Revista Catarinense da CIÊNCIA CONTÁBIL

ISSN 2237-7662, Florianópolis, SC, v. 18, 1-15, e2804, 2019

DOI: 10.16930/2237-766220192804
Available at http://revista.crcsc.org.br

CRCSC CONSELHO REGIONAL DE CONTABILIDADE DE SANTA CATARINA

THE IMPACT OF THE INTRODUCTION OF MARKET MAKERS ON THE NEGOTIATIONS OF THE BRAZILIAN DEPOSITARY RECEIPTS

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ABSTRACT

The present study aims to analyze the effect generated in the liquidity of the Brazilian Depositary Receipts (BDRs) with the introduction of market makers for these stocks. The sample of this study was composed by the BDRs with at least 200 days of negotiations before and after the hiring of the market makers, thus reaching the final number of 42 BDRs, between the years of 2010 and 2017. For the stocks of the sample were obtained the historical series of liquidity proxies, bid-ask-spread, number of trades and volume, an AR (1) model was then estimated for each BDR, and then the Chow test was used to test the stability of the model's parameters. The results found in the Chow test showed that, for a 99% confidence level, 29 BDRs, that is, 69% of the BDRs studied, had abrupt and statistically significant changes in bid-ask-spread, 23 BDRs (55 %) showed significant changes in the number of deals and 22 BDRs (52%) showed significant changes in volume. When the confidence level was relaxed to 95%, 32 BDRs (76%) presented changes in the bid-ask-spread, 29 BDRs (69%) had changes in the number of deals and 29 BDRs, that is, 69% had statistically significant changes in volume. This result presents, therefore, strong evidence on the influence of market makers on the market liquidity of the BDRs, showing that the hiring of market makers can increase liquidity and contribute significantly to the negotiations of these papers.

Article presented at the XXI Seminars in Business Management – SemeAd, November 7 to 9, 2018 in São Paulo.

Submission on 12/20/2018. **Reviewed on** 5/21/2019. **Accepted on** 7/11/2019. **Published on** 9/3/2019.

Keywords: Market Makers. Liquidity. Chow's Test. Brazilian Depositary Receipts.

1 INTRODUCTION

After the bases of the Modern Finance Theory were created by Markowitz (1952) and after the emergence of asset pricing models such as Capital Asset Price Model (CAPM), Consumption Capital Asset Price Model (CCAPM) and Arbitrage Pricing Theory (APT), among others, there was room to evaluate problems related to the process of determining market equilibrium. Radner (1979) argues that it is necessary to carry a more detailed analysis of the equilibrium situation, which needs more complete specifications on trading mechanisms than those usually employed.

In this context, the theory of market microstructure emerges, which seeks to explain how different trading mechanisms affect asset prices and deals in detail with the trading arrangements in a market, such as the impact of market rules and operating methods on trading arrangements. This theory encompasses the processes and results of asset exchanges under a specific set of rules. The study of the influence of trading mechanisms on equilibrium pricing seeks to analyze how specific trading mechanisms such as transaction costs, informational asymmetry and market liquidity affect pricing processes (O'Hara, 1995).

Demsetz (1968), in dealing with the effect of transaction costs on determination of securities prices, states that it is possible that there is disequilibrium between supply and demand caused by the time dimension effect. However, this disequilibrium can be eliminated if there are agents willing to pay a price for immediacy. Obtaining this price means that there are two equilibrium prices for the same market. This cost of immediacy enables a more formal study from the perspective of the market microstructure theory. Based on this, Garman (1976) has studied how stock prices are determined given the presence of market makers characterizing themselves as major market participants committed to regularly and continuously buying and selling offers during the trading section and negotiating with uncertainty about prices and shares. Market makers' purpose is to get prices for assets with the intention of avoiding their own bankruptcy. To do so, these agents assign a lower price when buying shares and a higher price when selling them, resulting in a spread that protects them from an inevitable bankruptcy condition.

For Copeland and Galai (1983), the informational aspect among market participants explains the spread determination. . According to the authors, market makers trade with both informed and uninformed traders and the spread determination allows them, with gains realized by trading with uninformed traders, to offset losses incurred with informed traders, thereby keeping solvent. Based on a scenario with informational asymmetry and acting competitively, market makers promote greater market stability (Glosten, 1989).

Market makers fit into the context of the benefits generated by greater liquidity of assets in financial markets. Several markets, such as the National Association of Securities Dealers Automated Quotations (NASDAQ), Euronext and NYSE: The New York Stock Exchange (NYSE), use market makers in their trading structures. In Brazil, that function has been regulated in 2003 with CVM Instruction no. 384 [Brazilian Securities and Exchange Commission (Comissão de Valores Mobiliários – CVM)] and, as pointed out by Perlin (2013), its use consists of a strategy to promote trading in the assets listed in Brazilian Stock Exchange B3 [(in full, B3 – Brasil Bolsa Balcão S.A. (B3) Brazil, Stock Exchange and Over-the-Counter Market), formerly BM&FBOVESPA].

