Stock Market Bubbles

Was there a bubble in the BM&FBOVESPA stock exchange during 2006-2011?

Erasmus University Rotterdam
Erasmus School of Economics
Department of Finance

Supervisor: A. Markiewicz

2-8-2011

W.J. Heslinga
Student Number: 312462
Email: wiggerheslinga@hotmail.com
Thesis: Bachelor (FEB13100)

Contents

Chapter 1 Introduction:

1.1 Research Question & Preface

The goal of this research paper is to detect whether there was a stock market bubble in Brazil (the BM&F-Bovespa) during the period 2006-2011. This is done with the assistance of 2 statistical systems (Eviews and SPSS, the datasets are created in Excel). I made multiple graphs to show the pattern of the 3 indices used in this research, these graphs indicate that there was steep increase in the Brazilian stock market during the pre-financial crises period (2007) and during the post-financial crisis period (2009). These graphs are in line with my hypothesis: There was a stock market bubble in the Brazilian Stock Exchange (BM&FBovespa). To be able to correctly conclude that there was at least 1 stock market bubble in Brazil (2006-2007 or 2009-2010); the results have to be compared to a benchmark for the worldwide stock market. The American and European stock market function as a benchmark for the worldwide stock market, through the use of the S&P500 index and the Euronext-100 index. When the pattern of the Ibovespa (the leading index BM&FBOVESPA) is compared with the patterns of the S&P500 and Euronext-100, you can see that there is a steeper increase in stock market returns in the Ibovespa index in both the Pre-financial crisis period and post-financial crisis period. Hence, I decided to test whether the returns on the Brazilian stock exchange were larger than the returns of the American and European stock markets, while controlling for differences in systematic risk. The time period taken is from January 2006 until April 2008 for the first test, and April 2009 until March 2011 for the second test.

There are 2 factors taken into account that might explain the existence of any excessive returns in the Brazilian stock exchange, namely differences in inflation and GDP growth rates between Brazil and the United States or Europe. Therefore I will have to develop an effective model which can control for the differences in inflation and GDP growth. This model is similar to the CAPM model and the Market Model for event studies, but it has to be adjusted in a way that it fits all the components to conduct my research. The evidence found here indicates that neither the graphs nor the regression analysis detect the presence of a stock market bubble in Brazil. The stock market returns are high, but they can be explained by the differences in systematic risk and due to other factors. In order to determine these other factors, further research is necessary.

1.2 What is a Stock Market Bubble?

One of the first bubbles in the world was what became known as the South Sea Bubble, which took place during the first decades of the 18th century in England. At that time England was in the middle of a period of great prosperity and wealth; this resulted in fat savings and thin investment outlets. People considered owning stocks something like a privilege in these times. The South Sea Company, which was the first company to fill the need for investment opportunities for the general public, was given a monopoly over all trade to the South Seas. From the start, the South Sea Company reaped profits at the expense of others. Even though the company was actually badly performing and the fact that England was in war with Spain did not affect the share prices of the South Sea Company. The share prices even rose a bit over these years. When the peace with Spain was announced the company flourished like never before; at one point the directors decided to proof their reputation by offering to pay off England's National Debt of 31 million pounds. After this announcement the South Sea Company's stock price rose from £130 to £300. The South Sea Company reacted immediately by offering a new issue of stocks for £300. These £300 stocks could be bought with an immediate down-payment of £60, and the rest had to be paid in 8 successive payments. Multiple similar issues were made thereafter, the public loved it. The South Sea Company introduced even easier payment schemes and the stock price skyrocketed to a staggering £1000 during the summer of 1720. During these years a lot of similar companies were set up, satisfying the need of the general public for 'beneficial' investment opportunities. These new companies were given the title 'bubble' companies. Not every investor at this time believed in the actual profitability of these 'bubble' companies, but they believed in what we now know as the greater fool – theory.
To all good things an end comes; during August people started to realize that the price of the shares in the market did not reflect the real value and performance of the company, which resulted in a deep decline in stock prices and panic among the public broke out. Within a couple of months normal stock prices were restored. (Circling around £100 instead of the £1000 share price during summer peak)
During history multiple similar bubbles rose and popped; The Tulip Mania in Holland, the Wall Street Crash of the 1920's and the biggest bubble of all time so far: The Internet bubble, when this bubble burst $8 trillion of market value evaporated.[1]

There are different accepted approaches to explain the rise and existence of stock market bubbles, in general there is a distinction between 2 sorts of stock market bubbles. First the Rational stock market bubble; the market price of a stock is higher than its fundamental value. This value difference is justified by the rational expectations of market participants. If on the other hand the stock price lies too far from its fundamental value, which cannot be rationalised through the support of dividend income, one speaks of a Speculative bubble.[2]
The theory of rational expectations implicates that share prices are reflecting the expectations of the public. All expectations are based on the information at hand. Therefore when stocks have a positive prospect, prices will rise, stocks will be bought. When stocks have a negative future prospect prices will drop, and stocks will be sold. This shows that the expectations of investor's are incorporated in the share prices, hence when there is a new information release, a new optimal trade-off share price will be realised. This all can be explained through the Efficient Market Theory. But the assumptions made in this Efficient Market Theory are too simplistic to illustrate the real world. Other aspects are of importance in explaining stock prices, many of which can be explained through the behavioural part of finance.

