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Influence of variation of liquidity in asset pricing: panel analysis of the brazilian market for the period january 2000 to june 2008

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SUMMARY: The influence of liquidity on return on assets has been subject of much research in recent years, from the point of view of individual assets as well as considering the liquidity of the market as a whole. This study aims to evaluate the influence of change in liquidity in the pricing of assets. The measures of liquidity consisted of variations in the quantity of securities, in the number of trades and in financial volume, as well as these variables weighted by the Bovespa index and also the same variables lagged. The sample is made up of the shares traded in the São Paulo Stock Exchange. Monthly data were collected for the period of January 2000 through June 2008. The results show that return on assets is positively influenced by the Bovespa index and by variations in liquidity. In general, it is the companies with the lower liquidity levels that show the highest positive variations of their own liquidity, therefore, having higher returns.

Keywords: Variations in liquidity; return; panel data.

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1. INTRODUCTION

The influence of liquidity on the return on assets has been widely researched in recent years. From the standpoint of individual returns, Amihud and Mendelson (1986, 1989), Brennan and Subrahmanyam (1996), Brennan, Chordia and Subrahmanyam (1998), Datar, Naik and Radcliffe (1998), Liu (2008) using different measures for liquidity, have found a negative relationship between liquidity and the gross return on assets.

Another research group has focused on the issue of commonality of liquidity and to respond if liquidity is a systematic risk factor. Chordia, Roll and Subrahmanyam (2000), Hasbrouck and Seppi (2001) and Huberman and Halka (2001) document the existence of commonality in liquidity for the U.S. market

Regarding the liquidity premium, even opting for different liquidity measures, several authors have found results that support its existence. Amihud (2002) measures market illiquidity as the ratio between absolute return and trading volume, and finds an illiquidity premium. Pastor and Stambaugh (2003) measure liquidity based on the principle that the flow of orders leads to a major reversal of returns when liquidity is low and find that expected returns increase with the liquidity's beta, which is a measure of sensitivity to innovations in market liquidity. These results are interpreted by the authors as evidence that systematic liquidity risk is priced. Gibson and Mougeot (2004) measure liquidity through the number of shares normalized by the S&P 500 index and also concluded that systematic liquidity risk is priced. In addition, several authors (CHORDIA, ROLL and SUBRAHMANYAM, 2001, PASTOR and STAMBAUGH, 2003, PORTER, 2003) find that the liquidity risk premium remains even after controlling for factors such as market risk (beta), size and book-to-market.

Much of the literature on liquidity has the U.S. market, the world's most liquid, as research subject. On the other hand, it is in emerging markets that liquidity effects can be particularly strong. Due to seasonal and transverse variations in liquidity, emerging markets provide an ideal context to examine the impact of liquidity on expected return. Martínez et al. (2005) employ three measures of liquidity risk and find that systematic liquidity risk is priced in the Spanish market. Bekaert, Harvey and Lundblad (2006) measure liquidity based on the proportion of daily returns equal to zero and conclude that, for many countries, market liquidity is an important determinant of expected returns, especially in emerging markets.

The Brazilian stock market is in terms of liquidity, a highly concentrated market. An example of this concentration is the composition of the Bovespa index, where only 66 stocks represent 80 % of negotiability index (portfolio of the first quarter of 2009). In this sense, the Brazilian market has characteristics typical of emerging markets, where many stocks have low liquidity.

This study aims to evaluate the influence of the variation in liquidity pricing. Due to the large number of stocks with low liquidity in the Brazilian market, this work also seeks to examine whether the results are affected by the treatment of intervals without negotiation.

The paper is divided into four sections besides this introduction. Section two refers to the review of the literature on the relationship between liquidity and return. Section three deals with the methodological procedures used in the research. The results are shown in the fourth section. Finally, section five presents the conclusions about the study.

2. LITERATURE REVIEW

Although there is no universally accepted concept for liquidity, in general, liquidity refers to the possibility of trading a large amount of assets, quickly, inexpensively and with minimal impact on price (LIU, 2006). This definition highlights four basic dimensions of liquidity: the trading volume, the speed of trading, the cost of trading and the impact on price. Because of this multidimensionality, researchers studying the relationship between liquidity and return, have been using a wide range of measures for liquidity.

Amihud and Mendelson (1986) developed a theoretical model that predicts that asset returns are an increasing and concave function of relative spread (bid-ask spread divided by price) and that there is a clientele effect, where long-term investors select assets with high spreads. The empirical test used data for the period 1961 to 1980, and applied the CAPM (Capital Asset Pricing Model) framework. In separate regressions they found a linear relationship between excess return and the beta and confirm the concavity of the relationship between excess return and relative spread.

Later, Amihud and Mendelson (1991) show that out of the four factors identified by Merton (1987) as significantly related to risk-adjusted returns only the beta remains significant when the relative bid- ask spread is included as an explanatory variable.

Datar, Naik e Radcliffe (1998) evaluate whether the returns are negatively related to liquidity, as predicted by Amihud and Mendelson (1986), but using the turnover as a measure of liquidity. The results support the model of Amihud and Mendelson. Returns are a decreasing function of the rate of turnover and the relationship persists even after controlling for firm size, book- to-market and beta.

Brennan and Subrahmanyan (1996) assess whether the illiquidity due to information asymmetry affects the rate of return required by investors. Given the evidence that the effects of information asymmetry is captured by the impact on the price of a trade or by the variable component of the cost of negotiation, the authors use the models of Glosten and Harris (1988) and Hausbrouk (1991) to split the estimated cost of trade into fixed and variable components and use the factors of Fama and French (1993) to adjust to risk. These factors are the excess market return, the return of a portfolio that is bought in stocks of small companies and sold in shares of large companies, and the return of a portfolio that is bought in stocks with high book-to-market and sold in stocks with low book-to-market. Random portfolios by "λ " an inverse measure of market depth developed by Kyle (1985) are assembled and by size of the company are selected. The results show that the indicators increase monotonically when one moves from the portfolios with low "λ "to the ones with high "λ ". The coefficients of the fixed component and of the variable component are also positively related to the excess return. These results confirm the hypothesis that portfolios with "λ "values have a higher risk-adjusted return and show that there is a premium associated with the fixed and variable components of the transaction cost.

Amihud (2002) evaluates the relationship between returns and illiquidity in two contexts. First, he proposes that over time, the expected excess return is an increasing function of expected market illiquidity. Next, he evaluates whether the expected excess return above the risk premium also reflects a compensation for expected market illiquidity. The author uses as a measure of the illiquidity, the ratio of absolute daily return and the volume in dollars. Following Fama and Macbeth (1973), the cross-sectional model presents a regression of returns against risk-related variables (beta and standard deviation of return) and includes control variables (dividend yield, past returns, size).