These agents' performance in the Brazilian market, as described by Ambrozini, Gaio, Bonacim and Cicconi (2009), aims to attract new investors, increase the asset shareholder base and directly increase liquidity. Market makers' role, as defined by current legislation, may be exercised by specialized traders such as securities dealers and brokers, multiple banks and

investment banks. In addition, it is noteworthy that market makers act differently from regular investors since their interest lies not in financial speculation or portfolio immunization but in the compensation received in the form of spread for providing liquidity to the market. The spread generated is higher for assets with higher price volatility given the higher inventory risk generated by market makers maintaining this asset in the portfolio (Perlin, 2013).

Perlin (2013) has reached the same conclusions from Ambrozini *et al.* (2009), who indicate that the introduction of market makers is viewed by the market as a positive event for the future of companies traded at B3 as it appears to affect liquidity and other variables related to financial assets. In addition to Brazilian companies, B3 also trade with the so-called *Brazilian Depositary Receipts* (BDRs) – securities issued in Brazil and backed by assets, usually shares, issued abroad. BDRs are an ideal mechanism for foreign companies to establish themselves in the Brazilian capital markets. As reasons that lead foreign companies to access the International Market by listing a BDR program, it is possible to mention greater visibility among consumers, diversification and expansion of their shareholder, customer and investor bases, better international valuation by placing themselves with their peers and increase of the total liquidity of their shares by attracting new investors, among others. In addition, operating in Brazil contributes to future public offerings, acquisitions and consolidation of corporate growth (B3, 2017).

Therefore, the present study proposes to answer the following question: *What is the effect of introducing market makers on increasing BDRs liquidity?* In addition to the importance of BDRs for the Brazilian capital market and the relevance of understanding market makers' impact on this financial instrument, there is also academic interest in observing liquidity behavior and inferring causal relationships in these markets, as those found in studies by (1981), Morais and Portugal (1999), Pereira (2006), Neves (2007), Correia, Amaral and Bressan (2008), among others. Thus, it is important that the academy continue to contribute studies that help to understand the craft of the Brazilian capital markets.

For better understanding, the content to be presented, besides this introduction, this study consists of four other sections. Section 2 provides a brief theoretical background on market microstructure theory, market liquidity and market makers' performance. Section 3 describes the methodology used in this study, the sample, the variables and the econometric model employed. Section 4 presents the analysis of the results found and Section 5 presents the conclusions of the study.

2 THEORETICAL FRAMEWORK

Regarding development and understanding of the aspects addressed in this study, market microstructure definition is substantial, where O'Hara (1995) stands out pointing to the microstructure as allusive to the study of a given market under explicit rules encompassing the trading process to attributes that impact assets pricing. Under this perspective, Madhavan (2000) points out that the market microstructure theory is devoted to studying how investors' demands influence asset prices and market development. Among the many studies covering the market microstructure, stand out those by Stoll (1978), Kyle (1985), Glosten and Milgrom (1985), Amihud and Mendelson (1987), O'Hara (1995) and Madhavan (2000).

In Stoll (1978), author of one of the precursor works on microstructure, market makers play a crucial role in shaping asset prices, attributing the spread to the stock costs incorporated in order to promote market liquidity. On the other hand, Amihud and Mendelson (1987) have studied the impacts of the trading mechanism and price behavior on the NYSE stock and understood that the trading mechanism has a significant effect on stock price behavior. Alternatively, to Stoll (1978), the understanding by Glosten and Milgrom (1985) is that the *spread* may reflect information asymmetry among informed and uninformed traders. Kyle (1985), in turn, has suggested a model in which there are three types of agents in the market:

irrational ones (noise traders), informed ones (insiders, risk neutral) and market makers, who observe other agents' activities and change assets' prices.

O'Hara (1995) has strengthened the market microstructure theory. The author points out in her study that asset prices adjust to new information and that, in a perfect world, new information would be instantly disseminated and analyzed by all market traders, who would quickly adjust assets prices backed by agents' preferences. This perfect world where prices completely reflect all information available in the market is called the efficient market hypothesis (EMH) by Fama (1970, 1991). However, for O'Hara (1995) the market microstructure theory eases EMH assumptions and focuses on pricing studies, risk analysis, trading transparency models, protocol design and market rules and asset liquidity. In other words, the market microstructure theory encompasses the entire informational and institutional framework on which financial transactions are carried out.