[1] A Random Walk Down Wall Street, by Burton Malkiel 2007
[2] Anatomy of Stock Market Bubbles, by Gyorgy Komaromi, 2006

Economic definition of Stock Market Bubbles; A stock market bubble exists when a stock is structurally traded at a price higher than the fundamental value of the stock, because of unrealistic growth/profit expectations of the traders.

"A bubble appears when an asset price is significantly different from its fundamentals (i.e. the value based on the discounted sum of expected future earnings)."[3]

"Bubbles work like a pyramiding chain letter. Speculative beliefs feed rising stock prices that beget even higher prices, spurred on by further speculation. Momentum investing displaces fundamental investing, promoting the rise in prices." [4]

"A combination of forces such as rapidly increasingly stock prices, market confidence that the companies have strong potential of churning future profits, individual speculation at every corner, and a widely available investment capital create an environment which inflates the stock prices and gives rise to a situation that is termed as stock market bubble." [5]

"Kindleberger and Sornette have identified the following generic scenario developing in five acts, which is common to all historical bubbles: displacement, take-off, exuberance, critical stage and crash."[6]

Multiple studies have been conducted researching price behaviour explained by rational expectations.

"Finally, bubbles seem to be due to uncertainty about the behaviour of others, not to uncertainty about dividends, since making dividends certain does not significantly affect bubble characteristics; futures markets help to dampen (but not to eliminate) bubbles by allowing trades in a future spot market to occur in advance and thus speed up the process of creating common expectations; limit price change rules make bubbles worse, apparently by giving traders a perception of reduces downside risk, causing the bubbles to carry further and longer."[7]

"Stock Market bubbles – inefficient capital markets – are damaging to economies."[8]

---

[3] Testing for Stock Market Bubbles Using Nonlinear Models and Fractional Integration, by Cunado, Gil-Alana, Perez de Gracia, 2007.

[4] The Behavior of Stock Market Prices, Fama, 1965)

[5] Stock Market Bubble, by Michael James, http://www.EzineArticles.com

[6] What is an Asset Price Bubble: An Operational Definition, Siegel, 2003

[7] Stock Market Bubbles in the Laboratory, Journal of the Behavioral Finance, Porter, 2003

[8] The Quality of Financial Statements: Perspective from the Recent Stock Market Bubble, Accounting horizons, Penman, 2003

1.3 The Brazilian Stock Market

The BM&FBOVESPA stock exchange is located in São Paolo, Brazil. The BM&FBOVESPA was created in 2008, through an integration between the São Paolo Stock Exchange (Bolsa de Valores de São Paolo) and the Brazilian Mercantile & Futures Exchange (Bolsa de Mercadorias e Futuros).
Since August 20, 2008 it has been listed under the BVMF3 ticker in the Novo Mercado. Its equities also integrate the Ibovespa index, which holds the equities with most liquidity in Brazil.

On August 23, 1890 the "Bolsa Livre" was founded by Emilie Pestana, in 1934 it changed location and was officially named "Bolsa Oficial de Valores de São Paulo". Until the 1960s, the Bovespa and other Brazilian stock markets were state owned companies. During 1965 the Brazilian stock exchanges decentralized, assuming a more institutional role. 1967, brokerage houses and floor traders emerged, the exchange becomes known as "Bolsa de Valores de São Paulo – Bovespa". During 1986, trading sessions begin at the "Bolsa Mercantile & de Futuros – BM&F. In 2007, however, the Exchange became a profit company, under the supervision of the Comissão de Valores Mobiliários (CVM). Now the BM&FBOVESPA is one of the largest exchanges in the world in terms of market value.
There are 21 indices of the BM&FBOVESPA stock market; the most popular two of these indices are the Ibovespa and the IBrX-100.[9]

Difficulties arise when searching for scientific or empirical literature about bubbles and the São Paulo Stock Exchange. But, there was a stock market bubble in Brazil during the 1970s; the Rio de Janeiro Stock Exchange boomed and popped. In just 6 months time, prices rose from ten times earnings to over thirty times earnings. Prior to 1971, the Rio Exchange was the largest in Brazil and the decade of the 1960s were its golden years. Never again was the Rio Exchange to have the honour of being Brazil's premier securities market.
For the next generation, the progress of the Rio Exchange was downward. By the 21st century, the Rio bourse had disappeared, having been absorbed by the São Paulo Exchange.[10]

[9] http://www.bmfbovespa.com.br/en-us/home.aspx?idioma=en-us
[10] http://www.capital-flow-analysis.com/investment-tutorial/case_1h.html#down, Professional Capital Flow Analysis, by Schroy,2003-2006