The results show that illiquidity has a positive and highly significant effect on expected returns. The effect of beta is positive and significant, however, it becomes insignificant when size is included in the model (an expected result since the betas were calculated for portfolios based on size). The standard deviation of returns and the dividend yield have negative coefficients. The negative coefficient of the dividend yield can be negative due to the possibility that it might be reflecting the effect of risk factors not observed (less risky companies can choose higher dividend yields).

To test the proposition that the expected excess return is an increasing function of expected market illiquidity, the authors follow the methodology of French, Schwert, Stambaugh (1987), which tests the effect of risk on the expected return. The expected illiquidity is estimated by an autoregressive model. The results show that expected illiquidity has a positive and significant effect on the expected excess return (return on the stock return lower than return on government bonds), i.e., the expected excess return of an asset, besides the risk premium, represents a premium of the share's illiquidity.

Chordia, Subrahmanyam and Anshuman (2001) evaluated the relationship between trading activity and stock returns. Given the evidence that liquidity affects the returns, a reasonable hypothesis would be that the second moment of liquidity could also be priced. If agents are risk averse, stocks with high variability in liquidity would require higher returns. As liquidity measures, volume and turnover are used. The results document a negative and significant correlation between the average return and the level and the second moment of the measures of trading. The negative relationship between return and liquidity is consistent with the hypothesis that liquidity is priced. However, the negative relationship between return and the variability of liquidity proved contrary to expectations. Based on Merton (1987) the authors argue that the variability of trading activity serves as a proxy for the heterogeneity of investors who hold the share, so, an increase in heterogeneity could reduce the required rate of return, which is consistent with the results. It is possible that the increase in volatility corresponds to the entry of institutions that increase liquidity or it may indicate the entry and exit of investors, resulting in lower trading costs and high liquidity in terms of the capacity to accommodate block-traders.

Acharya and Pedersen (2005) develop an equilibrium model, called liquidity adjusted CAPM, where the expected return of a security depends on its own liquidity as well as on the covariance of its return and of its liquidity with the market's return and liquidity. Empirical tests show that the required return of an asset is positively related to the covariance between the asset's illiquidity and the market's illiquidity; negatively related to the covariance between the asset's return and the market's illiquidity; and negatively related to the asset's illiquidity and the market's return. The model also shows that liquidity shocks are associated with low contemporaneous returns and high future returns.

As Acharya and Pedersen, Liu (2006) also develops a model to incorporate liquidity to the CAPM, but using a different measure of liquidity, turnover normalized and adjusted for the number of days without trading volume. The empirical tests conducted by Liu (2008) show that the results found by Liu (2006) for the U.S. market after 1963 are also robust for the period from 1926 to 1962.

From an individual standpoint, assets with low liquidity generate significantly higher expected returns than assets with high liquidity, considering an investment period of twelve months. And yet, neither the CAPM nor the three-factor model of Fama and French are able to eliminate the liquidity premium. At the aggregate level, the measure of Liu (2006) captures the market liquidity. Liquidity risk is negatively correlated with market performance, indicating that investors price liquidity risk relatively high in slack periods. Historical beta liquidity predicts returns for different intervals of one to twelve months. Stocks with high sensitivity to fluctuations in market liquidity earn significantly higher returns than stocks with low sensitivity, i.e., high expected returns compensate investors who bear the liquidity risk.

Evidence on the role of liquidity are also being developed in other markets. For example, Bekaert, Harvey and Lundblad (2006) study eighteen different markets, Zhang, Tian and Wirjanto (2007) the Chinese market, Hwang and Lu (2009) the British market, Martínez et al. (2005) the Spanish market and Bruni and Famá (1998), and Vieira and Milach (2008) the Brazilian market.

Bekaert, Harvey and Lundblad (2006) examine a set of markets where liquidity can be particularly important in emerging markets. Using as one of the liquidity measures the proportion of firms with daily returns equal to zero, the authors show that liquidity is significant in predicting returns and unexpected liquidity shocks are positively correlated with returns and negatively correlated with dividends. Assuming that market liberalization can affect the relationship between liquidity and return, a number of asset pricing models that follow the local market or the world market depending on whether the country's market is integrated or segmented were estimated. The results indicated that the systematic risk of liquidity may be more important than market risk, and that in countries with high political risk and faulty legislation, the role of liquidity in the explanation of returns is higher.

Zhang, Tian and Wirjanto (2007) investigate the existence of systematic liquidity risk in the Chinese market by implementing an empirical test of the theoretical model developed by Weill (2005). The results show that, in equilibrium, liquidity risk is significantly priced. Specifically, the liquidity risk is economically significant reaching respectively 10 % per year and 6.7 % the year before and after controlling for market risk, size and book-to-market.

For the British market, Hwang and Lu (2009) seek to evaluate the link between liquidity and value premium. Since Fama and French (1992, 1993), many researchers have documented the existence of the value premium, i.e., the excess return for value stocks (high book-to-market) on growth stocks (low book-to-market). The authors show that in the UK market there is a significant value premium. The difference in return between portfolios assembled according to book-to-market, is higher than 10 % per year. The authors provide evidence that this anomaly can be explained by the CAPM adjusted for liquidity. And yet, the role of liquidity for explanation of the value premium does not disappear even when the model included factors related to bankruptcy and several macroeconomic variables.

For the Spanish market, Martínez et al. (2005) evaluate the relationship of returns with three measures of liquidity: the one proposed by Pastor and Stambaugh (2003); the illiquidity developed by Amihud (2002); and market-wide liquidity defined as the difference between returns highly sensitive to change in the bid-ask spread, and relative returns with low sensitivity to these changes. The results show that using these measures, the Spanish market has a liquidity premium.

In the Brazilian stock market, Bruni and Famá (1998) evaluated the shares traded on the São Paulo Stock Exchange during the months of July 1988 and June 1997. Using as measure of liquidity stock's marketability index, 25 portfolios were assembled, recalculated annually. For each portfolio the average returns, betas and marketability were obtained. Subsequently, these variables were used in a cross-section regression. The results showed a significant negative association between returns and liquidity, as measured by marketability. Thus, the Brazilian market seems to behave similarly with other markets, since less liquid stocks would be evaluated so as to allow higher levels of return.

Vieira e Milach (2008) analyzed the behavior of the liquidity/illiquidity measures in the period between January 1995 and June 2005 from 12 multiple regression models and using the method proposed by Fama and Macbeth (1973). Over the years the market showed a significant improvement in its trading activity, both in terms of number of trades and in terms of trading volume. Most of the coefficients of the liquidity variables were not significant, only the variables related to illiquidity, illiquidity and spread, were significant. Tests carried out with the exclusion of the entries in the months of January also showed that the analysis is not significantly affected by the "January effect".

