

Title

Property Structure of Stock Exchanges and Market Quality: A Study of the Bovespa Demutualisation

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Abstract

This paper aims to investigate the relationship between stock exchanges' property structure and the quality of the service they supply. The analysis is accomplished through the study of the Bovespa case, which changed its property structure in 2007, resulting in either deterioration or improvement of its quality. The research applied an endogenous structural break test in the average bid-ask spread to answer its research question. The result has indicated that there was a significant break in the series trend during the demutualisation process and that the property structure change was associated with an improvement in the marketplace quality.

1. Introduction

One of the most important occurrences in financial markets in the last twenty years has been the change in the property structures of several stock exchanges. This process began in 1993 with the demutualisation of the Stockholm Stock Exchange and was followed by modifications in other markets around the world. As a special type of firm¹, stock exchanges can be for-profit private corporations, mutual structures of brokers, and closed companies, among other alternatives. In the beginning of 2009, almost all the main stock exchanges from the Organization for Economic Co-operation and Development (OECD) countries were corporations with explicit profit goals, only three of which had not listed their own stocks despite being demutualised: the Tokyo, Warsaw and Swiss stock exchanges (OECD, 2009). In 2007, Brazil's stock exchange (Bovespa), which was the only stock exchange operating in Brazil at the time and is the focus of this paper, changed its structure from a not-for-profit civil association to a for-profit corporation.

Frequent explanations for changes in the property structures of stock exchanges include the need to raise capital and search for more efficient productive processes (Elliot, 2002; Lee, 2003). These needs have become stronger with the technological revolution that has been occurring since the 1980s and the consequent increased international competition with other stock exchanges. According to the New Institutional Economics (NIE) approach, this change process is beneficial to society in the sense that enterprises make modifications to increase efficiency. Specifically, this school of thought teaches us that, in organizations with profit goals, administrative monitoring is more efficient (Alchian and Demsetz, 1972) and the acquisition of financial capital is facilitated (Hansmann, 1980).

Previous studies have analysed the differences between stock exchanges with distinct property structures. For example, Serifsoy (2007) used data envelopment analysis and the Malmquist productivity index to evaluate the operational efficiency of twenty-eight exchanges, concluding that property structure explains differences among organizations, although to small extent. Krishnamurti, Sequeira and Fangjian (2003) analysed quality measures for two Indian stock exchanges with different property structures and concluded that the demutualised exchange, National Stock Exchange, provided better quality than the Stock Exchange of Bombay, its competitor with a mutual structure. Given the interest in understanding the differences between for-profit and not-for-profit organizations and the importance of stock exchanges in capital markets, this work aims to conduct an econometric exercise related to the demutualisation of the Brazilian stock exchange. It does not intend to fully evaluate this process but rather to verify if there were statistically significant changes in average spreads, which are considered to be an informational measure of quality, at the Bovespa during the time the change took place.

The analysis will be conducted using daily bid-ask spread series and applying Lumsdaine and Papell's (1997) model of two endogenous structural breaks to test the unity root null hypothesis against the alternative hypothesis of stationarity with trend. The choice of a two-break rather than a one-break model is a result of a visual examination of the data. Endogenous structural break models allow for the evaluation of whether the timing of the change in the property structure of Bovespa is associated with any significant alterations in the bid-ask spread series, with the advantage of not having to specify the period of change *a priori*. The results indicate that there was a significant break in the series trend when the demutualisation occurred. The reversal of the bid-ask spread trend during the demutualisation suggests that the change in the property structure of the Brazilian stock exchange is associated with an improvement in the quality of the information it provides.

The paper is structured into five sections including this introduction. In the second section, the theoretical aspects related to changes in property structures will be presented. The third section is dedicated to describing the methodology and presenting the data. The fourth section shows the results and the fifth and final section includes final considerations.

2. Brief Literature Review

A potential theoretical foundation to analyse changes in the property structures of stock exchanges is the neoclassic Industrial Organization perspective. However, it would not be appropriate to employ this theoretical construct to explain the change in the property structure of the Bovespa because it assumes a monopolistic motivation for contractual alterations and reformulations (Williamson, 1985 and 2008) and the Brazilian stock exchange held a *de facto* monopoly on stock transactions in the country before demutualisation occurred in 2007.

An alternative theoretical foundation is the New Institutional Economics (NIE), which advocates that modifications in contractual structures occur as endogenous processes within organizations in their search for efficiency in production and resource allocation. The New Institutional Economics approach fits the Kuhnian conception of paradigms (Kuhn, 1962) because it is composed of a family of theories built on the pillar of limited and bounded rationality that is coherent with the observed real world.