Chapter 2: Empirical Evidence

There are multiple different methods developed for testing for the presence of stock market bubbles. The following tests are concerned with testing for returns on the Brazilian stock market:

De Medeiros studied to test the Efficient Market Hypothesis for the Brazilian stock market. This paper studies the behaviour of the Brazilian stock market compared to the American stock market and to find support for the presence of efficiency. He uses market indices as a benchmark in order to eliminate stock specific anomalies and to examine stock market behaviour. The benchmark adopted for generating abnormal returns for the Brazilian stock exchange is the Dow Jones Stock Index, associated to the NYSE. The return of the Brazilian market index is then regressed on the return of the Dow Jones Index to generate events. The index he uses for the BM&FBOVESPA is the Ibovespa index, which is the oldest and most traditional indicator of the average stock-price behaviour in Brazil. To conclude, he found evidence that the Brazilian stock market overreacts to positive events and under reacts to negative events; the Brazilian market behaves not according the Efficient Market Hypothesis.[11]

Costa & Vasconcelos report an empirical study of the Ibovespa index of the Sao Paolo Stock Exchange (BM&FBOVESPA) in which they test for long-range correlations and non-stationary. They question the accepted assumption of EMF, (Efficient Market Hypothesis) which implicates that all information available about a share is incorporated within its current share price. They find that the Ibovespa index time series cannot be satisfactorily modelled; the Ibovespa follows a multifractal process.[12]

Chen, Firth & Rui investigate whether there are stock market linkages within the Latin American countries. They investigate the interdependence of the major stock markets in Latin America with non-stationary index level series. And construct a co integration analysis and an error correction vector auto regressions technique to model the interdependencies. These tests conclude that buying shares in different Latin American countries reduces portfolio risk vis-à-vis a portfolio made up of shares of a single country.[13]

Aguiar, Moura Sales & Sousa use a more behavioural finance approach to test for abnormal returns in the Brazilian Stock Market. They test for overreaction and under reaction in the Brazilian stock market by using a new model based on the fuzzy set theory, named behavioural fuzzy model. According to them some sectors within the Brazilian stock market present statistical meaningful evidence of overreaction or under reaction to changes. This means that aspects of behavioural finance influence the behaviour of the Brazilian stock market. [14]

De Medeiros &Matsumoto carried out a study that investigates Brazilian stock returns with the announcement of equity issues by Brazilian firms to determine market reaction. They used Ordinary Least Squares to measure abnormal returns, after that they used ARCH and GARCH models to analyse the measured abnormal returns. They find that the Brazilian market overreacts even before the announcement date, and show long-term negative abnormal returns to equity issue announcements. [15]

---

[11] Reaction of the Brazilian Stock Market to Positive and Negative Shocks, by De Medeiros, Department of Accounting, 2005

[12] Long-range Correlations and Non-Stationary in the Brazilian Stock Market, by Costa & Vasconcelos, Laboratorio de Fisica Teorica e Computacional, published in Elsevier Science Nr 2, 2008

[13] Stock Market Linkages: Evidence from Latin America, by Chen, Firth & Rui, Journal of Banking & Finance Vol. 26, page 1113-1141, 2002

[14] A Behavioral Fuzzy Model for Analysis of Overreaction and Underreaction in the Brazilian Stock Market, by Aguiar, Moura Sales & Sousa

[15] Brazilian Market Reaction to Equity Issue Announcements, by De Medeiros & Matsumoto, 2005

Some other economists conducted similar tests, all researching the returns of stocks compared to paid out dividends.
Psaradakis, with the study: "A Simple Procedure for Detecting Periodically Collapsing Rational Bubbles"; bubbles can be detected by comparing the paid-out dividends with the stock prices. In this paper he proposes a new procedure for detecting stock market bubbles; the procedure is based on random-coefficient autoregressive models, it involves testing for the presence of a random unit root in prices and underlying fundamentals and estimating random coefficient models for the 2 series. [16]
Cunado, Gil-Alana, Perez de Gracia, test for bubbles in the S&P500 stock market index using monthly data over the period 1871M1 until 2004M6. They use fractional integration techniques, allowing for structural breaks and a nonlinear adjustment process of prices to dividends. They find a stock market bubble during the period 1932, a period in which the stock market began rising again after the market crash of 1929. To conclude, they do not find significant evidence that can prove the relationship between asymmetric price adjustments and dividends using autoregressive models.[17]
Froot & Obstfeld tested for the existence of intrinsic bubbles in the American stock market; they tested whether the behavior of American stock prices can be explained through the presence of a specific type of bubble; an intrinsic bubble. An intrinsic bubble is a bubble that depends on aggregate dividend, hence depending on exogenous economic fundamentals. They try to test if stock prices can overreact to changes in economical fundamentals. They compare the Standard and Poor's stock price with the dividend indices from the Securities Price Index Record. The estimates reveal a strong nonlinear relationship between stock prices and dividends which can be interpreted as a rejection of the hypothesis that there is no bubble. Hence, they significantly proved the presence of stock market bubbles during their research periods. (1900-1988)[18]
Brooks and Katsaris present empirical evidence from 3 different types of bubble identification techniques for the FTAS Index. They test whether the divergence of the London Stock Exchange equity prices from paid out dividends can be explained with the existence of a speculative bubble. They used the following techniques: variance bounds tests, bubble specification tests, and cointegration tests. They found that during the 1990's the FTAS index was not solely driven by market fundamentals, the long-run relationship between prices and dividends did not hold during the late 1990's. This shows that other variables drove stock prices at that time instead of economic fundamentals, these other variables can be explained as a speculative bubble.[19]
Campbell & Shiller present empirical evidence that proof the existence of speculative bubbles when testing for co-integration between stock prices and dividends. Their evaluation of the present value model for stocks indicates that the spread between stock prices and dividends moves too much and that deviations from the present value model are quite persistent; which implicates the existence of a speculative bubble.[20]
Naoui used 2 different types of statistical tests in his paper to detect bubbles. First, he applied stationarity and a co integration test to prices and dividends. Secondly, he directly estimated