O'Hara (1995) has proposed models directed towards understanding market makers' problems, who, being always present in asset purchase and sale negotiations and aiming at maintaining solvency and maximizing gains, establish negotiation prices. Because market makers want to maintain efficient portfolios and need to offset risks of carrying inefficient portfolios, they set different purchase and sale prices, thus generating spread. For O'Hara (1995), this action by market makers interferes with assets liquidity and is called adverse selection problem.

Finally, Madhavan (2000) has investigated empirical and theoretical literature on market microstructure regarding price formation, including the dynamic process by which prices incorporate information, market participants' ability to observe information about trading processes, market structure and design, including the relationship among pricing and trading protocols and applications to other areas of participation, and including, in this case, asset prices, international investments and companies. For the author, the market microstructure studies the processes by which investors' latent demands are translated into prices and volumes.

From this perspective, market liquidity plays an indispensable role in investors' demands when they wish to focus their investments on portfolios that can be quickly traded with low transaction costs. Amihud and Mendelson (1986) define market liquidity as the cost of the immediate execution of a purchase or sale order and say that it is related to the risk in pricing financial assets and that, under equilibrium, the return on assets should be determined in a decreasing function of liquidity. That is, for the authors, there is a liquidity premium in asset pricing.

In a more recent study, Amihud and Mendelson (2008) emphasize that an asset liquidity also impacts companies' capital structure given that if shares and securities traded by a company are less liquid the return required by investors shall be higher. The authors also conclude that measures that increase asset liquidity are beneficial to companies such as advertising around them, the level of information disclosed, the size of the trading lot of assets and the hiring of *market makers*.

Because of this, in order to increase liquidity, attract more investors and pulverize the shareholder base, companies choose to make use of *market makers*. Liquidity promotion by these agents is complex because traders may have private information about an asset and market makers may not. In high-frequency markets, market makers seek small gains that expand on large-order transactions and their gains depend solely on controlling the risk of adverse selection. The likelihood that these market makers shall gain from trading large amounts of assets increases when there is equilibrium between purchase and sale order flows. When there is no such equilibrium there is a chance that market makers shall be the target of adverse selection and consequently, due to the high toxicity, they shall liquidate their positions, reducing market liquidity *(*Siqueira, Amaral & Correia, 2017).

Because of the relationship between market liquidity and return on assets, it is important to understand how agents impact market liquidity. Venkataraman and Waisburd (2007),

analyzing the French stock market reaction to the announcement of market makers entering the negotiations, have concluded that the market reacted positively to the announcement of the use of market makers, with a positive and significant variation in liquidity and stock returns shortly after the announcement. In the same understanding by Venkataraman and Waisburd (2007), Perotti and Rindi (2010) have investigated the effect of the entry of market makers on shares of the Italian stock exchange and concluded that the entry of these liquidity agents increased the number of trades and decreased spreads and price volatility. Clark-Joseph, Ye and Zi (2017) have studied the impact of market makers on the US stock liquidity. According to the authors, market makers significantly improve liquidity in the modern electronic market.

In Brazil, Ambrozini *et al.* (2009) have studied, from March 2003 to December 2007, the relationship between market makers' performance and the increase in shares liquidity in Brazilian publicly traded companies. These authors conclude that there is significant evidence that hiring market makers may increase the liquidity of Brazilian shares traded at B3, facilitating the trading of these securities in the Brazilian market. Like Ambrozini *et al.* (2009), Costa and Salles (2010) have verified, from time series, the influence of adopting market makers by Brazilian companies on the liquidity of their shares. To this end, the authors have selected a sample of 10 shares traded from January to May 2009 and determined time series using heteroscedastic volatility models to determine liquidity. Results have indicated that the benefits of adopting market makers were valid only for part of the assets analyzed and that their benefits have not spread to the same extent by all companies that used market makers.

Sanvitto (2011) has started from a larger sample than the one used by Costa and Salles (2010) and has tested market makers' performance results on the stock of companies that have opted for hiring the service from 2003. Results from the study indicate that the market makers' performance has provided liquidity and has positively impacted the contracting companies' market value. Silva (2012), in turn, has analyzed 204 companies traded at B3 that hired market makers in order to verify whether these companies had a very significant increase in the number of trades, in the volume traded and, consequently, in the liquidity increase of their shares. The author has identified positive differences that have occurred after the hiring of market makers in all variables analyzed, especially in the number of trades and volume traded, demonstrating that the market makers' performance has increased the liquidity of the shares analyzed.

Rogers and Mamede (2014) have conducted two event studies at 66 companies that hire market makers from January 2013 to December 2014. The first event with the date of disclosure of the hiring a market maker and the second with the start date of operation. Results show that between 15 days before and after hiring market makers there were positive abnormal returns, which for the authors generates support to discuss liquidity pricing which, until the date of the study, was not found in the Brazilian capital market.