Overall, the empirical evidence presented in these studies point to the existence of a liquidity premium, whether in a developed market like the U.S. or in emerging markets. There are also a variety of measures and models for liquidity. The use of different measures is associated with the fact that liquidity is a multidimensional concept, which has a number of aspects that cannot be captured in a single measure (AMIHUD, 2002; SARR e LYBEK, 2002; BANERJEE, GATCHEV e SPINDT, 2005; CHOLLETE, NAES e SKJELTORP, 2006). Regarding the construction of models, it is noted that the studies have different focuses. Some seek to evaluate the relationship between return and the asset's liquidity, while others seek evidence of the influence of market liquidity on the asset's return.

It is important to emphasize that the notion of liquidity for individual assets differs from the notion of liquidity for a market as a whole. Despite the conditions of supply and demand determining the liquidity in both cases, the factors that determine the liquidity of a security are mainly related to the individual characteristics of the security while the liquidity of the market is largely influenced by macroeconomic issues (legal, political, fiscal, etc.).

3. METHOD

The sample was assembled from publicly traded corporations, with shares traded on the São Paulo Stock Exchange (BOVESPA), and whose data were available in Economática ® from December 1999 to June 2008. The time series begins to be analyzed in January 2000; however the data for December 1999 is necessary to calculate the return. For each company the share with the highest liquidity was selected. Data were collected monthly adjusted for earnings, in Reais.

Most studies evaluating the influence of liquidity on asset returns, despite the different formulations and methods have in common that they consider the effect of market risk and liquidity (e.g. AMIHUD (2002), ACHARYA and PEDERSEN (2005), ZANG, TIAN and WIRJANTO (2007), among others). Thus, we defined the following model to be tested.

$$y_{i,t} = \beta_1 + \beta_2 Ibov_t + \beta_3 Liq_{i,t} + e_{i,t} \tag{1}$$

where the subscript $i = 1,..., N$ indicates the company, $t = 1,..., T$ time, and β's the regression coefficients. The variables are given by y_{it} = return of company i in time t; $Ibov_t$ = return of the Bovespa index in time t; $Liq_{i,t}$ = variation of liquidity for company i in time t; e_{it} = error term for the company i in time t.

However, because there is no consensus on the most appropriate measure of liquidity we opted for the use of the securities, of the volume and of the trades. And yet, because of evidence that investors are willing to accept a lower return for the assets with high returns at times when the market is illiquid (e.g., PASTOR and STAMBAUGH (2003), ACHARYA and PEDERSEN (2005), among others) it was decided to add to the model measures of weighted liquidity measures as a way to evaluate the behavior of asset liquidity on the behavior of market liquidity.

Variables used in the study are presented in Chart 1.

Variable	**Index/Measure**
Stock return (dependent variable)	Stock price on *t* divided by stock price on *t-1*.
Index Return	Bovespa index on *t* divided by the Bovespa index on *t-1*.
Securities	Number of company shares traded on *t*.
Weighted Securities	Number of company shares traded on *t* divided by the total number of shares in the Bovespa index on *t*.
Volume	Total financial volume of company shares traded on *t*.
Weighted volume	Total financial volume of company shares traded on *t* divided by the total trading volume on the Bovespa index on *t*
Trades	Number of trades in company stock on *t*.
Weighted trades	Number of trades in company stock on *t* divided by the number of trades in the Bovespa index on *t*.

Chart 1: definition of variables and measures.
Source: the authors

For all variables, the natural logarithms were calculated (*LN* symbol) and for the liquidity variables, the variations were also calculated (symbol *d*). For example, the variation of volume is the natural logarithm of financial volume traded on *t* minus the natural logarithm of financial volume traded on *t-1* (symbol *d ln Vol*).

It was decided to use the technique of data analysis in panel that according to Biagni (2003, p. 75) "it is one of the most usual methods in academia to analyze the effects that some variables exert, or appear to exert on others". Marques (2000) completes, explaining that one of the advantages of estimation with panel data is the treatment of heterogeneous data. Thus, the panel data suggest the existence of distinguishing characteristics in individuals, where these characteristics may or may not be constant over time, so that temporal or cross-sectional studies that do not take into account this heterogeneity will almost always produce heavily biased results.

According to Gujarati (2006) panel data, also known as combined data, mix time series and cross-sections into a single study, i.e. the same unit cross section is followed over time. For the author the main advantage of this technique is to obtain more informative data, with more variability, less co-linearity, more degrees of freedom and more efficiency

For Marques (2000) the reduction of data co-linearity is obtained in function of their variability, because the diversification of the data helps to reduce the possible co-linearity between variables, particularly in models with distributed lags. Thus, the use of panel data adjusts the diversity of individual behavior with the existence of dynamics of adjustment, even if potentially different, i.e. it allows to characterize the reactions of individuals to certain events, at different times.

There are basically three ways to simplify and adjust the general model in order to make it more functional: the Pooled Model, the Fixed-Effects Model, and the Random Effects Model. In the first model the intercept is the same for the whole sample, i.e., it is assumed that all elements of the sample have identical behavior. The Pooled Model does not consider the effect of time or the individual effect of each company (BALTAGI, 2001 *apud* DAHER, 2004).

The fixed effects model is based on the premise that the regression coefficients may vary from individual to individual or over time, even though they remain as fixed variables, i.e., not random (MARQUES, 2000). This type of model can additionally be dynamic when a lagged variable is included in the model, and static, otherwise (BALTAGI, 2001 apud DAHER, 2004).

Lastly, there is still the random effects model that follows the premise that the influence of individual behavior or the effect of time cannot be known. Thus, it is assumed that the existence of the error is not correlated with the regressors. Marques (2000) argues that the presupposition ingrained in the model is that the behavior of individuals and of time cannot be observed or measured, and in large samples such lack of knowledge can be represented by a normal random variable, i.e. the error.

In constructing the model, first it is necessary to verify that if the variables have significant linear associations. If this occurs, one might have to face the problem of multi-co-linearity that will be checked by calculating the Variance Inflating Factors (VIF), given by $VIF(j) = 1/(1 - R(j)^2)$, where $R(j)$ é o is the coefficient of multiple correlation between the variable *j* e as and the other independent variables. If the model is free of multi-co-linearity, the choice between models can be realized by the specific tests.

4. ANALYSIS OF RESULTS

Due to seasonal and cross-section variations in their levels of liquidity, emerging markets are ideal for studying the impact of liquidity on asset returns (BEKAERT, HARLEY, LUNBLAD, 2006). However, in these markets often the lack of liquidity for some shares requires the definition of a procedure to handle periods in which the share was not traded. Lesmond, Ogden and Trzcinka (1999) argue that if the value of information is insufficient to offset the costs associated with the transaction, market participants will prefer not to negotiate, resulting in an observed zero return. In this study it was decided to estimate the models considering two different samples.

