AN ANALISYS OF THE BETA COEFFICIENT'S STATIONARITY REGARDING BRAZILIAN PUBLIC COMPANIES TRADED BETWEEN 2002 AND 2011

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ABSTRACT
In this paper we examine the reliability of historical data as basis for the estimation of stocks' and portfolios' future risk, through the analysis of the assets' beta coefficient's stationarity. We estimated betas from logarithmic returns on stocks publicly traded between 2002 and 2011 on the Brazilian stock exchange (BM&FBOVESPA), and on logarithmic returns on Ibovespa and IBRx portfolios under the CAPM model. We performed correlation studies between 52-week betas and the following 52 weeks betas, finding little no evidence of strong correlation, either for individual stocks and industry portfolios. Companies that were traded since 2002, however, converged to a higher degree of beta stability from 2008 to 2011, benefiting from the stabilization of the local economy. We conclude that the usage of betas estimated from past market data must be approached with caution when estimating the cost of equity of securities publicly traded on the Brazilian market.

Keywords: Betas; CAPM; Stationarity; Brazilian Market.

Área Temática: Mercados Financeiros, de Crédito e de Capitais

1 INTRODUCTION

The stationarity of stocks' beta coefficients, one of the main components of the Capital Asset Pricing Model (CAPM) as theorized by Sharpe (1964) and Lintner (1965), is of pivotal relevance for the valuation of companies, business enterprises, and public traded assets. If assets' beta coefficients tend to behave in a stationary manner, historic coefficients, measured based on the stocks past correlation with the Market portfolio, could be deemed as reliable

estimators of future beta coefficients.

Levy (1971) stated that perfect assessments of future risk for individual securities could be obtained if betas were constant over time, but since betas are supposed to present some instability, the question to be answered is the actual degree of stationarity presented by this statistic. If betas behave in an almost stationary way, we could consider them to be static, improving, thus, the reliability of the practical applications derived from the CAPM, which is a model of expectations, dependent on ex ante parameters.

In order to investigate the reliability of past beta coefficients as fair estimators of future betas, we intended to verify the stationarity of betas regarding companies that have been publicly traded on Brazil's main Stock Exchange (BM&FBOVESPA) from 2002 to 2011. Our verification was conducted through a large set of correlation studies, considering past and future betas of individual stocks, from a relative standpoint, since we established period (*t)* as basis for historic betas and period (*t + 1*) as basis for future betas.

Furthermore, considering the assumptions that (a) companies pertaining to a specific industry are exposed to similar market risks, and (b) all of the other relevant risks are diversified by the marginal investor, the present study offers a new approach regarding the measurement of beta's stationarity, through the determination of industry betas, and the consequent analysis of the correlation between past and future industry betas. If these betas present a somehow more stable behavior, with a correlation to the market beta that is consistently stationary, these betas could be considered for further studies considering the possibility of its usage as better estimators of securities' future betas.

Tests previously reported in the relevant literature are focused either on the stationarity of betas of single stocks or of portfolios built through ranked selection (e.g. deciles of betas sorted by size) or random selection. It is our understanding that this kind of portfolio tests over rely on the method of selection of stocks, and its results are consequently dependent more on the chosen method than on the general stationarity of betas that the practitioners of CAPM would expect to exist in order for the model to be useful, coping with real life behavior of stocks. If one concludes that randomly chosen portfolio betas are stable, how useful could that information be for the estimation of CAPM inputs?

To achieve our objective, we have conducted several studies of serial correlation, following the method presented by Levy (1971). In these studies, we have measured the correlation coefficient between stocks' or portfolios' historical betas (regressing stock and Market returns of period t-1) and their future betas (period t), for 52-week period. In our method, however, we introduced is the usage of logarithmic returns.

The results we report hereon are not favorable to the hypothesis of strong stationarity of the betas or total-betas, considering either individual companies or sector-built portfolios, whether we use Ibovespa or IBrX theoretical portfolios as a proxy for the market true portfolio.

The remainder of this paper is structured as follows: section two presents a review of the relevant literature on the stationarity of beta coefficients; section three describes thoroughly the dataset and the methodology applied in our tests; in section four, we present the results and discuss their implications; finally section five presents our conclusions.

2 RELEVANT LITERATURE REVIEW

The Capital Asset Pricing Model, attributed to Sharpe (1964) and Lintner (1965), allows the pricing of assets as a function of the return required by investors, being premised on the fundamental relationship between systematic risk and asset returns. This model is widespread both in academia and in the professional practice of managers, investors, appraisers and other economic agents.