As can be seen, there are several studies showing that market makers' performance has had a positive impact on various markets liquidity. However, no studies have been found on the role of these agents in BDRs liquidity. This highlights the need for research seeking to fill this gap.

3 METHODOLOGICAL PROCEDURES

These are descriptive and quantitative approaches that, for Martins and Theóphilo (2007), are studies that aim to analyze or describe data using statistical methods. Secondary data were obtained from the B3 website and the information system at (privately held financial, software, data and media company) Bloomberg L.P. and handled by the Microsoft Excel® software v. 2016. Subsequently, to perform the statistical method, we have used the (open-source statistical package) gretl® v. 2018.

From the 255 assets traded by *market makers* on the data collection date (November 30, 2017), five were Unit (Share Certificates of Deposit), four FII (Real Estate Investment Fund), 15

ETF (Exchange Traded Funds), 127 BDRs and 104 shares. The whole of data for the study consists of the 127 BDRs. However, in order to perform the Chow test (proposed by econometrician Gregory Chow) for structural breaks to be employed in this study, it is necessary that BDRs trading has taken place before hiring *market makers.* Therefore, it was necessary to verify the dates of hiring these market makers and the date of the first negotiation that the Bloomberg information system provided on each BDR.

Following this verification and deletion of BDRs that did not meet the analysis criteria, a final figure of 42 BDRs with at least 200 trading days prior to hiring market makers was reached. . These 42 BDRs were chosen in order to avoid erroneous conclusions caused by the Brazilian market volatility. The time frame chosen goes from November 29, 2010 (first day of operation of a *market maker* on BDR) until December 31, 2017. The aim was to work with as much time as possible. Table 1 presents a relationship with the 42 BDRs present in the sample, the contracted market maker and the date of the market maker's first performance.

Table 1
Research sample

Tickers	*Market maker*	Start of activities	*Tickers*	*Market maker*	Start of activities
AALC34	Credit Suisse	9/1/2016	DISB34	Bradesco	9/21/2015
BLAK34	Credit Suisse	5/18/2017	DUPO34	Credit Suisse	5/18/2016
BOAC34	Guide Invest.	7/4/2016	EXXO34	Guide Invest.	7/4/2016
COCA34	Guide Invest.	8/11/2014	FCXO34	Guide Invest.	9/27/2013
GPIV33	Credit Suisse	3/21/2013	FDMO34	Guide Invest.	9/27/2013
MCDC34	Guide Invest.	7/4/2016	GEOO34	Guide Invest.	9/27/2013
MRCK34	Guide Invest.	9/27/2013	GSGI34	Guide Invest.	7/4/2016
ORCL34	Guide Invest.	8/11/2014	HALI34	Guide Invest.	9/27/2013
SLBG34	Guide Invest.	8/11/2014	ITLC34	Guide Invest.	9/27/2013
USSX34	Credit Suisse	9/1/2016	MSCD34	Guide Invest.	8/11/2014
WFCO34	Guide Invest.	9/27/2013	MSFT34	Guide Invest.	9/27/2013
AAPL34	Guide Invest.	7/4/2016	NFLX34	Guide Invest.	9/27/2013
AMGN34	Guide Invest.	9/27/2013	NIKE34	Guide Invest.	8/11/2014
AMZO34	Guide Invest.	8/11/2014	PFIZ34	Guide Invest.	7/4/2016
ARMT34	Guide Invest.	7/4/2016	PGCO34	Guide Invest.	9/27/2013
AVON34	Guide Invest.	7/4/2016	QCOM34	Guide Invest.	9/27/2013
CATP34	Guide Invest.	8/11/2014	TIFF34	Guide Invest.	2/22/2016
CHVX34	Guide Invest.	8/11/2014	TWTR34	Credit Suisse	12/14/2015
CMCS34	Guide Invest.	9/27/2013	USBC34	Guide Invest.	2/22/2016
COLG34	Guide Invest.	8/11/2014	VERZ34	Guide Invest.	9/27/2013
CSCO34	Guide Invest.	9/27/2013	WALM34	Guide Invest.	7/4/2016

Source: Adapted from Brazilian Stock Exchange B3 [(in full, B3 – Brasil Bolsa Balcão S.A. (B3) Brazil, Stock Exchange and Over-the-Counter Market), formerly BM&FBOVESPA]. *BDRs – Brazilian Depositary Receipts*. Recovered on December 11, 2017, of http://www.bmfbovespa.com.br/pt_br/listagem/bdrs-brazilian-depositary-receipts/