The NIE confronts the rational agent with perfect foresight of the neoclassical school, promoting a revolution in the economic thought of organizations. The year of 1937, when Ronald Coase's classic "The Nature of the Firm" was published, is considered a turning point in this revolution. Until then, the economic literature failed to explain satisfactorily why firms exist. Concerned with markets, the mainstream theory at that time restricted itself to viewing organizations as black boxes, observed and studied through a given production function. The NIE took further steps, adopting transactions instead of markets as the focus of analysis. This approach has not seen the firm as a hermetic unit, thereby making it possible to examine several of its previously neglected aspects.

According to Williamson (2000), the NIE's analyses addressed formal institutions and governance structures. With this delimitation, the author considered the informal restrictions related to habits and social traditions to be well-known by analysts. In other words, changes happened in the long term and were therefore assumed to be fixed. In a simplified manner, the different theories that compose the NIE can be grouped in two major categories: incentives and transaction costs (Williamson, 1985). They share some joint aspects, in addition to the previously mentioned fact that they both focus their analyses on transactions rather than on markets. In addition, they equally recognize the importance of property right, or the right to use, to appropriate or to change the form or substance of assets. (Williamson, 1985: 24) According to Buchanan (1975: 225), analysing the implicit mutual benefits in voluntary transactions in line with the contract perspective, rather than the neoclassical approach, allows for a better comprehension of exchanges.

Demsetz takes a broad view of property rights, stating that they are "an instrument of society and derive their significance from the fact that they help a man form (...) expectations which he can reasonably hold in his dealings with others" (1967: 347), with such expectations being formed by laws and habits. With this characteristic, the property right serves the allocative function of internalising existing externalities, thereby reducing the bargaining costs involved in an exchange. In other words, the property right specification determines how costs and rewards will be allocated. In addition, because

property right is specified via contracts, the behaviour of organizational managers will depend on the nature of these contracts.

Through property rights theory, it is possible to explain business quality in stock exchanges. Two of the main products of stock exchanges are publishing information about the transactions conducted in their business environment and about the companies, a task they share with regulators like the Brazil's Comissao de Valores Mobiliarios (CVM). In this sense, for price information to be comparable over time, a certain standardisation of contracts negotiated is desirable. This standardisation occurs when appropriate property right specifications underlie the contracts and trades, for example through the proper disclosure of the rights that a new stock owner will have. In this regard, good stock exchange quality will only be obtained if the property rights of the traded stocks are well-specified.

In this property right context, limited liability over shares boosted the development of capital markets, creating incentives for the participation of wealthy shareholders. According to Demsetz,

(...) "limited liability considerably reduces the cost of exchanging shares by making it unnecessary for a purchaser of shares to examine in great detail the liabilities of the corporation and the assets of other shareholders; these liabilities can adversely affect a purchaser only up to the extent of the price per share." (Demsetz, 1967: 359)

Agency theory has developed independently from property rights theory, despite the fact that the research goals of both are quite similar. In a classical paper related to agency theory, Berle and Means (1932) proposed the existence of a conflict between the goals of managers and stockholders, indicating the superiority of companies managed by owners relative to corporations with diffused ownership. In addition to accept the possibility of this conflict, at least partially, Berle and Mean's conclusions have been questioned over time. According to Jensen and Meckling (1976), for example, the growth of open corporations suggests that the benefits of the diffusion of control outweigh its costs. For Demsetz (1983), the distance between the interests of managers and stockholders is reduced by the existence of a high percentage of managers who are also stockholders and whose remuneration is largely based on stock performance, mainly because of the implicit monitoring imposed by stock prices.

The conflict in the relation between managers and owners, known as the principal-agent relation, has generated a broad range of works seeking to create mechanisms to align incentives *before* the composition of contracts in order to increase the efficiency of exchanges. In the real world, the costs of redrawing property rights are not negligible and different contractual relations defined *ex ante* cannot be efficient *ex post*.