[16] A Simple Procedure for Detecting Periodically Collapsing Rational Bubbles, by Psaradakis, 2000
[17] Testing for Stock Market Bubbles using Non-Linear Models and Fractional Integration, Cunado, Gil-Alana, Perez de Gracia, 2007
[18] Intrinsic Bubbles: The Case of Stock Prices, by Froot and Obstfeld, The American Economic Review Vol 81, nr 5, page 1189-1214, 1991
[19] Rational Speculative Bubbles: An Empirical Investigation of The London Stock Exchange, by Brooks and Katsaris, Bulletin of Economic Research 55:4, page 319-346, 2003
[20] Co integration and Tests of Present Value Models, by Campbell and Shiller, Journal of Political Economy, Vol 95 Nr 5, page 1062-1088, 1987

intrinsic bubble coefficients. He studied the annual prices and dividend indices during 1871 – 2009 of the S&P500, and noted the presence of a bubble with features consistent with intrinsic bubbles theory.[21]`
Porter & Smith constructed 72 laboratory asset market experiments which included experimental treatments for speculative bubbles. Bubbles were verified and replicated in laboratory asset markets for 7 years. They investigate the rational expectations model that predicts that when the value of an asset is equal to the dividend value of an asset an individual will trade. With their research they conclude that bubbles seem to be existent due to uncertainty about the behavior of others, not to the uncertainty about dividends. Making dividends certain does not significantly affect the laboratory bubble characteristics.[22]

This kind of testing between prices and dividends is in general a very difficult and intensive procedure. Furthermore, from an investor's point of view it is better to compare the stock prices of Brazil with the stock prices around the world, to see if there are abnormal returns in Brazil. Hence, I have decided to compare the Ibovespa with the S&P500 and the Euronext-100. These represent the stock prices of the leading companies in the United States and Europe.

Although there are many studies conducted towards statistically testing for stock market bubbles, either using the dividends as a benchmark, or comparing the return of one stock market with a benchmark for the world stock market. Not all economists are positive towards these research methods, some of them argue that it is impossible to predict stock market bubbles, others even warn for the problem that the studies pointing towards a stock market bubble are in fact false. These bubble indicators are only present through a false specification in the model.[23]

Chapter 3: Data

Bubbles are time continuous, which means that a bubble cannot pop and burst in one day. Therefore, instead of using the daily indices I used monthly data in order to predict the existence of a stock market bubble.
The data used in this paper are mainly collected through the DataStream Database at the Erasmus Universiteit Rotterdam, the BM&FBOVESPA website and the OECD statistical website. In this research, I compare multiple indices, which are converted to the same currency. The following data is retrieved from the DataStream database:

- The Standard & Poor's 500 composite price index The S&P500 has been regarded as the best indicator of the U.S. equities markets. It was first published in 1957. The index includes the top 500 leading companies within the leading industries of the U.S. economy. According to the S&P website, the S&P500 index captures almost 75% of the US equities market.
- The Euronext-100 price index. The Euronext-100 comprises the largest and most liquid stocks traded on Euronext. The Euronext-100 index captures 80% of the total market capitalization of Euronext.

[21] Intrinsic Bubbles in the American Stock Exchange: The case of the S&P500 Index, by Naoui, International Journal of Economics and Finance, Vol 3, Nr 1, 2011
[22] Stock Market Bubbles in the Laboratory, by Porter and Smith, The Journal of Behavioral Finance, Vol 4, page 7-20, 2003
[23] Econometric Test of Asset Price Bubbles: Taking Stock, by Gurknayak, 2008

Next the exchange rates composition between the Euro, Dollar and Real are necessary in order to make a reliable comparison of price indices. The exchange rates are retrieved from the DataStream database:

- The Brazilian Real to US $, from January 2006 until March 2011
- The European € to US $, from January 2006 until March 2011

The Sao Paolo stock exchange, the BM&FBOVESPA, has a total of 21 indices and the data is retrieved from the BM&FBOVESPA website.