The relationship between the asset' systematic risk and its expected return enables the

determination of a rate of return that can be taken as benchmark for the assessment of investments, acting as a mechanism for price adjustment on expected cash flows. Theoretically, the more widespread the use of the model by the market players, the greater its explanatory power regarding the adjustment of asset prices as a function of their returns and perceived risk by these agents.

For any investor operating under the CAPM, the relevant risk of any asset is the risk added by this asset to the investor's portfolio, being this risk measured in terms of a beta coefficient, obtained through the regression of stock returns in relation to a market portfolio's returns. (Damodaran, 2004).

In order to estimate the yield that will be required by a diversified marginal investor on a given security, its beta coefficient is multiplied by the overall market premium, being the result added to the expected return of a theoretical risk free asset, which is the required return on an investment with a fixed return (therefore riskless).

According to Sharpe (1964), the derivation of the equilibrium conditions of the capital markets depends on the assumption of a general pure interest rate, with which all investors able to borrow or lend on equal terms and on the hypothesis of homogeneity of investor expectations, under which it is assumed that investors agree on the prospects of various investments - their expected values, standard deviations and correlation coefficients.

Under the mechanism proposed by Sharpe, rational investors will only be interested in buying assets that are efficient in terms of risk and return, reducing the demand for securities offering worse conditions. This move will reduce the price of riskier assets, making their expected return (as a function of price) to increase, which will lead these securities to the condition of efficiency. The continuous movements of investors, adjusting asset prices to perceived risk, will dynamically lead this asset prices to an equilibrium state.

Sharpe (1964) emphasizes that there may be various combinations of assets that are mean-variance efficient. Hence, his theory does not imply that all investors would allocate their financial resources in the same portfolio.

Considering Sharpe's theory (1964), prices will adjust until there is a linear relationship to the magnitude of the asset's responsiveness to economic activities, being that risk undiversifiable, and measured through the regression of the asset's and the efficient Market portfolio's returns.

As later stated by Sharpe (2007), while explaining the Market Risk/Reward Theorem, the market risk that is relevant for asset pricing in equilibrium conditions is defined as an investment's Market beta, following that:

$$E(R_i) = r + \beta_i^{f(R_m)}(E(R_M) - r)$$

where:
$E(R_i)$: Expected return on asset i
r: Risk-free rate
$E(R_M)$: Expected return of Market portfolio
β: Beta of asset i

As one can infer from the equation above, the CAPM is a model of expectations. Therefore, its inputs must be of ex ante parameters, denoting the expectations of rational diversified marginal investors. The question about the level of stationarity of betas is highly relevant for the practical applications of this model, since stable betas are supposed to provide a greater reliability on the estimation of future betas, since all one should do is to look into past data.

Blume (1971) investigated the stability of beta coefficients in the U.S. stock market,

based on monthly returns of stocks in the period from June 1926 to June 1968, concluding through studies of serial correlation that during that period the betas of portfolios showed a higher temporal stability compared with betas of individual stocks, responding positively to the enlargement of the portfolios.

Levy (1971) extended the investigations in the U.S. market, using a sample of 500 stocks' weekly returns, recorded in the period between December 30 1960 and December 18, 1970. The author noted that both the serial correlation and the correlation between the relative positions occupied by the stocks on theoretical portfolios (depending on the value of the beta coefficient) increased significantly with an increase on the number of stocks in those theoretical portfolios, concluding similarly to Blume, that the betas of individual stocks do not exhibit significant stationarity.

Since the works of Levy and Blume, instability and randomness of the beta coefficients through time were identified with varying intensities both in developed (Fabozzi and Francis, 1978; Sunder, 1980; Alexander and Benson, 1982; Simmons et al., 1986; Collins et al., 1987) and emerging economies (Brooks et al., 1998; Onour, 2010).

Oran and Soytas (2009) examined the characteristics and stability of individual stock and portfolio betas of stocks listed in the Istanbul Stock Exchange, finding evidence supporting significant relationships between market returns and both individual stock and portfolio returns. The evidence found by the authors, however, did not seem to support that those relationships were stable or that portfolio betas were more stable than individual betas.

Rodrigues and Ramos Filho (2005) estimated and analyzed the systematic risk (beta) of the CAPM (Capital Asset Pricing Model) as proposed by Sharpe (1964) from five Brazilian companies representative of various sectors of the national economy (petrochemical, financial, telephone, steel and beverages), verifying the relationship between the estimated coefficient and the overall economic context and specific to each company. According to the authors' report, the sample period of the mentioned study was the years 2000 and 2004, which was characterized by significant political and economic instabilities (Argentine crisis, terrorist attacks on the U.S., recession of the world economy, presidential elections in Brazil). In that study, Rodrigues and Ramos Filho compared the real return of stocks with Ibovespa performance, which was used as a proxy of the market portfolio in Brazil, concluding that there is sufficient evidence to state that the beta remained relatively stable for this period and this sample, with only three exceptions (2000 to Ambev PN, PN 2002 for Itaubanco and 2003 for the Belgo Mineira PN), probably due to political and economic instability both on the Brazilian and the world market at the time.