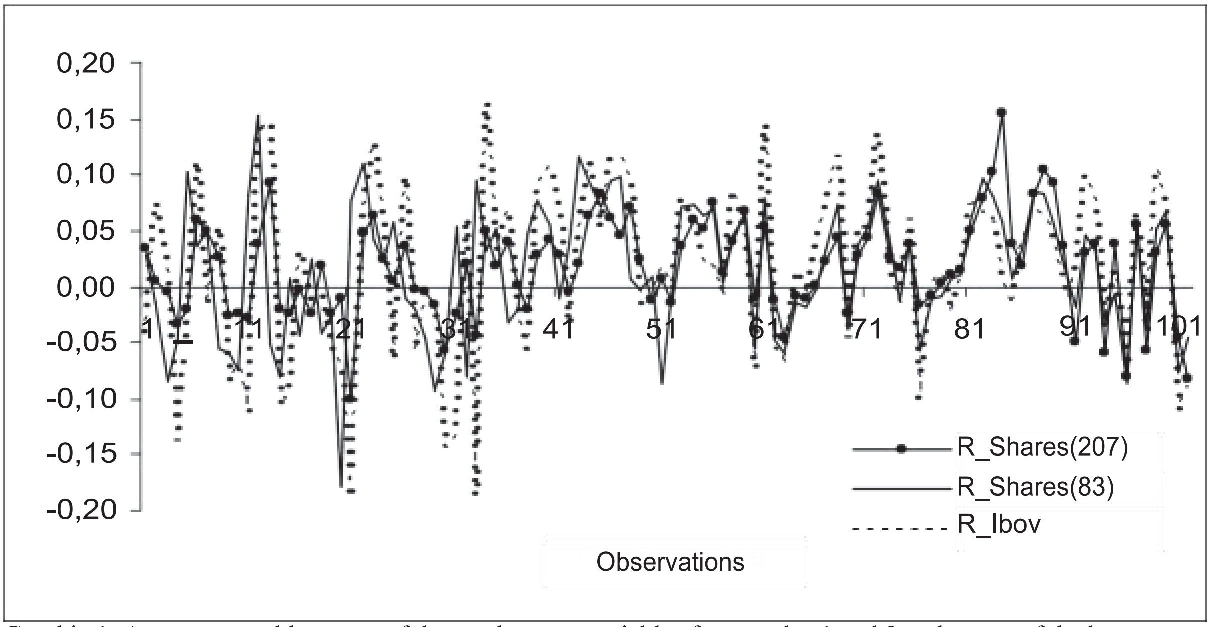
In the first one, it was established that the return and liquidity variables would be equal to zero in the month in which the share was not traded. Using this procedure we obtained a sample of 207 stocks with a series of 101 months (January 2000 to June 2008) for a total of 20,907 observations (called sample 1). In the second one, we chose to keep in the sample only those shares which had data for the entire period. In this case, we obtained a sample of 83 stocks with a series of 101 months (January 2000 to June 2008) for a total of 8383 observations (called sample 2)

In estimating the models, besides all variables being analyzed in terms of variation, two lagged periods were included. The initial estimates of the three models (Pooled, Fixed Effects and Random-Effects) showed no significant differences. Therefore, in order to standardize the interpretation of results, we chose to include all estimates of the pooled regression model this work.

Later, to validate the results, the data were divided randomly into two sub-samples and the models were re-estimated models for comparison of the coefficients obtained.

4.1 DESCRIPTIVE STATISTICS

The monthly averages for the two samples were calculated to visualize the behavior of variables over the period. Graphics 1, 2 and 3 describe the average behavior of the variables.

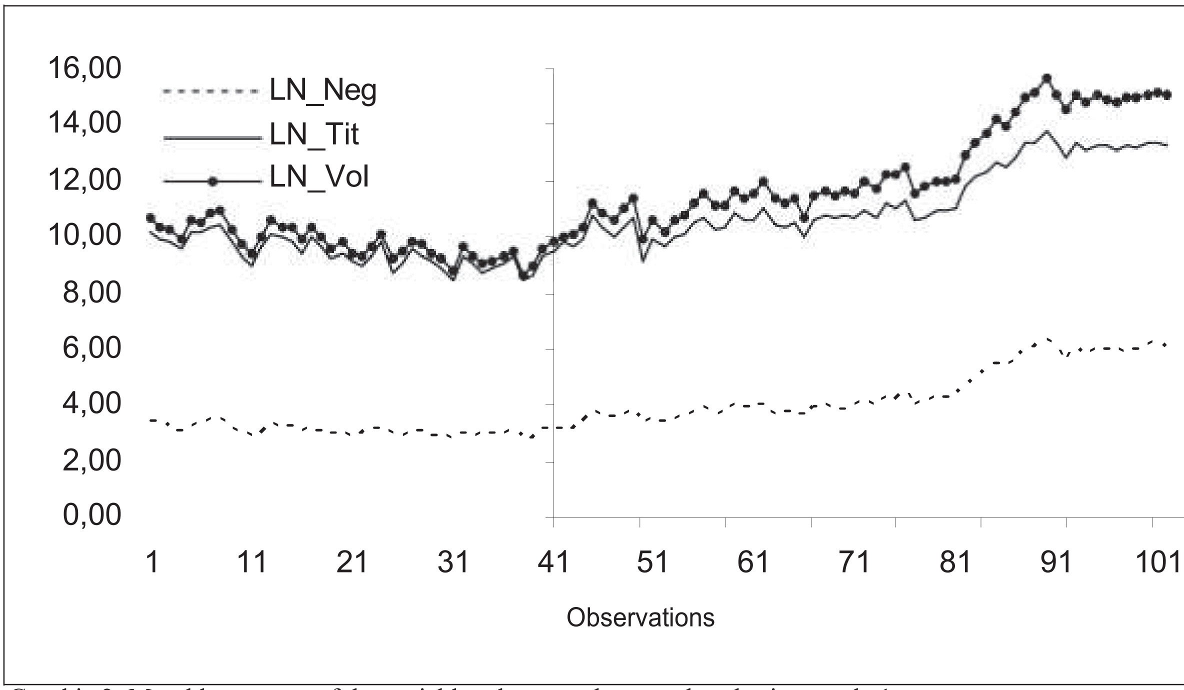


Graphic 1: Average monthly return of the stock return variables for samples 1 and 2 and return of the bovespa index.
Source: the authors

This graphic shows the average daily returns of all shares (R_Shares) belonging to the samples 1 and 2 and the monthly return of the Bovespa Index (R_Ibov). Sample 1 is composed of 207 stocks with returns equal to zero for the month in which the share was not traded. Sample 2 is composed of 83 shares that had returns for all months studied. The series is made up of 103 months (January 2000 to June 2008).