- The best of these indices is the Bovespa index. The Bovespa index – Ibovespa is the most popular, traditional, reliable and prominent indicator of the Brazilian stock market's average performance. It reflects the variation of BM&FBOVESPA's most traded stocks. The data period is from January 2006 until March 2011.

After analysing the graphical development of all the indices, I expect to find abnormal high returns for the Brazilian stock market compared to the American and European stock market. But these abnormal returns can perhaps be explained by differences in country specific economic indicators. In this paper, I implement 2 of these economic indicators retrieved from the OECD website:

- GDP growth rates, expressed through the 'Industrial Production index'. The Industrial Production Index refers to the volume of output produced by establishments engaged in mining, manufacturing and production of electricity, gas and water. Making it a very reliable indicator for GDP development differences between the selected countries. The data is presented as the volume measure changes over time as indices, with 2005 as base year = 100.[24] Here the monthly data is expressed as an index to 2005 and it has to be converted to an index referring the growth from the previous month. This is done with Excel.
- Inflation rates, expressed through CPI; "the Consumer Price Index is an instrument designed to measure changes over time in the prices paid by households for the goods and services which they customarily purchase for consumption"[25]. It measures changes in the price level of consumer goods and services purchased by households. The CPI measure presented in the Excel file, retrieved from the OECD website, is the "all items" level, with 2005 as base year = 100. This means that the monthly data is expressed as an index towards 2005; it still has to be converted to an index referring to the growth compared to the previous month, this is done with Excel.

When analysing the graphical development of all these indices during the period 2006-2011 it is noticeable that there might be a bubble in the Brazilian stock market during 2 time windows. From 2006 onwards there is a steep lift in the Ibovespa Composite Price index compared to its American and European counterparts; this could indicate the presence of a stock market bubble. This increase culminates around April 2008, and is followed by a sharp decline in stock market prices. This sharp decline is noticeable in all the indices selected for this research paper and can be explained by the worldwide financial crisis due to a liquidity shortfall by the United States banking system and the collapse of the U.S. housing bubble. The crisis interval lasts from April 2008 until April 2009; from April 2009 onwards all stock markets begin to recover from the financial crisis. The Ibovespa index rises sharply compared

[24] http://stats.oecd.org/index.aspx, Monthly Economic Indicators is selected, then Main Economic Indicators, followed by MEI Original release data and revisions and finally Index of Industrial Production.
[25] http://www.oecd.org/dataoecd/48/35/2371876.pdf

to its American and European counterparts, similar as before the global financial crisis; this might indicate again that there is a stock market bubble present in the Brazilian stock market. Hence, the time windows taken in this research paper are:

1. January 2006 until April 2008
2. April 2009 until February 2011

Chapter 4: Methodology

The goal of this research paper is to detect if there was a stock market bubble in Brazil during the periods 2006-2008 and 2009-2011. In order to be able to make a reliable conclusion, an effective model has to be determined. This model needs to check if the returns of Brazilian stock are increasing higher than the returns of the chosen benchmark. The United States (S&P500) and Europe (Euronext-100) function as proxies for the World Stock Index and so function to check for abnormal returns in the Brazilian stock market.

Multiple similar studies have be conducted by different economists to test for stock market bubbles that might be of help in order to determine my model. As described above there are a couple of different methods. Studies by Psaradakis, Cunado,Gil-Alana & Perez de Gracia, Froot & Obstfeld, Katsaris, Campbell & Shiller and Naoui measure the presence of a bubble on the basis of dividends paid out in relation to stock prices. One problem that arises when comparing stock prices to dividends is that it is a very complex and intensive procedure; The dividends of each individual listed company has to be taking into consideration, together with its weighted market capitalization to the index.

Another method of testing for abnormal returns in stock markets is developed by Otavio R. De Medeiros; he compares the Brazilian stock market with the World stock market through an event study. He uses the American stock market as a benchmark for the world stock market and he uses the best performance reflecting indices to protect against stock-specific anomalies and to examine market behaviour.
The event study methodology is well explained by MacKinlay (1997); "The market model is a statistical model which relates the return of any given security to the return of the market portfolio."[26] The model that he constructs is a model that resembles the model that is used to calculate the required return on equity, namely the Capital Asset Pricing Model. Brown, Harlow and Tinic[27] as well as Shachmurove[28] use the same model in their studies in order to detect if one market overreacts to positive events or under reacts to negative events.

With this research paper the event study methodology is used combined with the CAPM model to test for the efficiency of the Brazilian Stock Market relative to the World Stock Market Index. All data refers to the monthly closing stock market indices; for Brazil the Ibovespa, for the United States the S&P500 and for Europe the Euronext-100. My study uses market indices as a benchmark for stock exchanges in order to eliminate stock specific anomalies. As stated before the time windows span from January 2006 until April 2008 and April 2009 until February 2011; for the first time period this results in 28 observation and 23 observations for the second time period.