The second group of NIE theories, known as Transaction Costs Theory (TCT), was developed in this environment. TCT proposes that the decisions made by agents after contract formulation can be changed by their opportunistic behaviour, and together with the non-negligible costs related to the legal system, it allows for a larger focus on *ex post* contracts within private institutions (or support institutions). TCT was developed based on the perception that the neoclassical theory neglect of transaction costs was not plausible in the real world. According to Coase (1937), the explanation for the existence of firms was that they saved transaction costs. Otherwise, the exchanges that took place within firms would have occurred via markets. This make-or-buy decision is sensitive to the attributes associated with transactions. Specificity is an important transaction attribute, whether geographic, physical, or human, and it increases the current losses related to hold-up, which represent an opportunistic behaviour attributed by agents. Therefore, when investments are highly specific, integration should be the predominant governance structure for reducing transaction costs. For example, Saha (2005) justified the appearance of stock exchanges as organizations by the reduction of costs suffered by brokers when they negotiate with each other without an organised market and did not have compensation warranties for their businesses.

The warranties cited above can be made intrinsically possible through property right specifications of the negotiated stocks, as previously mentioned, but they will only produce the desired result if such rights are guaranteed and implemented by some formal organization that is supported by laws and habits. In this context, restrictions to over-the-counter businesses, which enjoy information about prices formed in stock exchanges but do not contribute to the costs associated with covering the publication of quotes, can be regarded as an opportunistic behaviour that should increase the costs of global stock transactions. This conclusion supports changing stock exchanges to closed corporations and suggests that the monopolisation of transactions improves well-being.

Alternative governance structures are also debated in the NIE context. Not-for-profit and structured organizations such as cooperatives deserve the special attention they have received from several authors. Some of these ideas are presented below.

2.1. *Not-for-profitⁱⁱ and Cooperative Organizations*

Hansmann (1980) sought to comprehend the role of not-for-profit organizations, defined by the non-distribution restriction in which it is impossible for profit to be appropriated by owners or sponsors.ⁱⁱⁱ The author has created a taxonomy of such organizations, embracing their financial and control structures. Financial structures could be commercial if they generated resources from their own activities or based on donations. In terms of control structures, organizations can be managerial, if administrative freedom is provided by their patrons, or mutual, if backers exercise control. In this taxonomy, Bovespa could be viewed as a commercial, mutual and not-for-profit organization until 2007.

In 2001, Bovespa merged with 11 other Brazilian exchanges, forming a *de facto* monopoly. At that time, as the monopolist of stock trading in the country and still characterised by a mutual not-for-profit structure, Bovespa could have increased its prices or trading fees but member-brokers could not appropriate excess profits. Noia (2000) explains the old stock exchange cooperative structure as a strategy to prevent monopolistic rent appropriation given the market power of local stock exchanges. Becoming a for-profit organization is thus justified as a means for allowing members to appropriate excess profits. Another explanation could be that not-for-profit firms may suffer from multiple goals and conflicts, whereas some members may desire to minimise fees, and others may pursue the maximisation of trading volume or other goals. Kanter and Summers (1987) noted that not-for-profit firms were characterised by the temporary alliances of separate groups, each of which interpreted the organization's goals slightly differently. Diverse objectives could make the raising of capital to invest in new technologies cumbersome with some members desiring to invest more than others. Furthermore, the horizon goal problem referred by Lee (1998) also makes investment difficult. Therefore, obstacles to obtain financial capital, without the possibility of offering stocks to the public, could help justify the appearance of the for-profit structure.

It is frequently argued that when consumers are unable to correctly evaluate promised and delivered products, regardless of whether this is caused by the transaction circumstances or the characteristics of the product, there will be more well-being if the products are supplied by not-for-profit organizations. This is because not-for-profit organizations have more restrictions on increasing prices or decreasing quality due to the distribution of profits being impossible by definition. In other words, the advantage of these organizations is that “the discipline of the market is supplemented by the additional protection given the consumer by another, broader ‘contract’, the organization's legal commitment to devote its entire earnings to the production of services” (Hansmann, 1980: 844). However, Alchian and Demsetz (1972) compared not-for-profit organizations to open corporations with profit goals and noted that more opportunistic behaviour, which reduces average productivity, could be expected from not-for-profit organizations, that are not subject to monitoring through the possibility

of the easy and fast transfer of property rights, a feature that has been observed in open corporations. In other words, there is a lack of efficiency in the administration of not-for-profit organizations due to the incorrect alignment of incentives, which the absence of profit distribution provokes.

Hart and Moore (1996) analysed pricing practices among cooperatives with conflicting goals, i.e. organizations with and without profit goals. According to the authors' model, which examines decisions by average voters, the organization will prefer to act with profit goals in the case members' distribution become more skewed. Moreover, in line with the result of Hansmann (1988), some deficiencies generated by the decision-making process of cooperatives would be minimised if their members were homogeneous. In contrast, according to Pirrong (1999), cooperatives with profit goals should be dominant over not-for-profit ones. His argument is based on the possibility of exercising market power that could be detrimental to a cartel compelled by a not-for-profit cooperative.