Regarding the liquidity measures, according to Machado and Medeiros (2011), there is no fully accepted measure in the literature that captures all dimensions of liquidity. Thus, in order to capture the multiple dimensions of market liquidity, it was decided to use three *proxies*: *bid-ask-spread*, the number of trades and the trading volume. The *bid-ask-spread* (Equation 1) is the difference between the highest purchase price (bid) and the lowest sale price (ask) of the asset in the market. Proposed by Demsetz (1968), the author suggests that the higher the bid-ask-spread, the lower the liquidity of the asset in question. This *proxy* has already been used by Amihud and Mendelson (1986), Amihud and Mendelson (1991), among others. The second *proxy* analyzed, number of trades, consists of the amount of trades performed with the asset and has been used in studies such as that by Correia *et al.* (2008), Vieira and Milach (2008) and Machado and

Medeiros (2011). Finally, the third *proxy*, trading volume, represents the daily trading volume of each asset and has been used in studies as those by Chordia, Subrahmanyam and Anshuman (2001), Jun, Marathe and Shawky (2003) and Correia *et al.* (2008).

$$Spread_t = ask_t - bid_t \qquad \text{Equation (1)}$$

Where:
$Spread_t$ is the difference between the offer to sell and the offer to buy over time *t*;
ask_t is the sale offer on time *t* and
bid_t is the purchase offer on time *t*.

For analysis of the time series of the BDRs that hired *market makers* the statistical methodology of the Chow (1960) test for structural breaks has been applied, the purpose of which is to verify if there has been any behavioral change (abrupt changes) in the time series at a given time. Therefore, the Chow test was applied to the bid-ask-spread series, number of trades and volume of each of the BDRs in order to find out if there was any change in these proxies in the period after hiring market makers. Chow test analysis was performed based on its directly interpreted p-value, that is, the probability of rejecting the null hypothesis that the series has no structural break. Confidence levels were set at 90%, 95% and 99%.

Choosing the Chow test as an analysis tool was due to the fact that the test is considered one of the main and most efficient structural breakdown tests in the econometric literature. Moreover, from the Chow test it is possible to determine and test the break, given a specific point in the series suspected to happen. It is a test that needs a priori specification of when a structural break shall occur (Ambrozini *et al.*, 2009). The option was for using the first order autoregressive time series model (AR(1)) proposed by Box and Jenkins (1970) and with a structure similar to that presented in Equation 1, since the objective is to analyze a series containing only one variable.

$$Y_t = \alpha + \beta Y_{t-1} + \varepsilon_t \qquad \text{Equation (2)}$$

Where:
α e β are unknown constants and -1 <β <1;
ε_t is a random error, usually distributed with zero mean and standard deviation σ.

The time series of each proxy were divided into three samples. Sample I consisted of data prior to hiring market makers. Sample II consisted of data after hiring them. Moreover, sample III was formed by all data from the proxies of the 42 BDRs studied. In order to demonstrate that market makers' performance impacted asset liquidity, there must be statistically significant differences between the residual sum of squares (RSS) of sample III and the RSS of samples I and II.

After the result, the null hypothesis is rejected or not based on the p-value and significance levels of 1%, 5% and 10%. The p-value analysis, also known as significance probability or descriptive level, represents the probability of obtaining a test statistic equal to or more extreme than that observed in a sample under the null hypothesis. In hypothesis tests, the result is statistically significant when the observed p-value is less than the established significance level α. The null hypothesis (H0) used in the Chow test was that the regression parameters are the same for the different subsamples; that is, there is no structural break. By rejecting the null hypothesis, it is indicated that hiring market makers had an effect on the proxies analyzed (bid-ask-spread, number of trades and trading volume), resulting in alteration of the BDRs market liquidity.

4 ANALYSIS AND INTERPRETATION OF DATA

In order to verify if there was an impact on the 42 BDRs liquidity after hiring market makers, the Chow stability test was performed on bid-ask-spread proxies, number of trades and trading volume. In this study, different levels of significance were set at 1%, 5% and 10%. Whenever the p-value is higher than the established significance level, it is not possible to reject H0, that is, there is no abrupt change in the time series of the proxy analyzed, which suggests no increase in liquidity by hiring a market maker. When the opposite occurs, H0 is rejected, that is, there are indications of changes in BDRs liquidity after hiring a market maker.

Table 2 presents the values for the test, identified by their p-value, for the 42 BDRs analyzed. As observed, given the significance levels established, it is not possible to reject H0 in the analysis of BDRs BOAC34, MCDC34, MRCK34, CSCO34, GSGI34, NFLX34 and PFIZ34, that is, given a significance level of 10%, only in 7 out of the 42 BDRs analyzed H0 cannot be rejected. In this sense, when measured by the bid-ask-spread proxy, hiring market makers does not appear to have had an impact on these BDRs the market liquidity. Chow test for structural breaks has also been applied to another market liquidity proxy: the number of trades. Analyzing the p-value results, given the significance level of 10%, it is not possible to reject H0 for the tests of BDRs AALC34, SLBG34, AVON34, FDMO34, GSGI34, HALI34, NFLX34, NIKE34, QCOM34 and USBC34. In other words, hiring market makers does not seem to have an impact on these BDRs market liquidity when measured by the proxy number of trades. Results from these BDRs are in line with the study by Rogers and Mamede (2014), who have verified an increase in the liquidity of shares that hired market makers from January 2013 to December 2014.