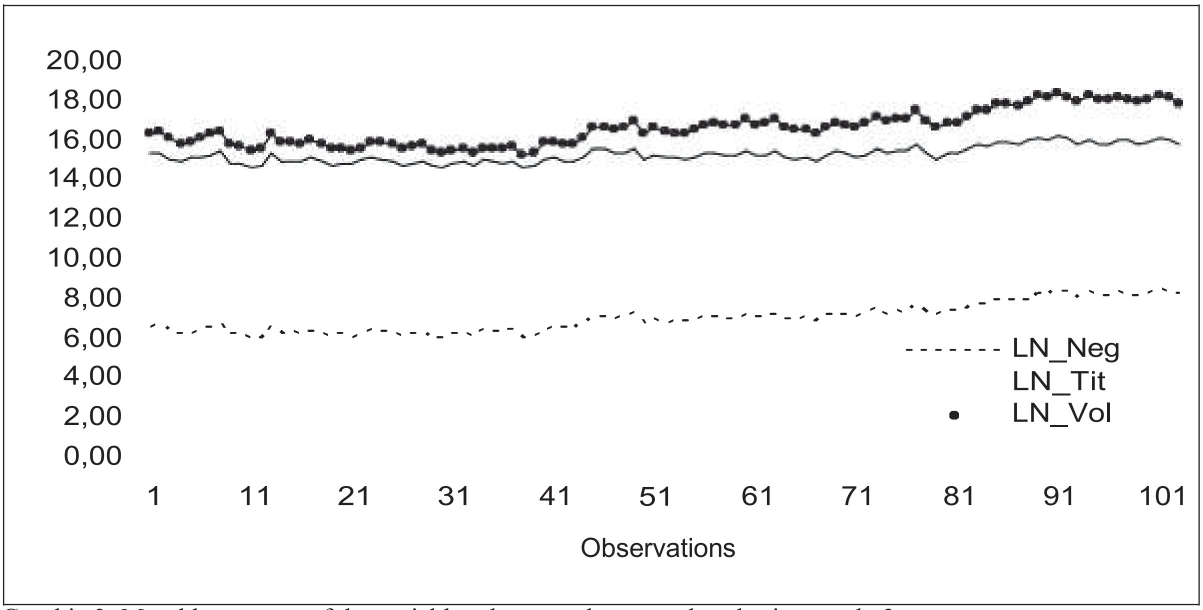
The three series exhibit very similar behaviors over the study period. As the criterion of formation of the Bovespa index is of companies with higher rates of negotiability, it is natural, especially in sample 2 (83 shares), comprising the most liquid companies, that the behavior of the average return is very close to the behavior of the index. It should also be noted that the series of returns of sample 1 shows a lower variability.

The behavior of average liquidity measures was divided into two graphs. The first one, Graphic 2, shows the behavior of the variables of sample 1 and the second one, Graphic 3, is the behavior of the variables of sample 2.



Graphic 2: Monthly average of the variables shares, volume and trades in sample 1
Source: the authors

This graph shows the monthly average of the shares (Tit = monthly quantity of shares traded), volume (Vol = monthly financial volume) and trades (Neg = number of trades in the month). All variables were calculated as LN (natural logarithm). Sample1 consists of 207 shares with variables equal to zero for the month in which the share was not traded. The series is made up of 103 months (January 2000 to June 2008).

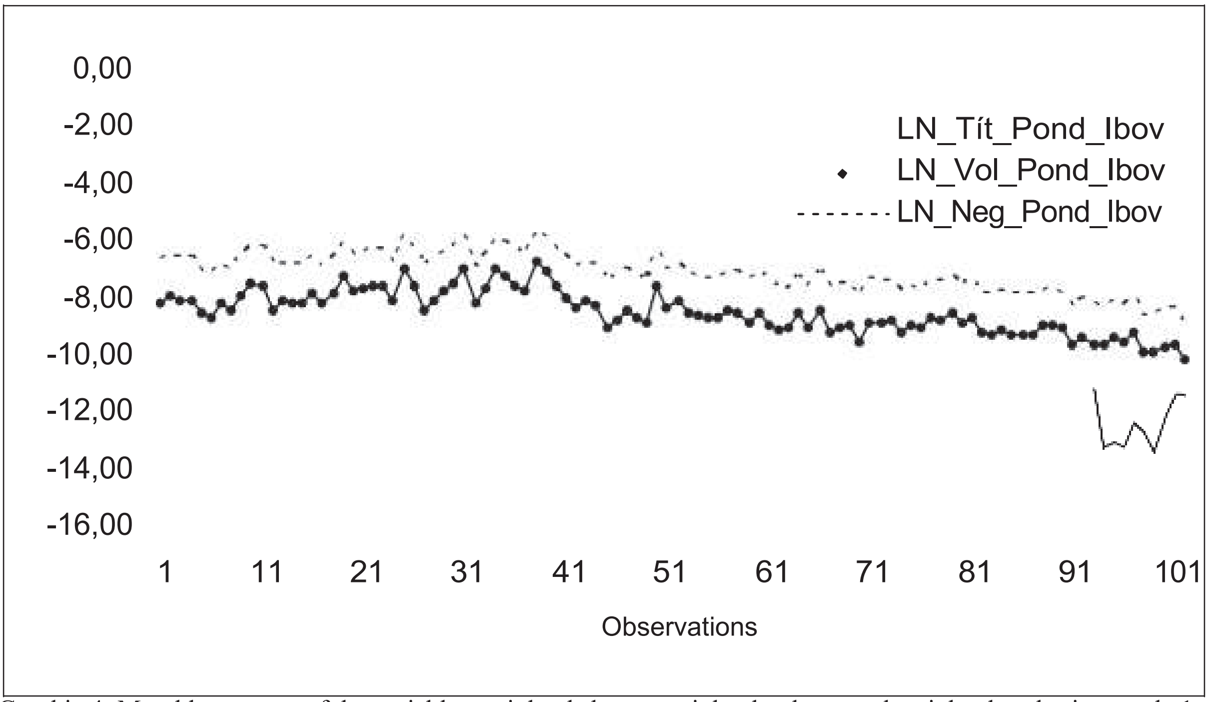


Graphic 3: Monthly average of the variables shares, volumes and trades in sample 2
Source: the authors

This graph shows the monthly average of the securities (Tit = monthly quantity of shares traded), volume (Vol = monthly financial volume) and trades (Neg = number of trades in the month). All variables were calculated as LN (natural logarithm). Sample 2 is composed of 83 shares that had returns for all months studied. The series is made up of 103 months (January 2000 to June 2008).