[26] Event Studies in Economics and Finance, by MacKinlay, Journal of Economic Literature, Vol. XXXV, 1997
[27] Risk Aversion, Uncertain Information and Market Efficiency, by Brown, Harlow and Tinic, Journal of Financial and Quantitative Analysis, 1988
[28] The Behavior of Secondary European Stock Markets to Positive and Negative Shocks, by Shachmurove, International Journal of Business, 2002

To be able to make a reliable and accurate comparison between stock prices of the different regions it is necessary to create a common currency for all the stock prices. The Ibovespa (Real) and Euronext-100(Euro) indices were translated to US Dollar. This is done through multiplying each monthly stock price closing rate with the US $ exchange rate at that time. E.g. The Ibovespa closing price index of March 2006 was multiplied with the US$ exchange rate of March 2006.[29]

The S&P500 and Euronext-100 are used as benchmarks to generate excessive returns for the Ibovespa index. The rate of return of the Ibovespa index is regressed on first the S&P500, and secondly, on the Euronext-100. This regression can be shown as:

1. **$Rt(Ibovespa) = \alpha + \beta * Rt(S\&P500) + \varepsilon$**
2. **$Rt(Ibovespa) = \alpha + \beta * Rt(Euronext\text{-}100) + \varepsilon$**

Where Rt(Ibovespa) is return for the Brazilian stock market, Rt(S&P500) is the return of the Unites States stock market, Rt(Euronext-100) is the stock return for Europe, and together these 2 are used as proxies for the World Stock Index. The α and β are the regression coefficients, and ε is the Gaussian white-noise error term. This can be expressed as:

3. **$\varepsilon \mid X \sim N(0,\sigma^2)$**

The returns are computed on a continuous-time capitalization basis, because bubbles take time to develop before they eventually pop:

4. **$Rt(Ibovespa/S\&P500/Euronext\text{-}100) = LN \frac{I_{Ibov/S\&P500/Euronext\text{-}100\ t}}{I_{Ibov/S\&P500/Euronext\text{-}100\ t-1}}$**

Where, LN is the natural logarithm operator, whereas $I_{Ibov/S\&P500/Euronext\text{-}100}$ are the Brazilian, S&P500 and Euronext-100 stock market indices, respectively. From now on, Rt will be the result of the natural logarithm on a time-continuous basis.
The β indicates the systematic level of risk of either the S&P500 or Euronext-100 index. In order to compare both the returns of the indices it is necessary to control for this systematic risk; a lower risk leads to a lower return and a higher risk leads to a higher return. When the higher returns for the Brazilian stock market are fully explained by the relatively high β, this implicates presence of a higher systematic risk. The results can be interpreted as that no stock market bubble occurred; the higher returns are only due to the higher risk of the Brazilian Stock Market. The fitted values of the Brazilian stock return are thus given by:

5. **$Rt(Ibovespa) = \beta * Rt(S\&P500)$, and**
6. **$Rt(Ibovespa) = \beta * Rt(Euronext\text{-}100)$**

These can be rewritten towards easier understandable formulas:

7. **$Rt(Ibovespa) - \beta * Rt(S\&P500) = 0$**
8. **$Rt(Ibovespa) - \beta * Rt(Euronext\text{-}100) = 0$**

These formulas indicate that there are excessive returns in Brazil when α is significantly above 0.

[29] Stock Market Linkages: Evidence from Latin America, by Chen, Firth and Rui, Journal of Banking & Finance, Vol 26, page 1113, 2002.

As stated before these excessive returns can be explained by differences in country specific economical indicators between the various countries. When analysing the GDP growth development during the period 2006-2011 for each of the regions, it becomes clear that Brazil has a higher average monthly GDP growth rate than the United States or Europe. This is confirmed when looking at the average Industrial Growth compared to the previous month of the 3 regions: Brazil's average monthly Industrial Production growth rate is 0.43% for the pre-financial crisis period and 1.04% for the post crisis period. While the average Industrial Production monthly growth rate for the United States is 0.09% during the pre-financial crisis period and 0.36% during the post-financial crisis period. And for Europe the average Industrial Production monthly growth rate is 0.33% during the pre-financial crisis period and 0.58% during the post-financial crisis period.
Next to the differences in GDP monthly growth rates there is also a difference in the region's inflation rates that might lead to higher returns for the Brazilian stock market compared to the returns of the American and European stock market. When analysing the graphical development of the inflation rates during the periods January 2006 – April 2008 and April 2009 – February 2011, it becomes obvious that the average monthly inflation rate (CPI) in Brazil was higher than in the United States or Europe. This is confirmed when looking at the average Consumer Price Index compared to the previous month of the 3 regions: Brazil's average monthly inflation rate is 0,343% during the pre-financial crisis period and 0,452% during post-financial crisis period. For the United States the average monthly inflation rate is 0.313% during the pre-financial crisis period and 0.173% during the post-financial crisis period. For Europe the average monthly inflation rates are 0.223% for the pre-financial crisis period and 0.124% for the post-financial crisis period.