According to the brief review above, the NIE explains several characteristics of stock exchanges relating to their appearance and development. Moreover, this perspective facilitates the comprehension of changes in the property structures of these organizations. Such changes could affect the product supplied by the stock exchanges: information. Whether the change in the Brazilian stock exchange led to deterioration in quality or transaction costs for traders, due the need to raise profits and cut costs, or to improvement in quality, due to an increase in efficiency, is a question that needs an empirical answer.

3. Methodology and Data

The main goal of this paper is to verify if there is a break in the time series measure related to the business quality of Bovespa around the period when its property structure was changed. The employed measure is the daily average bid-ask spread from all the stocks negotiated at Bovespa, $SPDAY_{i,t}$, which is calculated by the bid-ask spread of each stock leveraged by its daily trading volume.

Firstly, we calculated $SP_{i,t}$, which is the difference between the last best bid ($BID_{i,t}$) and the last best ask ($ASK_{i,t}$) divided by the average of these two prices for each stock i in each day t . Algebraically, $SP_{i,t} = (ASK_{i,t} - BID_{i,t}) / [(ASK_{i,t} + BID_{i,t}) / 2]$. The daily average bid-ask spread ($SPDAY_t$) was then calculated for each day t by multiplying $SP_{i,t}$ to the ratio of its volume

$(VOL_{i,t})$ and the total volume negotiated at the same day t ($\Sigma VOL_{i,t}$). Algebraically,

$$SPDAY_t = \sum_{i=1}^n SP_{i,t} (VOL_{i,t} / \sum_{i=1}^n VOL_{i,t})$$

Many papers in the finance literature investigate whether there is a correlation between the costs of trading stocks and other variables, such as stock prices and transaction volumes. It is common for these papers to employ the bid-ask spread as a proxy for the true transaction costs of trading stocks. A large spread indicates a higher cost; which means a buyer must pay a higher mark-up on the price and the seller must accept a higher discount than she would receive with narrow spread. Furthermore, the works of Atkins and Dyl (1997) and Bessembinder (2003) lead to the conclusion that there is a strong negative correlation between volume and spread, as traders will gravitate toward market places with lower costs, thus spreads from other market places and volumes could be regarded as determinants of local spreads. Some other variables, such as market volatility and broker concentration, potentially affect the generated spread series. Volatility is directly related to spread and an increase in broker concentration could cause an increase in spreads because the direct costs of stock transactions would rise due to the brokers' ability to exercise market power.

Evaluations of changes in property structures should expurgate the influences of the determinants of the bid-ask spread cited above. This structural break assessment will calculate the error term (u_t) of the estimation using the ordinary least squares method in the equation 1 below. All the variables were transformed into monthly averages before estimation. This is due to availability of broker's concentration data and necessary to calculate standard deviations of returns.

$$(1) \quad SPMED_t = \beta_0 + \beta_1 SPADR_t + \beta_2 C8_t + \beta_3 VOL_t + \beta_4 DPBRA_t + u_t$$

- $SPMED_t$ is the monthly average of daily bid-ask spreads ($SPDAY_t$);
- $SPADR_t$ is a control variable that proxies for the NYSE spread. The variable is the average bid-ask spread in month t excluding stocks with American Depositary Receipts. This variable aims to capture the costs of international markets;
- $C8_t$ is a control variable calculated as the concentration ratio of eight brokers with the largest volumes at Bovespa in month t ;
- VOL_t is a control variable calculated as the average stockbroker volume in month t ;
- $DPBRA_t$ is a control variable calculated as the standard deviation of monthly average Bovespa returns. This variable aims to capture the risk perception of Bovespa's stocks.

All variables were employed as logarithms and they covered the period from July 1999 to August 2009. Table 1 presents a statistical summary of the variables.

Table 1 - Descriptive Statistics of Variables

Variable	Obs	Mean	Std.Dev.	Min	Max
SPMED _t	125	(5.00)	0.39	(5.87)	(4.12)
DPBRA _t	125	(3.60)	0.27	(4.03)	(2.56)
SPADR _t	125	(6.16)	0.41	(7.02)	(5.29)
C8 _t	125	3.74	0.14	3.38	3.95
VOL _t	125	16.27	0.63	15.14	17.78

Source: www.bovespa.com.br.