Ventura Forte and Fama (2001) analyzed the behavior of the stocks of three companies of different industries, with a high track of negotiability at the Brazilian market in the period 1995-2000, in order to verify if the stocks behavior followed the CAPM model. Authors report that that period in Brazil was characterized by relative monetary stability after years of hyperinflation. That study compared the stock performance and the performance of a proxy (Ibovespa) for the market portfolio in Brazil, through application of the CAPM model to identify the level of systematic risk of each share (represented by its beta coefficient). The authors compared the results of the sub-periods (annually) with the result of the full period, finding evidence that the beta actually remained stable over the periods and sub-periods, with only three exceptions (1995 to Itaubanco PN, 1995 and 2000 for Petrobras PN), probably due to changes in risk categories of the companies analyzed

Finally, Lima and Minardi (2009) tested the stability of the beta coefficients of Brazilian securities from a perspective of structural breaks and regime switches, particularly when a possible structural break point is not pre-established for modeling purposes. Through the application of Andrews (1993) and Andrews and Ploberger (1994) tests, taking samples of weekly and monthly returns of 92 stocks traded on the São Paulo Stock Exchange - Bovespa, from January 1995 to December 2006, using the Ibovespa and MSCI Brazil as proxies of the

market portfolio. The test results were compared with the results obtained from the application of Chow's (1960) Test, a more traditional test, where it is necessary to specify an structural break point).

According to Lima and Minardi, the results of the two classes of tests were diametrically opposed. While Andrews (1993), and Andrews and Ploberger (1994) tests did not reject the hypothesis that the beta coefficients are reasonably stable, the Chow (1960) test showed great instability for the coefficients. Furthermore, Lima and Minardi reported that both Andrews and Andrews and Ploberger tests indicated that the beta's stationarity increased with the use of a combination of monthly returns and MSCI Brazil as a proxy for the market portfolio, while Chow test indicates that the stability of the beta coefficient increases with weekly returns and finds no significant difference on the choice of proxy for the market portfolio.

The diverging results reported by Minardi and Lima, depending on the class of tests performed, indicates that the instability or non-stationarity of the beta coefficients could be much smaller than indicated by empirical evidence found in the finance literature.

3 APPLIED METHODOLOGY

3.1 Dataset

The samples analyzed comprised two sets of stocks traded on BM&FBOVESPA. The first set included stocks traded uninterruptedly in a period of 10 years (between 2003 and 2012) and the second set included stocks traded uninterruptedly in a period of 5 years (2008 to 2012). Some companies have more than one type of stock (e.g. proffered stock and common stock). In the event that more than one stock of the same company was traded continuously over the sample periods, we chose to keep in the sample only the most liquid class of stock of each company.

Our data set was extracted from the Economatica system, designed for the analysis of equities and investment funds, consisting of a suite of advanced analytical modules, which operate on top of a comprehensive and reliable database. Given that Economatica is of wide use among analysts at investment banks, portfolio managers at hedge funds, mutual funds and pension funds, faculty and students at universities, investor's relations departments and individual investors, we believe that the selection of database mirrors the most likely source of data available to a diversified marginal.

The first sample of stocks, which have been traded continuously in the period from 2002 to 2011, was composed of 32 stocks (Industries). The second sample of stocks, traded continuously in the period from 2008 to 2011, consisted of 120 shares, including a large number of companies that conducted their IPOs between 2004 and 2007. The distribution of stocks among industries, in both samples, is presented in the following table:

Table I – Stocks by Industry that have been considered in each of the samples

	2002-2011	2008-2011
Agriculture and Fishing		2
Building		12
Chemistry	2	4
Electricity	6	12
Electronics		3
Finance and Insurance	3	11
Food and Beverage	1	11
Industrial Machinery		1
Mining	1	2
Non-Metallic Minerals		1
Oil and Gas	2	2
Pulp and Paper	1	2
Retail and Commerce	2	6
Software and Data		2
Steel & Metallurgical	5	10
Telecommunications	3	5
Textile		1
Transportation Services		6
Vehicles and parts	1	5
Other	5	22
Total	**32**	**120**

Considering that portfolios comprised by only one stock could not be effective in our investigation of beta stationarity of portfolios, we run our tests both including and excluding single-stock portfolios. Section 4 presents results including single stock's portfolios, and for comparison purposes, we present also present a comparison with results with the exclusion of single stock's portfolios, because our results are similar to those obtained considering the inclusion of single-stock portfolios in our correlation studies.