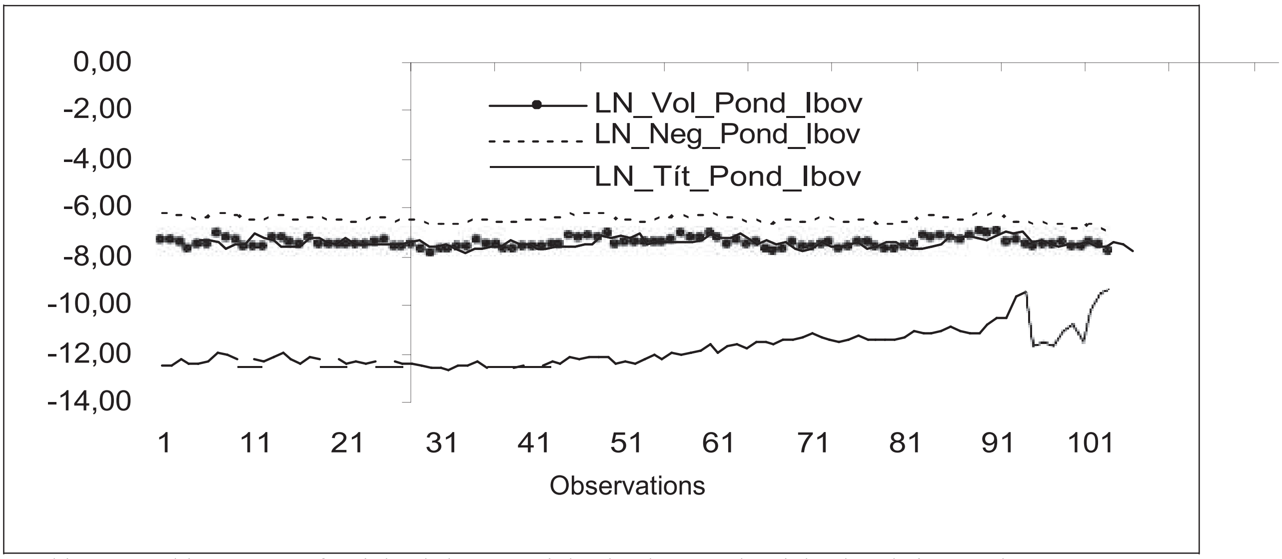
Both graphs show that the behavior of variables is very similar over time, which would be expected since all represent measures of liquidity. However, it is noteworthy that the two graphs show two differences. The first refers to the fact that for sample 1, one can see a growth trend, whereas in the graph of sample 2, the trend is much smoother. From the standpoint of liquidity, this suggests that over the period, the less liquid sample had a higher increase of liquidity than the sample of more liquid companies. The second refers to the differences in levels of liquidity as the average behavior of the variables of sample 1 is lower than the behavior of sample 2. In the axis of the natural logarithms the series of sample 1 are approximately in the 10-16 range while in sample 2 they are in the 14-16 range, i.e., the level of liquidity of sample 1 is below the level of liquidity of sample 2

The average performance of the liquidity variables weighted by the Bovespa index is shown in Graphic 4 for sample 1 and in Graphic 5 for sample 2



Graphic 4: Monthly average of the variables weighted shares, weighted voluem and weighted trades in sample 1
Source: the authors

This graphic shows the monthly average of weighted shares (Tit-Pond-IBOV = monthly number of shares traded divided by the number of securities of the Bovespa index), the weighted volume (Vol-Pond- IBOV = monthly trading volume divided by trading volume for the Bovespa index) and the weighted trades (Neg-Pond- IBOV = number of trades in the month divided by the number of trades of the Bovespa index). All variables were calculated as LN (natural logarithm). Sample 1 consists of 207 shares with variables equal to zero for the month in which the share was not traded. The series is made up of 103 months (January 2000 to June 2008).



Graphic 5: monthly average of weighted shares, weighted volume and weighted trade in sample 2
Source: the authors

This Graphic shows the monthly average of weighted shares (Tit-Pond-IBOV = monthly number of shares traded divided by the number of securities of the Bovespa index), the weighted volume (Vol-Pond-IBOV = monthly trading volume divided by the trading volume of the index Bovespa) and weighted trades (Neg-Pond-IBOV = number of trades in the month divided by the number of trades of the Bovespa index). All variables were calculated as LN (natural logarithm). Sample 2 is composed of 83 shares that had returns for all months studied. The series is made up of 103 months (January 2000 to June 2008).

The time series of Graphics 4 and 5 are located on the negative axis since the companies' liquidity levels are below the market liquidity levels of. It is observed that sample 1 shows a small drop at the end of the period while the second sample remained relatively more stable, except for the weighted volume at end of the period. This behavior suggests that relative to the market, represented by the Ibovespa, sample 1 showed greater gains in liquidity in the period.

For an overview of the descriptive statistics of the variables, the average and standard deviation of the series of monthly average values of each variable was calculated (Table 1)

Table 1: Average and standard deviation of the variables return, trades, shares, volume, weighted volume, weighted trades and weighted shares for samples 1 and 2

Variables	Sample 1 (207 Shares)		Sample 2 (83 Shares)	
	Average	Standard Deviation		Standard Deviation
Return	0.017	0.044	0.015	0.060
LN_Neg	3.943	1.049	6.819	0.728
LN_Tit	10.594	1.416	15.138	0.410
LN_Vol	11.388	1.903	16.437	0.876
LN_Vol_Pond_Ibov	-11.894	0.696	-7.427	0.193
LN_Neg_Pond_Ibov	-8.616	0.745	-6.499	0.156
LN_Tít_Pond_Ibov	-7.243	0.704	-11.800	0.724

Fonte: elaborada pelos autores

In terms of return, sample 1 had a higher average and lower deviation than sample 2. For liquidity variables, the means of sample 1 are lower than those in sample 2, except for weighted shares. It is worth noting that the fact of the variables having negative means is considered natural, because the share's level of liquidity tends to be lower than the market's level liquidity.

Overall, the descriptive statistics and the graphic analysis confirms that sample 1, which covers all 207 companies is less liquid and had a higher tendency to gain liquidity over the period studied. Although the behavior of the return of the two samples is very similar, the group with lower liquidity presented the higher returns which is consistent with the assumption that less liquid companies achieve greater returns

4.2 ESTIMATION OF MODELS

In the first estimation attempt, all the estimated models presented problems of autocorrelation and heteroskedasticity in the errors. To resolve such problems, lagged returns at t -1 and t -2 were inserted in the models as independent variables, and this robust estimate was used in face of problems of autocorrelation and heteroskedasticity in errors (*Heteroskedasticity and Autocorrelation Consistent* –HAC).

Table 2 shows the summary of the model that demonstrated to be the most adequate to explain the dependent variable, according to the Bayesian Information Criteria of Schwarz (BIC), the Hannan-Quinn Criterion (HQC) and the Ataike Information Criteria (AIC), which considers best the model that sows the lowest value. In the second column are the least squares estimates of the sample (Pooled OLS) and in the remaining columns are the values corresponding to standard error, *t* test, p-value and Variance Inflating Factor (VIF).