After obtaining the error term from equation 1 we applied an endogenous structural break test. These types of tests evaluate the unitary root hypothesis against the alternative stationarity with trend hypothesis. They can be employed, for instance, to evaluate the existence of a change in the series due to public policies. Furthermore, if politics are treated endogenously, the test extracts the period of the level or trend rupture as a by-product. Lumsdaine and Papell's (1997) model was employed because two apparent breaks were detected through a visual inspection (see Graph 1). Further information regarding the structural break models can be found in the Appendix.

4. Results

We first conducted the estimation of equation 1 to obtain error series and proceeded to identify any structural break on them. The estimation was satisfactory with a high R-squared (72.8%) and the individual statistics of almost all variables showing significant results with the expected signs. Exceptions occurred with the *DPBRA_t* parameter which is a risk measure that showed no impact on spread average, and *VOL_t*, which showed a sign that was different from what was expected. However, the parameter of the *SPADR_t* variable suggests that the spreads of Brazilian stocks are influenced by spreads in global markets and the *C8_t* variable suggests that an increase in broker's market power reduces the average spread. The main estimation results can be seen in table 2.

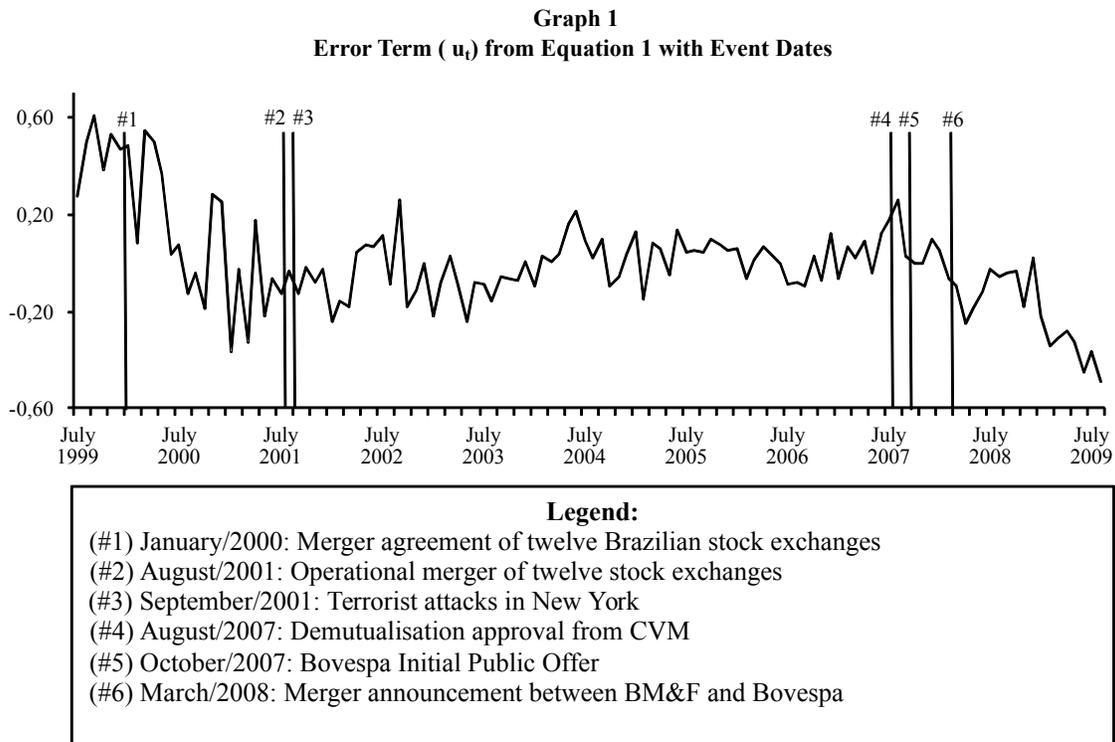
Table 2 - Estimation Results from Equation 1
(Endogenous: *SPMED*)

Variable	Coefficient	t statistic	p-value
<i>DPBRA_t</i>	0.0408	0.57	0.571
<i>SPADR_t</i>	0.6568	9.32	0.000
<i>C8_t</i>	-2.116	-12.61	0.000
<i>VOL_t</i>	0.2241	4.11	0.000

<i>Constant</i>	3.4711	5.83	0.000
125 observations - R ² : 0.728 - F Statistic: 84.08			

Source: Author

Graph 1 presents the evolution of errors; the vertical bars indicate important events that could have influenced changes in the bid-ask spread structure.