As proxies for the Market portfolio, we have chosen Ibovespa and IBrX in order to calculate the regressions necessary for the estimation of the stock's and portfolio's beta coefficients.

According to BM&FBOVESPA, the Ibovespa Index is defined as the current value of a theoretical stock portfolio constituted in 02/01/1968 (base value: 100 points), by a hypothetical investment. It is the most widely used and traditional index of the Brazilian stock market. This index's portfolio is constantly updated through a defined and publicly available methodology, based on data available to the general investor. Currently (as of January 10, 2013), 69 actively traded stocks are included in the Ibovespa Index' theoretical portfolio.

Ibovespa's portfolio is weighted by its stocks' negotiability index, being comprised of stocks that represent more than 80% of the number of trades registered on BM&FBOVESPA's cash Market. The companies that compose the Ibovespa are responsible, in average, for approximately 70% of the total BM&FBOVESPA's Market Capitalization.

BM&FBOVESPA defines The Brazil Index – IBrX as an index that measures the return on a theoretical portfolio composed by 100 stocks, selected among BM&FBOVESPA's most actively traded securities, weighted according to the outstanding shares' market value.

3.2 General Model

Based on the stocks' logarithmic returns and on the proxies selected for the market portfolio, we estimated the stocks and industries portfolios' beta coefficients for each 52-week period, through linear regression. For each period of 52 weeks we defined the observed beta as "historical beta" and the beta of the following 52 weeks as "future beta". As in Levy (1971), historical betas can be regarded as predictors of an asset's or portfolio's risk for the next period as well as future betas can be taken as the actual observed risk.

We subject these datasets of historical and future 52-week betas to subsequent serial correlation studies, in which we measured the correlation coefficient between all stocks' and portfolios historical (period t) and future betas (period t+1). Having Blume (1971) and Levy (1971) as reference, in order to minimize the effect of outliers in the datasets, we also performed rank order correlation studies. In this additional verification, we ranked each stock and portfolio in respect to its betas among the respective dataset, and subsequently verified the correlation coefficient between the stocks and portfolios historical and future betas' ranks.

This model of analysis is based on the assumption that the higher and more persistent the correlation between stocks or portfolios historical and future betas, the more reliable will be the usage of beta coefficients estimated from past data as predictors of future market risk. As stated by Levy, this method can be considered as an empirical test of stationarity.

3.3 Methodological Procedures

We obtained weekly price quotes for the companies included in the two samples, opting for each stock's average price of trading on the last day of the week in which trade occurred. Subsequently, we determined the logarithmic returns of each stock. Synchronously, we obtained Ibovepa and IBRx indexes' quotations for the same periods.

Next step involved the estimation of the stocks' beta coefficients for each 52-week period, through two sets of linear regressions, both having the stock's logarithmic returns as dependent variables. Regarding the independent variables, in the first set of regressions we considered Ibovespa Index' logarithmic returns, and in the second set we considered IBRx' index logarithmic returns as independent variable.

Then, we grouped the stocks of the two samples in portfolios organized by industries, according to the classification adopted by Economatica, forming 12 portfolios in the period from 2002 to 2011 and 20 portfolios in the period from 2008 to 2011. Following the procedure aforementioned, we estimated the portfolios' beta coefficients for each 52-week period, through two sets of linear regressions, both having the portfolios' logarithmic returns as dependent variables. Regarding the independent variables, in the first set of regressions we considered Ibovespa Index's logarithmic returns, and in the second set we considered IBRx's index logarithmic returns as independent variable. Portfolios were constructed considering one stock of each company per industry. For robustness, we also run our tests considering portfolios weighted by market value, finding similar results.

In summary, we report in next section the results of our empirical tests of stationarity in the Brazilian Market, based on historical and future betas' correlation, for individual stocks and industry portfolios. These results are reported considering two market indexes selected as possible proxies for the theoretical market portfolio in Brazil.

4 RESULTS

4.1 Stocks and portfolios' beta coefficients as a measure of risk

Tables II to V present, respectively, the result of serial correlation studies between historical and future betas for the sample of 10 years (2002 to 2011) and that of 4 years (2008 to 2011). The correlation coefficient was measured based on the relationship between two sets

of betas: (a) the historical betas, estimated in the 52 weeks ended on the dates presented in the table's first column, and (b) the future betas, estimated in the 52 weeks following the date shown in the table's first column. Intuitively, if the correlation coefficients are high and stable over time, we could argue that past betas are reliable estimators of expected (future) betas.