Therefore I decided to implement these 2 monthly economic indicators in my regression formula to test for bubbles and so to control for differences in Industrial Production growth and different inflation rates. The regression formula can be shown as:

9. $\mathbf{Rt(Ibovespa) = \alpha + \beta * Rt(S\&P500) + \gamma * (IP_{BRA} - IP_{US}) + \lambda * (CPI_{BRA} - CPI_{US}) + \varepsilon}$
10. $\mathbf{Rt(Ibovespa) = \alpha + \beta * Rt(Next\text{-}100) + \gamma * (IP_{BRA} - IP_{EU}) + \lambda * (CPI_{BRA} - CPI_{EU}) + \varepsilon}$

Rt(Ibovespa) is the return for the Brazilian stock market, Rt(S&P500) and Rt(Next-100) are the returns for the United States and European stock market. The α, β, γ and λ are the regression coefficients, and ε is the Gaussian white-noise error term, and is expressed as:

11. $\mathbf{\varepsilon \mid X \sim N(0,\sigma^2)}$

As stated before, the β indicates the difference in systematic risk of the Ibovespa and the S&P500 or the Euronext-100. α is the indicator for abnormal returns, γ describes the relation of the difference in Industrial Production growth rates between Brazil and the United States or Europe, λ describes the relation of the difference CPI between Brazil and the United States or Europe with the Brazilian returns.
The difference in Industrial Production between the countries is related to the high returns, because a high Brazilian Industrial Production growth rate means that Brazil is performing well in terms of volume of output produced, by activities engaged in mining, manufacturing and production of electricity, gas and water. Hence, if overall economic output is increasing, most companies will be able to increase profits as well. These rising profits are the primary driver of stock performance, hence when profits grow, the overall stock returns are expected to grow. The difference between the Industrial Production of Brazil and the United States or

Europe multiplied by its regression coefficient γ has to be added to the stock market return of the United States in Europe in order to equal the Brazilian returns.
The difference in Inflation rates expressed by CPI is related to the difference in stock market returns, because inflation means a rise of prices of goods and services. Stock prices and returns are determined by the net earnings of an entity, the stock prices are directly related to the performance of the company. When inflation is increasing, the company earnings will also subside and hence the stock prices and returns will be affected.

Chapter 5: Test Results

Multiple tests are conducted to check if there was a stock market bubble in Brazil during the pre financial crisis period or/ and post financial crisis period. The model used for calculating the regression coefficients that might indicate the presence of an actual bubble can be found above. With this model β resembles the difference in systematic risk between the different regions; when the higher returns are solely existent due to the presence of a higher systematic risk in Brazil, there is no stock market bubble. Γ and λ are the coefficients that describe the influence of the differences in Industrial Production growth and inflation rates between Brazil and the United States / Europe. α is the most important regression coefficient, because alpha is the only indicator that can illustrate the presence of a stock market bubble. Within this paper I used a significance level of 5 %. I used Eviews to calculate the regression coefficients and these can be found in the **Appendix**. But in order to perform the tests through Eviews I first made work files in Excel. The monthly closing returns of the 3 indices were selected, then the returns were computed on a continuous-time capitalization basis; bubbles are time continuous, they take time to pop and eventually burst. In the same Excel file I computed the monthly Industrial Production and Inflation growth rates. All this data was uploaded to Eviews in order to test for stock market bubbles in Brazil.
We can speak of a stock market bubble when α is significantly above 0, hence the following hypothesis were introduced to test whether α is equal to 0:

1. H_0: $\alpha^{S\&P500}_{\text{January 2006 - April 2008}} = 0$
   H_a: $\alpha^{S\&P500}_{\text{January 2006 - April 2008}} \neq 0$

2. H_0: $\alpha^{\text{euronext-100}}_{\text{January 2006 – April 2008}} = 0$
   H_a: $\alpha^{\text{euronext-100}}_{\text{January 2006 – April 2008}} \neq 0$

3. H_0: $\alpha^{S\&P500}_{\text{April 2009 – February 2011}} = 0$
   H_a: $\alpha^{S\&P500}_{\text{April 2009 – February 2011}} \neq 0$

4. H_0: $\alpha^{\text{euronext-100}}_{\text{April 2009 – February 2011}} = 0$
   H_a: $\alpha^{\text{euronext-100}}_{\text{April 2009 – February 2011}} \neq 0$

The EViews Regression Results display numerous pieces of information for this simple regression. The top window summarizes the input of the regression (Dependent Variable: Ribov), the method chosen to solve the regression (Ordinary Least Squares) and the number of observations (28 or 23). The most important element of EViews regression output is the middle window, which describes the estimated regression coefficients and the statistics associated with each coefficient. The lower window provides summary statistics about the whole regression; I will only use the R^2 item of this window. R^2 measures the overall fit of the regression; it provides a measure of how much of the dependent variable can be explained by the outcomes. When $R^2 = 1$, this means that the regression fits the data perfectly; the data

completely explains the dependent variable. But when $R^2 = 0$, this means that the regression does not have an influence on the dependent variable at all.