Source : Author

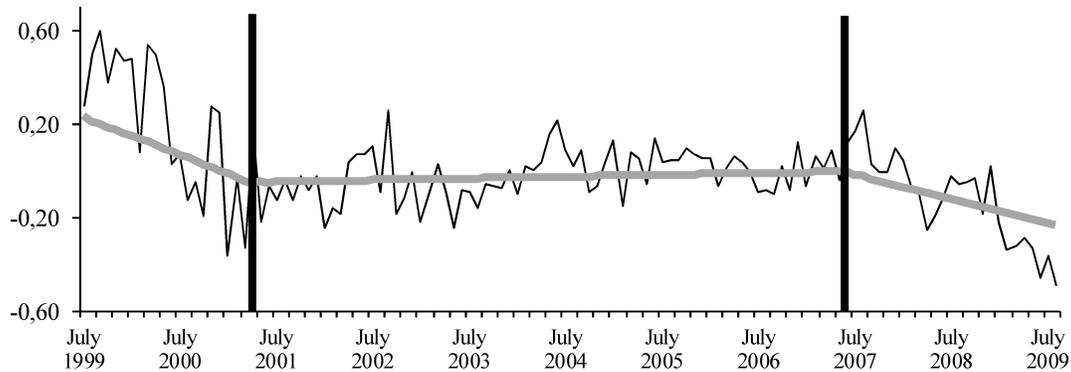
A visual examination of Graph 1 suggests that the error series exhibit trends with breaks shortly before the stock exchange mergers and around Bovespa's demutualisation. To evaluate the series behaviour and the possible break dates, we apply the CC Lumsdaine and Papell's (1997) model, presented in the appendix, whose estimation results, without the augmented term, are shown below:

$$y_t = 0,41 - 0,022t + 0,080 DU1_t + 0,023 DT1_t + 0,095 DU2_t - 0,015 DT2_t - 0,614 y_{t-1}$$

(5,259)	(- 4,69)	(1,321)	(4,745)	(1,549)	(- 3,82)	(- 6,08)	,
[0,000]	[0,000]	[0,189]	[0,000]	[0,124]	[0,000]	[0,05]	

The values in parentheses are the t -statistics and the values in brackets are the p-values. Statistically, the results indicated that there were breaks in the tendency ($DT1$ and $DT2$ with t -statistics of 4.74 and -3.82), though not in the intercept ($DU1$ and $DU2$ with t -statistics of 1.32 and 1.54). According to the conducted estimation, the null unitary root hypothesis was not rejected at a 5% confidence level in favour of a stationary series with breaks.

Graph 2
Error Term (u_t) with Trends and Break Dates



Graph 2 again presents the error terms from equation 1. The grey lines indicate the series tendencies and the thick vertical lines indicate the periods of structural breaks. The results suggested that the breaks occurred in March 2001 and May 2007. The first date is shortly before the announcement and effective merger of the Brazilian stock exchange. The second date is shortly after the demutualisation announcement and the capital offering by Bovespa. The results are therefore aligned with the idea that the stock exchange merger and Bovespa's demutualisation affected its quality, i.e. the bid-ask spread tendency. Furthermore, whereas the merger is associated with a decrease in quality (increase in transaction costs or spreads), demutualisation is associated with an improvement in quality (decrease in transaction costs or spreads).

5. Final Considerations

Changes in property ownership structures are important events to be investigated, especially those related with the demutualisation of stock exchanges, a process that began in 1993 with the change in the ownership structure of the Stockholm Stock Exchange. This subject is relevant because of the magnitude of trading in stock markets and the consequent theoretical discussion about the inappropriateness of neoclassical economics to explain these types of phenomena. In this sense, this paper has explored Bovespa's demutualisation, which occurred in 2007. The article's main

goal was to answer if the change in the property ownership structure of Bovespa could be associated with any change in the quality of services provided by the stock exchange.

Two different schools of thought provide different theoretical explanations for the demutualisation phenomenon. The neoclassic school heavily emphasises the monopolistic motivation. According to this theory, a firm could change its property structure to achieve its monopolistic goals. In contrast, the New Institutional Economics stresses the endogenous motivations of firms in their search for efficiency or reduction of transaction costs. Because Bovespa retained a *de facto* monopoly when it demutualised in 2007, the neoclassic school was not appropriate or could not be employed to explain the ownership change.