By means of the Chow test values, identified by the p-value, for the 42 BDRs analyzed by the last study proxy, the trading volume, no abrupt structural changes in the volume parameters of BDRs AALC34, BOAC34, ORCL34, SLBG34, AVON34, CHVX34, DUPO34, EXXO34, FDMO34, GSGI34, TWTR34 and USBC34 have been identified at a significance level of 10%, i.e., in 12 out of 42 BDRs analyzed, it was not possible to reject H0, indicating that hiring market makers does not appear to have had an impact on these BDRs liquidity when measured by the trading volume proxy.

It was possible to observe that, of the analyzed proxies, the bid-ask-spread had the biggest impact with the adoption of market makers, followed by the number of trades and, finally, by the trading volume. However, even with diverging liquidity proxies, hiring these market makers has proven to be a good alternative for BDRs wishing to increase their securities liquidity. The result is in line with those by Perlin (2013) for Brazilian capital markets and surpasses those found by Ambrozini *et al.* (2009), where the authors found evidence of increased liquidity in only 52% of shares at a 10% significance level.

Table 2
Chow test p-value result

Tickers	***Bid-ask-spread***	**Amount of businesses**	**Volume**	***Tickers***	***Bid-ask-spread***	**Amount of businesses**	**Volume**
AALC34	0.0000	0.2300	0.2300	DISB34	0.0100	0.0000	0.0000
BLAK34	0.0000	0.0100	0.0100	DUPO34	0.0000	0.0000	1.0000
BOAC34	0.1200	0.0000	0.3500	EXXO34	0.0000	0.1000	0.4400
COCA34	0.0000	0.0000	0.0000	FCXO34	0.0300	0.0400	0.0200
GPIV33	0.0000	0.0000	0.0000	FDMO34	0.0000	0.1500	0.4100
MCDC34	0.2800	0.0000	0.0400	GEOO34	0.0000	0.0000	0.0000
MRCK34	0.1200	0.0000	0.0000	GSGI34	0.2800	0.1700	0.2200
ORCL34	0.0000	0.0200	0.5000	HALI34	0.0800	0.3600	0.0200
SLBG34	0.0000	0.3500	0.2300	ITLC34	0.0000	0.0000	0.0000
USSX34	0.0000	0.0100	0.0000	MSCD34	0.0000	0.0000	0.0000

WFCO34	0.0000	0.1000	0.0600	MSFT34	0.0000	0.0000	0.0000
AAPL34	0.0000	0.0000	0.0000	NFLX34	0.2600	0.4000	0.0200
AMGN34	0.0400	0.0000	0.0000	NIKE34	0.0000	0.1200	0.0000
AMZO34	0.0000	0.0100	0.0000	PFIZ34	0.8500	0.0000	0.0000
ARMT34	0.0000	0.0200	0.0100	PGCO34	0.0900	0.0000	0.0000
AVON34	0.0000	0.1200	0.2300	QCOM34	0.0000	0.1900	0.0400
CATP34	0.0000	0.0000	0.0000	TIFF34	0.0100	0.0300	0.0300
CHVX34	0.0000	0.0500	0.2000	TWTR34	0.0600	0.1000	0.7200
CMCS34	0.0000	0.0000	0.0000	USBC34	0.0000	0.4600	0.4500
COLG34	0.0000	0.0000	0.0000	VERZ34	0.0200	0.0400	0.0200
CSCO34	0.1200	0.0100	0.0100	WALM34	0.0100	0.0000	0.0100

Source: Research data (2019).

In order to facilitate the results visualization, Tables 3, 4 and 5 summarize Table 2, showing the percentage of BDRs that rejected H0 for significance levels of 1%, 5% and 10% for bid-ask-spread, number of trades and trading volume proxies respectively. Results expressed in the Tables show the number and percentage of BDRs among the 42 analyzed, which has shown a possible increase in liquidity after hiring market makers.

Upon the analysis of Table 3, it can be seen that market makers' performance in BDRs seems to reduce their bid-ask-spread. Results suggest an increase in liquidity of 29 BDRs analyzed (69%) at a significance level of 1%. By raising the significance level to 5% and 10%, it is possible to see an increase in liquidity of 32 (76%) and 35 (83%) BDRs, respectively. By analyzing the bid-ask-spread proxy time series, it has been found, therefore, that market makers seem to contribute to promoting BDR liquidity.

