwin and Schultz [15] proposed a simpler way to estimate asymmetric information through the use of high, low, opening and closing stock prices, which has been tested in several ways [48-53].

Makarok and Rytchcov [54] developed an asset price forecasting model under rational expectations hypothesis and found asymmetric information is one of the variables that influence stock returns.

Rodrigues, Souza, and Stevenson [55] specified a model with asymmetric information in mergers and acquisitions deals and found the combination of microstructure and timing influenced abnormal returns. Küchler and Tappe [56] also included asymmetric information as a factor in a model with different processes. Renault, Heijden, and Werker's [57] model incorporated duration and timing pricing in addition to asymmetric information. Rotermann and Wilfling [58] tested a linear present value model under rational expectations and found that financial bubbles are consistent with the theory.

2. METHODOLOGY

Larsson et al. [17] developed a method of cointegration based on Johansen´s [30,31] maximum likelihood and trace statistics (from the cross section average), which allows heterogeneous data from various companies and periods to be analysed at the same panel throughout time series techniques, as presented in equation (1), with the specification without an intercept and a similar trend. $\Pi_i Y_{i,t-1}$ represents a short-run error correction vector, $\sum_{k=1}^{n} \Gamma_{ik} \Delta Y_{i,t-k}$ equals the long-run relationship vector and $\upsilon_{i,t}$ is the error term.

$$\Delta Y_{i,t} = \Pi_i Y_{i,t-1} + \sum_{k=1}^{n} \Gamma_{ik} \Delta Y_{i,t-k} + \upsilon_{i,t}, \qquad (1)$$

The Johansen-Fisher panel cointegration method has been applied in financial studies such as those of long-run relationships between GDP, energy patents and prices [59], banking and insurance development markets [60], foreign direct investments and other variables [61], savings and investments of European Union countries, price, productivity, wages and mark-up levels [62,63], financial development of Asian countries [64] and exchange rates [65].

In our study, the stock prices (CLOSINGPRICE) are measured using the quarterly closing price of 58 Brazilian listed companies from 1986:Q1 to

Table 1. Descriptive statistics

	Closing price	S_2	Delta	MB	Size	Return
Mean	19.89985	1.023716	0.273553	2.733553	15.78401	16.80090
Median	15.02082	1.062312	0.191266	1.596472	15.71026	12.33791
Maximum	133.6021	2.000000	4.400787	40.39923	19.79397	414.1659
Minimum	0.049871	-0.037669	0.004055	0.015627	11.64414	0.000422
Std. dev.	17.65215	0.544134	0.293654	3.560665	1.431295	19.20684
Skewness	1.858338	-0.211380	4.201268	3.768932	0.231597	6.384147
Kurtosis	8.541578	2.200984	34.40028	21.98074	2.952858	94.11463
Jarque-Bera	4865.967	89.30795	115475.4	45584.24	23.69121	925143.5
Probability	0.000000	0.000000	0.000000	0.000000	0.000007	0.000000
Sum	52197.29	2685.207	717.5297	7170.110	41401.46	44068.77
Sum sq. dev.	817011.2	776.3272	226.1020	33242.60	5371.440	967263.2
Observations	2623	2623	2623	2623	2623	2623

Note: Table 1 presents the descriptive statistics of variables representing stock prices (CLOSINGPRICES), asymmetric information (S_2), ten-year moving average of dividends on price ratio (DELTA), growth opportunities set (MB), company size (SIZE) and stock price variations in two quarters (RETURN).

Table 2. Correlation matrix

	Closing price	S_2	Delta	MB	Size	Return
Closing price	1.000000	-0.304503	-0.324442	0.120659	0.210008	-0.161448
S_2	-0.304503	1.000000	0.433525	-0.101229	7.24E-05	0.194769
Delta	-0.324442	0.433525	1.000000	-0.157380	-0.032326	0.736216
MB	0.120659	-0.101229	-0.157380	1.000000	-0.160855	-0.066061
Size	0.210008	7.24E-05	-0.032326	-0.160855	1.000000	-0.010521
Return	-0.161448	0.194769	0.736216	-0.066061	-0.010521	1.000000

Note: Table 2 presents the correlation matrix of variables representing stock prices (CLOSINGPRICES), asymmetric information (S_2), ten-year moving average of dividends on price ratio (DELTA), growth opportunities set (MB), company size (SIZE) and stock price variations in two quarters (RETURN).

2016:Q4. The growth opportunities set are represented by the market-to-book ratio (MB) and the influence of size (SIZE) is represented by the natural logarithm of gross sales. Stock return (RETURN) is represented by the variation of stock prices in each quarter. The intrinsic rate of return (DELTA) is calculated from the ten-year moving average of the dividend-price ratio (5). The asymmetric information measure (S_2) follows Corwin-Schultz's bid-ask overnight adjusted and non-negative spread [15,53].

As shown in Table 2, the results indicate that S_2, DELTA and RETURN were found to have a negative correlation with CLOSINGPRICE, whilst the opposite was true for MB and SIZE. Table 1 shows the range of closing prices from 2 to 34 Brazilian reals, meanwhile S_2 showed about the same monthly mean figure as Ripamonti [53] and the DELTA remained at 0.27 per quarter.

3. RESULTS

As shown in Table 3, the variables of prices and asymmetric information appear to have non-stationary behaviour. Such a result is the opposite to Ripamonti [66] regarding stationarity of asymmetric information and may be due to panel cointegration tests applied in this paper or any difference in estimation of the S_2 measure. The counterintuitive results can be also observed for the stationarity of market-to-book, size, return, and delta variables, although they have been found to be determinants rather than outcomes of financial parameters [18].