The NIE helps to understand some of the aspects of stock exchanges. Through the property rights context, it is possible to understand how contracts correctly specified, regarding the owner's rights, can increase the quality of a marketplace such as a stock exchange. In addition, the reduction of transaction costs between brokers explains the appearance of stock exchanges as organised markets. The NIE provides several indications to the variations of quality with different ownership structures. A transition from a mutual structure to a for-profit corporation could lead to a decrease in quality, due to the possibility of monopolistic rent appropriation, or to an improvement in quality, due to the more efficient allocation of resources. In short, there might not be a single answer to the question of the quality implications of demutualisation and it should therefore be addressed on a case-by-case basis. This empirical investigation calculated the daily average bid-ask spreads of all stocks traded on the Bovespa and used it as a measure of quality or transaction costs. Several papers endorse this choice of variable as a measure of quality (Atkins and Dyl, 1997).

The empirical analysis employed time series tools, thereby evaluating the existence of structural breaks in the bid-ask spread series. The utilised model was Lumsdaine and Papell's (1997) two-structural-break model after visual evaluation indicated the presence of two breaks in the series. The results suggested that there were breaks in the spread tendency in March 2001 and May 2007, which were close to the dates when the merger announcement and Bovespa's demutualisation took place. Moreover, the stationary unitary root hypothesis was rejected in favour of breaks and tendency, suggesting that random shocks in the series have temporary effects, with a tendency of the series to return to its long-term equilibrium path.

Finally, the analysis indicated that Bovespa's demutualisation was associated with a decrease in transaction costs (or an increase in average quality). The results showed that demutualisation did not produce higher costs for traders, as a naive

regulator could claim, on the basis of the possibility that more monopoly power could be exercised by Bovespa. In fact, the spreads revealed the opposite change, with smaller transaction costs for traders after the demutualisation.

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Appendix - Structural Break Models

Structural break models became popular after Perron's (1989) study, which called attention to the fact that the existence of structural breaks in time series data could influence the results of traditional unit root tests, such as the Dickey-Fuller and Phillips-Perron tests. By ignoring permanent breaks in deterministic components of series, researchers who used conventional tests would tend to accept the unit root null hypothesis more frequently than if the series were analysed separately before and after the break.

Perron (1989) confronted Nelson and Plosser's (1982) results for thirteen macroeconomic series with those obtained using the new methodology. Perron (1989) rejected the unit root null hypothesis for ten of the thirteen series. Until that time, there was a reasonable consensus that macroeconomic series were typically stochastic instead of stationary with trend. In this way, shocks would have permanent effects on time series. Perron's (1989) results were based on the following generalisation of the Augmented Dickey-Fuller model with level and trend changes:

$$(i) \quad \Delta y_t = \rho \cdot y_{t-1} + \sum_{j=1}^p \gamma_j \cdot y_{t-j} + \mu_t + \varepsilon_t,$$

where $\mu_t = \mu + \beta \cdot t + \theta \cdot DU_t + \gamma \cdot (t - TB) \cdot DT_t$ is a deterministic term. The break occurs in time TB. Based on this model, Perron (1989) considered three break possibilities:

- Model I – with trend and break on level:

$$\mu_t = \mu + \beta \cdot t + \theta \cdot DT_t,$$

- Model II – with breaks on trend and level:

$$\mu_t = \mu + \beta \cdot t + \gamma \cdot (t - TB) \cdot DT_t,$$

- Model III – combined:

$$\mu_t = \mu + \beta \cdot t + \theta \cdot DT_t + \gamma \cdot (t - TB) \cdot DT_t,$$

where, for the three models,

$$DT_t = \begin{cases} 1, & \text{if } t > TB \\ 0, & \text{if } t \leq TB. \end{cases}$$

The null hypothesis for each of these models is a unit root, with possible breaks captured by the introduced dummies. The alternative hypothesis reflects a stationary process with breaks. The shock period is identified *ex-ante* through economic intuition, which characterised Perron's work as an exogenous structural break model. During the early 1990s, a new class of

endogenous model emerged; noteworthy models include those of Zivot and Andrews (1992) and Lumsdaine and Papell (1997).

Zivot and Andrews's (1992) endogenous structural model is characterised by a sequence of tests in which dummies for different periods are applied. The break period is selected according to the smallest t -statistic. In other words, a break date is chosen when it is less favourable to the null hypothesis. As a result, this type of test has a greater difficulty in rejecting the unit root hypothesis. The null hypothesis (H_0) of the test proposed by Zivot and Andrews (1992) can be expressed as:

$$H_0: \quad y_t = \mu + y_{t-1} + \varepsilon_t$$

The alternative hypothesis (H_1), as in Perron (1989), is composed in three different manners (A, B and C):