Table II - Beta Coefficients / 2002-2011 – Ibovespa – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas. The third column presents the correlation coefficient between industry portfolios' historical and future beta, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
10/01/03	-0,1589	0,1683	0,1446
09/01/04	-0,0399	0,4833	0,3763
07/01/05	0,4797	0,5245	0,4357
06/01/06	0,4782	0,4391	0,4662
05/01/07	0,6464	0,7968	0,7220
04/01/08	0,5146	0,4818	0,3877
02/01/09	0,7488	0,6828	0,6975
30/12/09	0,6927	0,7596	0,7047
30/12/10	0,7386	0,6877	0,6492
Quadratic average	**0,5532**	**0,5881**	**0,5422**
Standard Deviation	**0,3329**	**0,1964**	**0,1972**

Table III - Beta Coefficients / 2008-2011 – Ibovespa – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas. The third column presents the correlation coefficient between industry portfolios' historical and future beta, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
02/01/09	0,5651	0,5101	0,5701
30/12/09	0,3101	0,5131	0,5951
30/12/10	0,4867	0,5682	0,7154
Quadratic average	**0,4663**	**0,5311**	**0,6301**
Standard Deviation	**0,1306**	**0,0327**	**0,0777**

As shown in Table II, which reports results for the sample of ten years, there are relevant levels of volatility in the initial periods for both betas of individual firms and sectors, with a trend towards greater stability as we approach the end of the sample period. The quadratic mean for individual companies and industrial portfolios lies in a range from 0.54 to 0.59, indicating instability and volatility, evident in terms of standard deviations meaningful. Comparatively, the choice of industry portfolios improves the quadratic mean of the

correlation coefficients by about 3 percentage points in the sample from 2002 to 2011. The biggest advantage of using portfolios of industry (one stock per company in the industry) is the reduction of the standard deviations of the correlation coefficients, reduced from 0.3329 to 0.1964. This result is intuitive, because it is expected that portfolios should be less volatile than individual stocks as a result of diversification.

In Table III, we see that adding more companies to the frequent trading market in the period 2008 to 2011 increased the range of the correlation coefficients' quadratic means, now ranging from 0.45 to 0.63. Although individual stocks' betas became more instable, we found a far greater stability level for betas of industrial portfolios, specially for portfolios weighted by market value. Standard deviations of the correlations of betas for companies and industries are quite small compared to those found in Table II. This result of lower volatility in the years of 2008 to 2011 relates with the trend observed in the sample from 2002 to 2011 (reported in Table II), in which the correlations increase significantly from 2008 to 2011. If we take the 32 stocks that are selected in the 2002 to 2011 sample, and calculate the quadratic mean of the correlations between historical and future betas of these 32 stocks in the period from 2008 to 2011, we will have a significant improvement in the correlation coefficients' quadratic means, as presented in the table IV below:

Table IV - Beta Coefficients / Sample 2002-2011 Correlation studies from 2008 to 2011 – Ibovespa – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas. The third column presents the correlation coefficient between industry portfolios' historical and future beta, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
02/01/09	0,7488	0,6828	0,6975
30/12/09	0,6927	0,7596	0,7047
30/12/10	0,7386	0,6877	0,6492
Quadratic average	**0,7271**	**0,7109**	**0,6842**
Standard Deviation	**0,0299**	**0,0430**	**0,0302**

We understand that it is possible to infer from the data above, that the stocks that were traded continuously between 2002 and 2011 have become significantly more stable over the time. Also for these stocks, the volatility of correlations between historical and future betas became very small. This result aligns itself to greater stability achieved by the Brazilian economy during the period. In connection with this reasoning, the results reported in Table III, which consider all companies traded continuously between 2008 and 2011 may be significantly affected by increased volatility of companies that went public between 2002 and 2007.

For the full samples (2002-2011 and 2008-2011), whose results we reported in Tables II and III, our results for individual stocks are close to those found by Levy (1971), who reported quadratic mean of 0.486 for individual stocks of U.S. companies between 1960 and 1970. The work of Levy reports that the correlation between historical and future betas is much larger for portfolios constructed by magnitude of beta than for individual stocks. We understand, however, that this result would result in little practical use for project and business valuations, considering that the portfolios constructed by Levy would be highly

benefited by diversification, in higher levels than we should expect regarding industry portfolios. However, it would be difficult and non-intuitive to choose one of these portfolios sorted by beta as a predictor of the expected beta of a stock whose market is to be appraised, because we would not have objective criteria to define an optimal method of choice.