Table 2: Coefficient, standard error, *t* test, p-value and variance inflating factors of the pooled regression model with robust standard errors (HAC) for sample 1

	Coefficient	Standard Error	t-test	p-value	VIF
Constant	0.009	0.001	8.520	0.000	
Ibov Return	0.396	0.024	16.440	0.000	1.009
Ibov t-1Return	0.114	0.016	7.054	0.000	1.056
d LN Neg	0.044	0.004	10.940	0.000	1.192
d LN Neg t-1	0.018	0.002	9.778	0.000	1.245
d LN Vol Pond	0.003	0.000	11.770	0.000	1.307
Share Return t-1	-0.059	0.018	-3.354	0.001	1.103
Share Return t-2	0.032	0.009	3.558	0.000	1.011
R-square	0,107	Durbin-Watson	2,003		

Source: Authors

This table shows the estimated coefficients, standard error, the values of the *t* test, of the p-value and of the variance inflating factors (VIF), for the pooled regression, with robust standard errors (HAC) of the model

$$Y_{i,t} = \beta_1 + \beta_2 Ibov_t + \beta_3 Ibov_{t-1} + \beta_4 Neg_{i,t} + \beta_5 Neg_{i,t-1} + \beta_6 VolPond_{i,t} + \beta_7 Y_{i,t-1} + \beta_8 Y_{i,t-2} + \varepsilon_{i,t} \quad (2)$$

where *Ibov*, is the return of the Bovespa index, *Neg* is the variation of the company's number of trades, *Volpond* is the variation of the company's financial volume weighted by financial volume of the Bovespa index, *Y* is the share's return and ε is the error term. The symbol *d* denotes variation and LN is the natural logarithm. Sample 1 is composed of 207 shares with a time series of 101 months totaling 20,907 observations. The table's lower part shows the coefficient of determination and the value of the Durbin-Watson test.

The Pooled Regression model showed seven significant variables. The return of the Bovespa index was the variable with the highest representativeness (0.396) followed by the return of the Bovespa index lagged by one period (0.114). The coefficients for the other liquidity variables, even if significant, are very low denoting their low representativeness in setting the return.

The last column of Table 2 shows the VIF results. This indicator shows values of at least 1.0 and in case of values higher than 10.0 may indicate a linearity problem. In case all VIF values being lower than 10.0 one must analyze the average value which should not very far from 1.

All the VIF values are lower than 10.0 and its average value is 1.13; therefore the model is free of interferences from multi-co-linearity. The value of the Durbin-Watson test (2.00) indicates the absence of autocorrelation of errors, confirming that the insertion of the lagged return variables proved adequate.

To assess the joint significance of the liquidity variables to explain the return, the model was re-estimated having as independent variables on the Ibovespa return, the lagged Ibovespa return and the lagged variable itself (reduced model). The F test over the coefficient of determination of the estimated model over the reduced model gave the result F=316.283 (p-value 0.000) indicating an information gain with the inclusion of the liquidity variables.

Due to the possibility of the treatment given to the periods without trades affecting the results, all models were re-estimated utilizing only the shares that showed data in all periods studied, i.e., sample 2. Table 3 shows the results.

Table 3: Coefficient, standeard error, *t* test, p-value and variance inflating factor of the pooled regression model with robust standard errors (HAC) for sample 2

	Coefficient	Standard error	t-test	p-value	VIF
Constant	0.006	0.002	3.286	0.001	
Ibov Return	0.664	0.037	17.920	0.000	1.024
Ibov t-1Return	0.132	0.031	4.202	0.000	1.194
d LN Vol Pond	0.033	0.007	4.826	0.000	2.137
d LN Vol t-1	0.021	0.004	4.699	0.000	1.246
d LN Neg	0.021	0.007	3.114	0.002	1.966
Share Return t-1	-0.076	0.036	-2.121	0.034	1.264
Share Return t-2	0.031	0.015	2.017	0.044	1.004
R-square		0.224	Durbin-Watson	2.010	

Source: Authors

This table shows the estimated coefficients, the standard errors, the value os the *t* test, the p-values and the variance inflating factors (VIF) for the pooled regression with robust standard errors (HAC) of the model

$$Y_{i,t} = \beta_1 + \beta_2 Ibov_t + \beta_3 Ibov_{t-1} + \beta_4 VolPond_{i,t} + \beta_5 Vol_{i,t-1} + \beta_6 Neg_{i,t} + \beta_7 Y_{i,t-1} + \beta_8 Y_{i,t-2} + \varepsilon_{i,t} \quad (3)$$

where *Ibov*, is the return of the Bovespa index, *Neg* is the variation of the company's number of trades, *Volpond* is the variation of the company's financial volume weighted by financial volume of the Bovespa index, *Vol* is the company's financial volume, *Y* is the share's return and ε is the error term. The symbol *d* denotes variation and LN is the natural logarithm. Sample 2 is composed of 83 shares with a time series of 101 months making up a total of 8,383 observations. The table's lower part shows the coefficient of determination and the value of the Durbin-Watson test.

For this model (Table 3) all the liquidity variables showed positive coefficients. The beta of the Bovespa index return changed form 0.396 (Table 2) to 0.664 (Table 3), indicating that the sensitivity of more liquid companies to the stock market is higher. It is also observed that, in comparison to the model generated with all companies, the liquidity variable volume *t-1* and the weighted volume showed higher coefficients than the ones in the previous model. At the same time the number of trades has a lower coefficient than the one in Table 2.

The F-test on the coefficient of determination of the estimated model against the reduced model provided the result of F=140.07 (p -value 0.000) indicating again that increased liquidity of the variables contributes to the improvement of the model.

It should also be noted that the coefficient of determination that in sample 1 was 10.7 %, changed in sample 2 to 22.4 %, indicating that the degree of explanation of the model improves considerably when companies with greater liquidity are evaluated. The results of the two samples show that the variations in liquidity are priced. As argued by Chordia, Subrahmanyam and Anshuman (2001) risk-averse investors would require higher returns for stocks with high variability in liquidity. The differences in the values of the estimated coefficients for the two samples also show that the most liquid companies (sample 2) are more sensitive to changes in volume and less sensitive to changes in trades than the full sample (sample 1).

4.3 VALIDATION OF THE MODELS

To ensure that the estimated models represent the sample group a validation test was undertaken (Tables 4 and 5). The procedure consisted in dividing each sample into two random subsamples. Thus, the initial model (sample 1) yielded two samples comprising 103 shares each (sub-sample 1.1 and subsample 1.2 in Table 4), with 101 periods each, for a total of 10,403 observations. Next, the coefficients were obtained for them. It is expected that if the model is valid, the coefficients of both are similar to the sample as a whole.