The restricted model has been observed as suitable for only one rank of cointegration between stock prices and asymmetric information. Table 3 shows the unrestricted model with five ranks of cointegration.

The tests of optimal lag choice for long-run relationships showed stock prices and asymmetric information have a negative and significative association in the same period. In the error correction model, stock prices of two quarters earlier were found to have negative and significant association, asymmetric information with a positive and significant association a quarter in advance, and market-to-book and return with positive and significant association also in a quarter, both of them to stock prices.

Table 3. Unit root and fisher rank tests

Unit root tests						
Method	**Variables**					
	Closing price	**S_2**	**Delta**	**MB**	**Size**	**Return**
LLC	0,3541	0,9997	0.0000	0,1272	1,0000	0,0000
Breitung	0,2642	1,0000	0.0000	0,0000	0,0001	0,0000
IPS	0,2434	1,0000	0.0000	0,0000	0,0104	0,0000
ADF-Fisher	0,2534	1,0000	0.0000	0,0000	0,0000	0,0000
PP-Fisher	0,2853	1,0000	0.0000	0,0000	0,0000	0,0000
Fisher rank test						
Unrestricted	5					
Restricted	1					

Note: Table 3 presents the unit root tests t-statistics of all variables, and the quantity cointegration rank of trace and maximum likelihood statistics for model specification [17].

The main result of this paper is that stock prices have been found to be highly and positively influenced by asymmetric information of the previous period, which can support the rational expectations hypothesis of Muth [1], whilst S_2 derives from the stocks' prices themselves. Another relevant observation is that the intuitive information dispersion through trading activities [1,10] also significantly corrects the actual stock prices through a negative association in the present period, as presented in the VECM estimates of Table 3. The results are also consistent with other studies [54,57].

As shown in Table 4, the significance (t-stat =-17,0363) and sense (negative) of S_2 long-run coefficients are very interesting because they show manager and investor information spread over the period and asymmetric information only causes short-run price fluctuations.

Table 4. Long-run relationship

Cointegration equation	Restricted	
	coef.	t-stat
Closing price	1,000000	
S_2	-918,1586	-17,0363
Constant	935,4086	

Note: Table 4 presents the long-run relationship and t-statistics of the specified model [17]

Table 5 shows that coefficients of traditional financial control variables have different associations with stock prices, are positive for the growth opportunities set and return, and negative for size and implicit cost of capital. The size variable's coefficient is counterintuitive, but can be explained by the consolidation hypothesis, where traditional companies tend to have fewer growth opportunities.

3.1 Concluding Remarks

For trading purposes, this paper has the obvious implication of stock price forecasting during asymmetric information monitoring. As the S_2 can easily be calculated from opening, closing, high and low prices, it becomes an incremental and relevant measure for portfolio management choices.

The theoretical implication is one of the main results of this paper. The rational valuation formula that comes from the rational expectations hypothesis can be improved with a stock price derivative measure, reinforcing the theory that price contains all market information without ignoring the expected shares of informed and uninformed traders.

Table 5. VECM Estimates

	Restricted	
	coef.	t-stat
Closing price (-2)	-0,062385	-3,144800
S_2 (-1)	13,693250	4,936080
S_2 (-2)	-0,122680	-0,048620
Constant	0,540835	0,538960
Delta	-0,541364	-1,119100
MB	0,116684	4,587720
Size	-0,036200	-0,591640
Return	0,027771	3,806080
R-squared	0,032126	
Adj. R-squared	0,028678	
Sum sq. Resids	46471,06	
S.E. equation	4,289183	
F-statistic	9,316132	
Log likelihood	-7286,079	
Akaike AIC	5,754005	
Schwarz SC	5,777027	
Mean dependent	0,203744	
S.D. dependent	4,352041	

Note: Table 5 short-run error correction mechanisms coefficients and t-statistics [17].

With regard to the econometric implications, the application of the Johansen-Fisher panel cointegration model has presented very important and comprehensible results for long-run and error correction estimates. However, the ADF-Fisher unit root test did not present very intuitive and consistent results, which can be attributed to panel issues or the estimation of the S_2 measure.

Some different segregation and tests could be relevant areas of study in the future.

It is important to note certain limitations of this study. Although the relaxation of the heterogeneity assumption of Larsson´s et al. [17] method could represent an advantage for analysing several sorts of samples, it seems there is no a reliable level of data absence and it could be a bias in the results.

The Brazilian stock market is developing and, in the last two decades, shareholder protection and information disclosure measures have been strengthened. This research attempted to obtain as wide a sample as possible and the analysis includes data from the pre-reform period, which may lead to some distortion.

4. CONCLUSION

Finally, the Corwin and Schultz [67,68] measure was calculated in order to compare with that of

another study [66], even applying the data to the same available files [68]. As previously mentioned, the stationarity results become different in sense. Such a difference could be due to the inclusion of an additional eight quarters in the sample.

Future research must improve the methodological issues. One suggestion is to create a portfolio of liquidity weighted averages of sample firms and to apply different time series techniques to test and consolidate the evidence.

Evidence of the role of asymmetric information in asset pricing in the Brazilian stock market could serve as evidence for comparison with other developing stock markets. If Corwin and Schultz's [67] model is taken as a valid measure of asymmetric information in other stock markets [48-52], investors in such markets will be able to anticipate stock prices and manage their portfolios by monitoring an easy to compute measure such as the one presented in this study. Theoretically, there are further implications when the assumptions of financial economics theories are not met, such as when the association between asymmetric information and stock market development becomes positive.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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