As shown in Tables V and VI, presented below, the use of a theoretical portfolio composed of a greater number of shares (IBrX) as an explanatory variable for the estimation of historical betas adds little in terms of improving the correlations measured.

Table V - Beta Coefficients / 2002-2011 – IBRx – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas. The third column presents the correlation coefficient between industry portfolios' historical and future beta, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
10/01/03	-0,1512	0,0915	0,0404
09/01/04	-0,0608	0,4435	0,2812
07/01/05	0,3827	0,4203	0,3369
06/01/06	0,4981	0,4394	0,5010
05/01/07	0,6485	0,7779	0,7080
04/01/08	0,5350	0,5136	0,4390
02/01/09	0,7755	0,7156	0,7321
30/12/09	0,7154	0,7793	0,7304
30/12/10	0,7372	0,7061	0,6778
Quadratic average	**0,5562**	**0,5833**	**0,5445**
Standard Deviation	**0,3418**	**0,2258**	**0,2426**

Table VI - Beta Coefficients / 2008-2011 – IBRx – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas. The third column presents the correlation coefficient between industry portfolios' historical and future beta, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
02/01/09	0,5762	0,5378	0,5881
30/12/09	0,2936	0,4760	0,5743
30/12/10	0,4549	0,5667	0,7328
Quadratic average	**0,4565**	**0,5282**	**0,6358**
Standard Deviation	**0,1418**	**0,0463**	**0,0878**

Tables VII and VIII show the correlation coefficients of the stocks' and portfolios' rank order of betas, with the objective of minimizing estimation problems that could arise from the presence of outliers. Results are similar to those seen in Tables II to VI, indicating

little influence of aberrant data in the performed correlation studies. Likewise, the use of logarithmic returns of Ibovespa or IBrX as an explanatory variable show very similar results both in the sample of ten years (comprised of 32 firms) and of four years (including120 companies).

Table VII - Beta Coefficients' Rank order / 2002-2011 – Ibovespa – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas' rank orders. The third column presents the correlation coefficient between industry portfolios' historical and future beta's rank orders, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
10/01/03	0,0007	0,2937	0,2797
09/01/04	0,0363	0,4196	0,4615
07/01/05	0,5297	0,5175	0,4615
06/01/06	0,4985	0,4825	0,6014
05/01/07	0,6096	0,7343	0,6573
04/01/08	0,5539	0,7483	0,6014
02/01/09	0,7137	0,5804	0,5594
30/12/09	0,6734	0,7972	0,6154
30/12/10	0,7353	0,7203	0,6434
Quadratic average	**0,5490**	**0,6104**	**0,5543**
Standard Deviation	**0,2759**	**0,1730**	**0,1215**

Table VIII - Beta Coefficients' Rank Order / 2008-2011 – Ibovespa – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas' rank orders. The third column presents the correlation coefficient between industry portfolios' historical and future beta's rank orders, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
02/01/09	0,5044	0,3759	0,4135
30/12/09	0,3975	0,5188	0,5233
30/12/10	0,5559	0,7203	0,7248
Quadratic average	**0,4904**	**0,5566**	**0,5687**
Standard Deviation	**0,0808**	**0,1730**	**0,1579**

The results we reported in Table IV, where we found a far greater stability level for the betas of the 32 stocks that were included in the 2002 to 2011 sample in the period from 2008 to 2011, with a significant improvement in the correlation coefficients' quadratic means, remains relevant if we consider the rank order of stocks' and portfolios' betas, although with a

slight increase on the correlation coefficient's standard deviation. These results are presented in Table IX.

Table IX - Beta Coefficients Rank Order / Sample 2002-2011 Correlation studies from 2008 to 2011 – Ibovespa – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas' rank orders. The third column presents the correlation coefficient between industry portfolios' historical and future beta's rank orders, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
02/01/09	0,7137	0,5804	0,5594
30/12/09	0,6734	0,7972	0,6154
30/12/10	0,7353	0,7203	0,6434
Quadratic average	**0,7079**	**0,7050**	**0,6071**
Standard Deviation	**0,0314**	**0,1099**	**0,0427**

Tables X and XI present correlation coefficients between historical and future betas' rank orders, substituting Ibovespa for IBRx as a proxy for the market theoretical portfolio. Concordantly with the results we reported regarding betas, the rank order correlation coefficients present minor changes with the adoption of IBRx.