Table 4: Coefficient, p-value and variance inflating factors of the pooled regression model with robust standard errors (HAC) for sub-samples 1.1 and 1.2

	Sub-sample1.1			Sub-sample 1.2		
	Coefficient	**p-value**	**VIF**	**Coefficient**	**p-value**	**VIF**
Constant	0.011	0.000		0.007	0.000	
Ibov Return	0.366	0.000	1.008	0.433	0.000	1.010
Ibov t-1Return	0.118	0.000	1.047	0.107	0.000	1.067
d LN Neg	0.051	0.000	1.207	0.038	0.000	1.182
d LN Neg t-1	0.019	0.000	1.274	0.017	0.000	1.221
d LN Vol Pond	0.003	0.000	1.314	0.003	0.000	1.306
t-1Share Return	-0.062	0.013	1.108	-0.056	0.026	1.102
t-2 Share Return	0.025	0.041	1.014	0.043	0.001	1.008

Source: Authors

This table shows the estimated coefficients, the p-values, the variance inflating factors (VIF) for the pooled regression with robust standard errors (HAC) of the model.

$$Y_{i,t} = \beta_1 + \beta_2 Ibov_t + \beta_3 Ibov_{t-1} + \beta_4 Neg_{i,t} + \beta_5 Neg_{i,t-1} + \beta_6 VolPond_{i,t} + \beta_7 Y_{i,t-1} + \beta_8 Y_{i,t-2} + \varepsilon_{i,t} \quad (4)$$

where *Ibov*, is the return of the Bovespa index, *Neg* is the variation of the company's number of trades, *Volpond* is the variation of the company's financial volume weighted by financial volume of the Bovespa index, *Y* is the share's return and ε is the error term. The symbol *d* denotes variation and LN is the natural logarithm. Samples 1.1 and 1.2 are comprised of 103 shares each, selected at random and without replacement, with a series of 101 months for a total of 10,403 observations in each sample.

In general, the two sub-samples showed similar results to the sample with all shares (sample 1). The Bovespa index variables return in time *t* and return in time *t-1* continued to present the highest coefficients. The signs of the liquidity variables remained the same and their difference in the two sub-samples is small, suggesting that the results are valid.

Similarly, the second sample was divided randomly into two, each with 41 shares (sub-sample 2.1 and sub-sample 2.2 in Table 5). The results are presented in Table 5.

Table 5: Coefficient, p-value and variance inflating factors of the pooled regression model with robust standard errors (HAC) for sub-samples 2.1 and 2.2

	Sub-sample 2.1			Sub-sample 2.2		
	Coefficient	**p-value**	**VIF**	**Coefficient**	**p-value**	**VIF**
Constant	0.007	0.000		0.004	0.179	
Ibov Return	0.647	0.000	1.024	0.689	0.000	1.022
Ibov t-1Return	0.055	0.050	1.009	0.184	0.000	1.171
d LN Vol Pond	0.027	0.000	2.055	0.036	0.002	2.151
d LN Vol t-1	0.018	0.000	1.179	0.022	0.004	1.242
d LN Neg	0.026	0.008	1.892	0.020	0.031	1.977
t-1Share Return	-	-	-	-0.107	0.044	1.239
t-2 Share Return	0.042	0.030	1.003	-	-	-

Source: Authors

This table shows the estimated coefficients, the p-values, the variance inflating factors (VIF) for the pooled regression with robust standard errors (HAC) of the model.

$$Y_{i,t} = \beta_1 + \beta_2 Ibov_t + \beta_3 Ibov_{t-1} + \beta_4 VolPond_{i,t} + \beta_5 Vol_{i,t-1} + \beta_6 Neg_{i,t} + \beta_7 Y_{i,t-1} + \beta_8 Y_{i,t-2} + \varepsilon_{i,t} \quad (5)$$

where *Ibov*, is the return of the Bovespa index, *Neg* is the variation of the company's number of trades, *Volpond* is the variation of the company's financial volume weighted by financial volume of the Bovespa index, *Y* is the share's return and ε is the error term. The symbol *d* denotes variation and LN is the natural logarithm. Samples 2.1 and 2.2 are comprised of 41 shares each, selected at random and without replacement, with a series of 101 months for a total of 4,141 observations in each sample.

For the two sub-samples (Table 5) the results are similar to those obtained for the full sample. Except for the constant which was not significant in sub-sample 2.2 and for the share return, where only one lag was significant in each sub-sample. Again the coefficients of the explanatory variables assumed the same sign estimated for sample 2, indicating a consistent behavior and thus suggesting the validity of the estimated model.

5. FINAL CONSIDERATIONS

This study evaluates the influence of liquidity for the return of shares traded in the São Paulo Stock Exchange. Using the methodology of panel data and a sample for the period of January 2000 to June 2008 it can be seen that the monthly return of stocks is directly influenced by the return of the Bovespa index. The coefficient obtained is the largest, confirming the central assumption of the CAPM asset pricing model, as it indicates that the market return influences the return of the share. This coefficient increases from 0.396 to 0.664 when the sample includes only the most liquid companies. This increase can be explained by the fact that liquidity is the central criterion for selection of companies that will be part of the Bovespa index.

With respect to liquidity variables, in both samples the coefficients assumed positive values. Positive coefficients are the result of the characteristics of companies that have high degrees of liquidity. In general companies with lower levels of liquidity have the highest positive changes of their own liquidity and thus have higher returns. On the other hand, companies that have high liquidity levels tend to have smaller positive variations and large negative variations in liquidity followed by a decrease in return levels. The representativeness of liquidity in the formation of return is much lower than in the Bovespa index, since the sum of all coefficients of the liquidity variables is lower than the coefficient of return of the Bovespa index.

Even though the models with liquidity variables show higher coefficients of determination than the reduced models, the low degree of explanation of the estimated models shows that there are other relevant variables for the explanation of return which were not included. In this sense, one way would be the inclusion of finer measures of individual liquidity, for example, spread, and the inclusion of measures of market liquidity, such as the ones developed by Amihud (2002). The incorporation of control variables like book-to-market and size could also contribute to improve the model, if they don't create problems of multi-co-linearity. Thus superior moments (co-skewness and co- kurtosis) could be included in an attempt to build more robust models.

The difference in results for the two samples showed that in studies of liquidity the decision on the treatment of data is crucial. If, on the one hand the definition of the sample including only companies that have data over the study period avoids the problem of missing data, it can create a significant bias in that it ends up analyzing only the most liquid companies on the market; on the other hand, the inclusion of less liquid variables requires the definition of method to treat the data. In spite of the theoretical arguments in favor of the insertion of zero values, in very illiquid markets, there may be a sub-evaluation of the statistics. Thus, new studies discussing the best methodology to solve this conflict would be a great contribution to the analysis of liquidity.

The liquidity theme in the Brazilian market is still little explored. The evaluation of liquidity starting from new variables, the test of other theoretic models and the study of the determinants of liquidity are some of the paths that can be followed. They will all lead to a greater knowledge of the theme and may in the future lead to the adoption of policies contributing to increase share liquidity, a most important factor to attract investors and reduce the cost of capital for the companies participating in the market.

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