$$(A) \quad H_{1A}: \quad y_t = \mu + \beta.t + \theta.DU_\lambda + \alpha.y_{t-1} + \sum_{i=1}^k c_i.\Delta y_{t-i} + \varepsilon_t$$

$$(B) \quad H_{1B}: \quad y_t = \mu + \beta.t + \gamma.DT_\lambda + \alpha.y_{t-1} + \sum_{i=1}^k c_i.\Delta y_{t-i} + \varepsilon_t$$

$$(C) \quad H_{1C}: \quad y_t = \mu + \beta.t + \theta.DU_\lambda + \gamma.DT_\lambda + \alpha.y_{t-1} + \sum_{i=1}^k c_i.\Delta y_{t-i} + \varepsilon_t$$

where

$$DU_t = \begin{cases} 1, & \text{if } t > TB \\ 0, & \text{if } t \leq TB \end{cases} \quad \text{and} \quad DT_t = \begin{cases} t - TB, & \text{if } t > TB \\ 0, & \text{if } t \leq TB. \end{cases}$$

The break point TB is chosen to minimise the t -statistics of the ADF test, with the most negative values leading to the rejection of the null hypothesis. The selection of one model (A, B or C) is not consensual. A conservative approach is to work with model C, which is the most general.

Lumsdaine and Papell (1997) amplify Zivot and Andrews's (1992) work, allowing for the possibility of a second endogenous break in the series under the alternative stationarity with trend hypothesis and breaks in the level and in the trend. The authors re-examined Nelson and Plosser's (1982) series, testing them for two unknown breaks and rejecting the null unitary root hypothesis for five of the thirteen macroeconomic series.

Lumsdaine and Papell's (1997) test uses similar logic employed by Zivot and Andrews (1992). The AA model allows for two breaks in the intercept and the CC model allows for two breaks in the intercept and slope. Finally, the CA model has a break in the intercept and trend and a break in the intercept only. These three models can be written as:

$$(AA) \quad y_t = \mu + \beta.t + \theta_1.DU1_t + \gamma_1.DT1_t + \alpha.y_{t-1} + \sum_{j=1}^k c_j.\Delta y_{t-j} + \varepsilon_t$$

$$(CC) \quad y_t = \mu + \beta.t + \theta_1.DU1_t + \gamma_1.DT1_t + \theta_2.DU2_t + \gamma_2.DT2_t + \alpha.y_{t-1} + \sum_{j=1}^k c_j.\Delta y_{t-j} + \varepsilon_t$$

$$(CA) \quad y_t = \mu + \beta.t + \theta_1.DU1_t + \gamma_1.DT1_t + \theta_2.DU2_t + \alpha.y_{t-1} + \sum_{j=1}^k c_j.\Delta y_{t-j} + \varepsilon_t$$

where the dummies $DU1$ and $DU2$ capture changes in the intercept and the trend dummies are $DT1$ and $DT2$, where

$$DU1_t = \begin{cases} 1, & \text{if } t > TB1 \\ 0, & \text{if } t \leq TB1 \end{cases} \quad \text{and} \quad DU2_t = \begin{cases} 1, & \text{if } t > TB2 \\ 0, & \text{if } t \leq TB2 \end{cases}$$

$$DT1_t = \begin{cases} t - TB1, & \text{if } t > TB1 \\ 0, & \text{if } t \leq TB1 \end{cases} \quad \text{and} \quad DT2_t = \begin{cases} t - TB2, & \text{if } t > TB2 \\ 0, & \text{if } t \leq TB2 \end{cases}$$

As in Zivot and Andrews's (1992) model, the two break tests in $TB1$ and $TB2$ are conducted in the period from $k+2/T$ to $(T-1)/T$, implying $TB2 > TB1 + 1$. The estimation performed in the paper refers to model CC, the most general of the three choices.

iEndnotes

From the perspective that firms represent long-term contractual relations, whereas markets are sets of spot transactions, stock exchanges should be classified as markets. Mulherim, Netter and Overdahl (1991) examined a set of external and internal contracts from the New York Stock Exchange (NYSE) and the Chicago Board of Trade (CBOT), framing them as particular cases of firms that produce accurate information under quotes. This point of view was adopted in this paper for the case of Bovespa.

ii We prefer to use the term not-for-profit instead of non-profit when referring to firms without profit goals. The use of the latter term could be misleading because not-for-profit firm could have profits without aiming them.

iii Hansmann (1980) retained the possibility of not-for-profit organisations to have profits. The existence of not-for-profit organisations would require no stocks and shares existence, along with any other property right that permits the holder (of the stock) to control both management and profit distribution.