Table 3
Percentage of BDRs according to the hypothesis of a structural break (*bid-ask-spread*)

	1%	**5%**	**10%**
There is a structural break	29 (69%)	32 (76%)	35 (83%)
There is no structural break	13 (31%)	10 (24%)	7 (17%)
Total	**42 (100%)**	**42 (100%)**	**42 (100%)**

Source: Research data (2019).

The result evidenced by Table 3 is in agreement with the study by Perlin (2013). *Ambrozini et al.* (2009), when studying the Brazilian stock market, has found evidence of increased liquidity in only 52% of shares at a 10% significance level. The result of the Chow test for the bid-ask-spread suggests, therefore, that in BDRs the hiring of market makers seems to have an effect on more securities than on Brazilian shares. In this sense, the increase in liquidity caused by the presence of market makers indicates that hiring them may be of interest to BDRs since only in 17% (at 10% significance) of the BDRs analyzed there seems to have been no decrease in bid-ask-spread, i.e., an increase in liquidity.

Table 4
Percentage of BDRs according to the hypothesis of a structural break (number of trades)

	1%	**5%**	**10%**
There is a structural break	23 (55%)	29 (69%)	32 (76%)
There is no structural break	19 (45%)	13 (31%)	10 (24%)
Total	**42 (100%)**	**42 (100%)**	**42 (100%)**

Source: Research data (2019).

Looking at Table 4, one can see that the market makers' performance in BDRs seems to increase their number of trades. Results obtained by the test suggest an increase in liquidity of 23 BDRs analyzed (55%) at a significance level of 1%. By raising the significance level to 5% and 10%, it is possible to see an increase in the number of trades of 29 (69%) and 32 (76%) BDRs, respectively. When compared to the proxy previously analyzed, it can be noted that hiring market makers may have decreased the bid-ask-spread of more BDRs than the number of trades. At the 10% significance level, for example, it is noted that 83% of the BDRs analyzed had a decrease in bid-ask-spread, thus showing an increase in liquidity. On the other hand, in 76% of the BDRs under study, there was an increase in the number of trades. It is also noted that some BDRs that have not had bid-ask-spread changes have had changes in the number of trades.

In Table 5, the results show that the market makers' performance in BDRs seems to increase their trading volume. The result obtained by the test suggests an increase in liquidity of 22 BDRs analyzed (52%) at a significance level of 1%. By raising the significance level to 5% and 10%, it is possible to see an increase in liquidity of 29 (69%) and 30 (71%) BDRs, respectively.

Table 5
Percentage of BDRs according to the hypothesis of a structural break (trading volume)

	1%	**5%**	**10%**
There is a structural break	22 (52%)	29 (69%)	30 (71%)
There is no structural break	20 (48%)	13 (31%)	12 (29%)
Total	**42 (100%)**	**42 (100%)**	**42 (100%)**

Source: Research data (2019).

The result is in line with those by Perlin (2013) for the Brazilian capital market and, even though it is below the conclusions of the bid-ask-spread and number of trades' proxies analysis, it still surpasses results by Ambrozini *et al.* (2009), who have found evidence of increased liquidity in only 52% of Brazilian shares at a significance level of 10%.

Table 6 below presents the descriptive statistics for liquidity proxies before and after the market agents' beginning operations. In relation to the amounts reported therein, when bid-ask-spread values and the number of trades are observed, there was an increase in the assets liquidity with hiring market makers whereas in relation to the volume what was seen was a reduction in liquidity with the market agents' beginning operations.

Table 6
Descriptive statistics before and after the beginning of market makers' performance

	Minimum	**Maximum**	**Average**	**Standard deviation**
Average of the *bid-ask-spread* beforehand	0.04	13.07	3.03	2.58
Average of the *bid-ask-spread* afterwards	0.13	15.93	2.29	2.66
Average of the business amount beforehand	0.00	4.00	1.41	0.75
Average of the business amount afterwards	1.13	109.19	4.42	16.59
Volume average beforehand	898	365965	13143.30	55930.96
Volume average afterwards	267	186817	7610.11	28831.18

Source: Research data (2019).

To continue the analysis, it is necessary to perform a normality test in order to identify which the best average (parametric or nonparametric) comparison test is. Thus, the Kolmogorov–Smirnov test (KS test), which is more suitable for the sample size (42 BDRs), has been performed. Expressed in Table 7, this test results have rejected the null hypothesis, in evidence that the data do not follow a normal distribution and a nonparametric test is more suitable for comparison of means.