Table X - Beta Coefficients' Rank Order / 2002-2011 – IBRx – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas' rank orders. The third column presents the correlation coefficient between industry portfolios' historical and future beta's rank orders, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
10/01/03	-0,0590	0,2238	0,1399
09/01/04	0,0242	0,3287	0,3497
07/01/05	0,4307	0,3916	0,3566
06/01/06	0,5521	0,4266	0,5315
05/01/07	0,5913	0,8322	0,6713
04/01/08	0,5594	0,7413	0,6853
02/01/09	0,7599	0,6294	0,6434
30/12/09	0,7115	0,7902	0,6573
30/12/10	0,7588	0,7343	0,6434
Quadratic average	**0,5594**	**0,6051**	**0,5509**
Standard Deviation	**0,3030**	**0,2257**	**0,1936**

Table XI - Beta Coefficients' Rank Order / 2008-2011 – IBRx – In the first column we present the reference date for estimating historical and future betas. The second column presents the correlation coefficient between individual stocks' historical and future betas' rank orders. The third column presents the correlation coefficient between industry portfolios' historical and future beta's rank orders, through portfolios comprised of one stock per company included in the sample. In the fourth column, industry portfolios are market weighted. The last two rows of the table present a quadratic average of the correlation coefficients of the observed period and the standard deviation of the correlation coefficients.

52 weeks ended in:	Individual stocks	Industry portfolios - 1 stock of each company	Industry portfolios - market weighted
02/01/09	0,5062	0,4241	0,4782
30/12/09	0,3841	0,4812	0,5699
30/12/10	0,5329	0,7143	0,7955
Quadratic average	**0,4788**	**0,5543**	**0,6288**
Standard Deviation	**0,0793**	**0,1537**	**0,1633**

To summarize our results, we present in Table XII a comparison of correlation between sample's quadratic means and standard deviations of correlation coefficients of stocks and portfolios. In table XIII, we present the same comparison based on the rank order of betas' correlation coefficient.

Table XII - Comparison of Sample's quadratic means and standard deviations of correlation coefficients based on stocks and portfolios' betas

				Quadratic Mean of Correlation Coefficients		
Original Table	**Period**	**Stocks**	**Proxy**	**Individual stocks**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**
Table II	2002-2011	32	Ibovespa	0,5532	0,5881	0,5422
Table III	2008-2011	120	Ibovespa	0,4663	0,5311	0,6301
Table IV	2008-2011	32	Ibovespa	0,7271	0,7109	0,6842
Table V	2002-2011	32	IBRx	0,5562	0,5833	0,5445
Table VI	2008-2011	120	IBRx	0,4565	0,5282	0,6358

				Standard Deviation of Correlation Coefficients		
Original Table	**Period**	**Stocks**	**Proxy**	**Individual stocks**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**
Table II	2002-2011	32	Ibovespa	0,3329	0,1964	0,1972
Table III	2008-2011	120	Ibovespa	0,1306	0,0327	0,0777
Table IV	2008-2011	32	Ibovespa	0,0299	0,0430	0,0302
Table V	2002-2011	32	IBRx	0,3418	0,2258	0,2426
Table VI	2008-2011	120	IBRx	0,1418	0,0463	0,0878

Table XIII- Comparison of Sample's quadratic means and standard deviations of correlation coefficients based on stocks' and portfolios' betas' rank orders

				Quadratic Mean of Correlation Coefficients		
Original Table	**Period**	**Stocks**	**Proxy**	**Individual stocks**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**
Table VII	2002-2011	32	Ibovespa	0,5490	0,6104	0,5543
Table VIII	2008-2011	120	Ibovespa	0,4904	0,5566	0,5687
Table IX	2008-2011	32	Ibovespa	0,7079	0,7050	0,6071
Table X	2002-2011	32	IBRx	0,5594	0,6051	0,5509
Table XI	2008-2011	120	IBRx	0,4788	0,5543	0,6288

				Standard Deviation of Correlation Coefficients		
Original Table	**Period**	**Stocks**	**Proxy**	**Individual stocks**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**
Table VII	2002-2011	32	Ibovespa	0,2759	0,1730	0,1215
Table VIII	2008-2011	120	Ibovespa	0,0808	0,1730	0,1579
Table IX	2008-2011	32	Ibovespa	0,0314	0,1099	0,0427
Table X	2002-2011	32	IBRx	0,3030	0,2257	0,1936
Table XI	2008-2011	120	IBRx	0,0793	0,1537	0,1633

As previously mentioned our results are very similar whether we consider or not in our correlation studies the inclusion of single stock's portfolios. We present below in tables XIV and XV the comparison of the correlation coefficients of betas and rank orders for portfolios excluding all of the single stock's portfolios. The only exception, where computing portfolios that at least two stocks increases the quadratic mean of correlation coefficients in comparison with portfolios computed without this exclusion rule, is the case of the 32 stocks traded uninterruptedly from 2002-2011, in the period of 2008-2011. In that case, the quadratic mean of correlation coefficients increased to 0,8083 from 0,7109 considering industry portfolios comprised by 1 stock of each company and to 0,7442 from 0,6842 considering market weighted industry portfolios.

Table XIV – Respective to Table XII - Comparison of Sample's quadratic means and standard deviations of correlation coefficients based on stocks and portfolios' betas

				Quadratic Mean of Correlation Coefficients			
				With single stock portfolios		**Without single stock portfolios**	
Original Table	**Period**	**Stocks**	**Proxy**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**
Table II	2002-2011	32	Ibovespa	0,5881	0,5422	0,5712	0,4994
Table III	2008-2011	120	Ibovespa	0,5311	0,6301	0,5047	0,6111
Table IV	2008-2011	32	Ibovespa	0,7109	0,6842	0,8083	0,7442
Table V	2002-2011	32	IBRx	0,5833	0,5445	0,5800	0,5232
Table VI	2008-2011	120	IBRx	0,5282	0,6358	0,5004	0,6169

Table XV - Alternate Respective to Table XIII- Comparison of Sample's quadratic means and standard deviations of correlation coefficients based on stocks' and portfolios' betas' rank orders

				Quadratic Mean of Correlation Coefficients			
				With single stock portfolios		Without single stock portfolios	
Original Table	**Period**	**Stocks**	**Proxy**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**	**Industry portfolios - 1 stock of each company**	**Industry portfolios - market weighted**
Table VII	2002-2011	32	Ibovespa	0,6104	0,5543	0,6389	0,5569
Table VIII	2008-2011	120	Ibovespa	0,5566	0,5687	0,5213	0,5323
Table IX	2008-2011	32	Ibovespa	0,705	0,6071	0,8591	0,7265
Table X	2002-2011	32	IBRx	0,6051	0,5509	0,6003	0,5781
Table XI	2008-2011	120	IBRx	0,5543	0,6288	0,5004	0,6169

5 CONCLUSIONS

This paper had the main purpose of investigating the behavior of the beta coefficients over time, especially in regard to its stability, which, if proven, would constitute a strong argument in favor of using historical beta coefficients as input for determining the market value of stocks traded on the stock exchange. In conclusion similar to that of Levy (1971), the evidence points to a very low level of stationarity of beta coefficients of companies considered individually. In this sense, our results are concordant to those presented in the literature regarding developed and emerging markets.

Nonetheless, our results are somehow contrary to those reported by the Brazilian literature on the subject, especially Rodrigues and Ramos Filho (2005), Ventura, Forte and Famá (2001) and Lima and Minardi (2009), in which the authors state that is not possible to affirm the instability of the beta coefficients. Our sample, however, is broader both in terms of the number of time periods and companies analyzed. The main exception we found was the case of the 32 companies that were traded uninterruptedly from 2002 to 2011, whose betas did became more stable from 2008 to 2011, maybe indicating a trend that more mature companies will converge to more stationary betas. Further research is needed on this subject, considering that since the shift of the Brazilian economy towards greater stability suggests theoretically that betas will become more stable in the coming years.

In most of the cases we have analyzed, the construction of industry portfolios did not result in betas sufficiently more stable than those of individual companies. Therefore, we cannot affirm that industry betas are more stable and therefore do exhibit a higher degree of predictability in comparison to individual stocks.

The choice of Ibovespa or IBRx indexes as proxies for the theoretical Market portfolios resulted in no significant differences in terms of stationarity of betas coefficients.

Due to the small number of firms with continuous trading between 2002 and 2011, and the large number of companies that are traded continuously since 2008, after the last big wave of IPOs in the Brazilian Market, an opportunity is open for studies with a larger sample (in terms of number of stocks) for longer periods of time, and with the use of longer intervals for estimation of historical betas. Monte-Carlo simulations could be used for the construction of various randomly selected portfolios, in order to measure the average correlation between historical and future betas considering the expected random behavior of portfolio investors.

Finally, we believe that the usage of betas estimated as a function of stocks and market

portfolios observed on the Brazilian stock Market, in order to determine the of cost of equity of publicly traded securities can generate significant problems. Therefore, we suggest further studies on alternative procedures in order to determine ex ante betas, specifically in the case of emerging markets as Brazil.

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