Table 7
Normality test for Kolmogorov-Smirnov means

	Statistics	df	Sig.
Average of the *bid-ask-spread* beforehand	0.154	42	0.014
Average of the *bid-ask-spread* afterwards	0.262	42	0.000
Average of the business amount beforehand	0.173	42	0.003
Average of the business amount afterwards	0.463	42	0.000
Volume average beforehand	0.439	42	0.000
Volume average afterwards	0.443	42	0.000

Source: Research data (2019).

Finally, Table 8 presents the results for the Wilcoxon signed-rank test, which has been performed with the objective of comparing averages for liquidity proxies before and after the market agents' beginning operations. Results from this test were unanimous in pointing to rejection of the null hypothesis, this being evidence that averages are different for the periods before and after the market makers' performance.

Table 8
Wilcoxon signed-rank test for the mean of two paired samples

	Average of the *bid-ask-spread* beforehand – Average of the *bid-ask-spread* afterwards	Average of the business amount beforehand – Average of the business amount afterwards	Volume average beforehand – Volume average afterwards
Z	-3.407	-3.407	-4.082
Significance Sig. (2 extremities)	0.001	0.001	0.000

Source: Research data (2019).

Results indicate that benefits of adopting market makers were valid in most of the assets analyzed. Even with different intensities for each proxy studied, the result surpasses those found at Ambrozini *et al.* (2009) and Costa and Salles (2010) and is in line with studies carried out by Sanvitto (2011), Silva (2012) and Rogers and Mamede (2014) by showing that market makers' performance provided liquidity and positively impacted companies that made use of this mechanism.

5 CONCLUSION

Market liquidity plays an essential role in forming stock market investment portfolios. For this reason, the objective of the present study has been to determine the effect of introducing market makers in increasing the liquidity of *Brazilian Depositary Receipts* (BDRs) – securities

issued in Brazil and backed by assets, generally shares, issued abroad. Therefore, the statistical methodology of the Chow (1960) test for structural breaks has been applied in 42 BDRs that have made up the study sample. The Chow test role was to examine whether there were abrupt changes in the liquidity proxy time series (bid-ask-spread, number of trades and trading volume) in each of the BDRs following the hiring of market makers.

To perform the Chow test, the time series of each proxy were divided into three samples. Sample I consisted of data prior to hiring market makers. Sample II consisted of data after hiring them. Moreover, sample III was formed by all data from the proxies of the 42 BDRs studied. In order to demonstrate that market makers' performance impacted asset liquidity, there must be statistically significant differences between the residual sum of squares (RSS) of sample III and the RSS of samples I and II. After the result, the null hypothesis is rejected or not based on the p-value and significance levels of 1%, 5% and 10%.

From the analysis of the p-value generated in each test, it has been observed that, as expected, in most of the BDRs studied the introduction of market makers has caused changes in the three liquidity proxies. Results found in the Chow test analysis at a 99% confidence level have indicated that, after hiring market makers, 29 BDRs, i.e., 69% of the BDRs studied, have had abrupt and statistically significant changes in bid-ask-spread, 23 (55%) have had abrupt changes in the number of trades and 22 (52%) have had changes in trading volume. By easing the confidence level to 95%, 32 BDRs (76%) have had abrupt changes in bid-ask-spread, 29 or 69% have had changes in the number of trades and 29, i.e., 69% have had changes in trading volume. At the 90% confidence level, results were 35 BDRs (83%) showing changes in bid-ask-spread, 32 BDRs (76%) showing changes in number of trades and 30 (71%) showing abrupt and statistically significant changes in trading volume.

In this sense, it has been possible to reject the null hypothesis that there was no abrupt structural break in the time series of liquidity proxies in most BDRs present in the sample studied. This result therefore provides strong evidence on the influence of market makers on BDRs market liquidity, showing that hiring market makers can increase liquidity and significantly contribute to these securities trading, facilitating their trading by investors. In addition, this result corroborates findings from other research addressing impact on liquidity arising from the introduction of market makers, such as in works by Ambrozini *et al.* (2009), Costa and Salles (2010), Sanvitto (2011), Silva (2012), Perlin (2013) and Rogers and Mamede (2014).

One of this paper's constraints is to present only whether or not there was an increase in liquidity after hiring market makers but it does not state how much liquidity was impacted. Despite the limitation, results answer the research question and contribute to the study of market liquidity and how market makers contribute to its rise. In addition, this study opens the way for new research possibilities such as verifying the degree of market makers' influence on liquidity as well as conducting analysis focusing market makers hired in order to show which were more efficient in promoting market liquidity in the companies that have hired them. It is also suggested that a more careful assessment be carried out on how market makers' actions cause abnormal returns or reduce investors' risk from changes in liquidity. Clearly, it would be interesting that such questions be answered in the future in order to further contribute to understanding factors that interfere with market liquidity and consequences of such interference.

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