EViews automatically computes the test statistic against the hypothesis that a coefficient equals zero. The 5th column under the "Prob" header shows the results of this test. As stated before, with all the tests I used a 5 % significance level and then I can only reject H_0 when the reported p-value is less than 0.05.

α-Test	**P-value**	**Sig 5 %**
S&P500 M1/2006 - M4/2008	0.0504	0.05
Euronext-100 M1/2006 - M4/2008	0.0948	0.05
S&P500 M4/2009 - M2/2011	0.0531	0.05
Euronext-100 M4/2009 - M2/2011	0.1023	0.05

As can be seen in the above test summary all the estimated p-values are above 0.05. This means that for these 4 tests the null hypothesis cannot be rejected. And that we cannot speak of a stock market bubble in Brazil during the periods January 2006- April 2008 and April 2009 – February 2011 with respect to the United States or Europe as a benchmark for the world.

Furthermore, I want to know whether the gamma's are significantly above 0. This would implicate that the difference in monthly Industrial Production growth rates between Brazil and the United States / Europe has a significant effect on the higher returns in Brazil.

γ-Test	**P-value**	**Sig 5 %**
S&P500 M1/2006 - M4/2008	0.983	0.05
Euronext-100 M1/2006 - M4/2008	0.4503	0.05
S&P500 M4/2009 - M2/2011	0.9453	0.05
Euronext-100 M4/2009 - M2/2011	0.366	0.05

The results for testing if the gammas are equal to 0 indicate that they do not significantly differ from 0. The hypothesis H_0 **$\gamma = 0$,** cannot be rejected, hence the difference in monthly Industrial Production growth rates does not have a significant influence in explaining the high returns in Brazil.

To test if Lambda has a significant influence in explaining the high returns in the Brazilian stock market we can compare the given p-values with the 5 % significance level. If the p-values are higher than 0.05 we cannot reject the hypothesis that lambda equals zero. Hence, the difference in monthly inflation rates does not have a significance influence in explaining the higher returns in Brazil.

λ-Test	**P-value**	**Sig 5 %**
S&P500 M1/2006 - M4/2008	0.9737	0.05
Euronext-100 M1/2006 - M4/2008	0.2514	0.05
S&P500 M4/2009 - M2/2011	0.0082	0.05
Euronext-100 M4/2009 - M2/2011	0.3658	0.05

As can be seen in the table above, one of the test results is significant. During the post financial crisis period of April 2009 until 2011 the difference in monthly inflation rates

between Brazil and the United States has a significant influence in explaining the higher returns in Brazil. The coefficient that resembles this influence is equal to -0.110189. This means that the difference in monthly inflation rates between Brazil and the United States has a negative impact on the Brazilian returns. The higher inflation in Brazil compared to the United States resulted in a negative impulse for the Brazilian stock market.

When looking at the results for the β coefficients we can conclude that every beta is significantly above 0; its respective p-value is below 0.05, we can reject the hypothesis that beta equals zero.

B-Test	P-value	Sig 5 %
S&P500 M1/2006 - M4/2008	0.0039	0.05
Euronext-100 M1/2006 – M4/2008	0.0015	0.05
S&P500 M4/2009 - M2/2011	0.0000	0.05
Euronext-100 M4/2009 – M2/2011	0.0000	0.05

This is expected, because beta represents the systematic risk of the indices. Thus beta is expected to lay around 1. When beta would be exactly 1, this would mean that there are no differences in systematic risk between the Brazilian, American and European stock markets.

The values computed by EViews for R^2 represent the fraction of the variance of the dependent variable explained by the regression. R^2 represents the amount to which the Brazilian stock market returns can be explained by the input of the regression equation. The closer R^2 is to 1, the bigger the fraction of the variance of the dependent variable is explained by the regression. If on the other hand R^2 is equal to zero, this means that the regression does not have explanatory power towards the dependent variable.

Period	R^2
S&P500 M1/2006 - M4/2008	0.304814
Euronext-100 M1/2006 - M4/2008	0.400663
S&P500 M4/2009 - M2/2011	0.773415
Euronext-100 M4/2009 - M2/2011	0.743294

The results for R^2 indicate that during the period January 2006 until April 2008 the Brazilian returns can be explained for less than 50% by multiplying the returns of the S&P500 and Euronext-100 with a systematic risk factor, plus a gamma factor multiplying the difference in Industrial Production and a factor lambda multiplying the difference in inflation rates. This means that besides these variables there are multiple other variables of importance with regard to the Brazilian returns. For the period April 2009 until February 2011 the explanatory power of the regression is a lot stronger resulting in a R^2 of 75%. This means that around 75% of the Brazilian returns are explained by the variables incorporated within this regression namely, the systematic risk, S&P500/Euronext-100 returns, factor gamma, differences in Industrial Production, factor lambda and differences in inflation. This still means that there were some other variables existing but only with a minor influence. The difference in R^2 between both periods means that during the first period there were some other variables with explanatory power existent that were not present during the second period.

To summarize, multiple tests were conducted for analysing the estimated results for the regression formula. The results indicate that there was no stock market bubble during January

2006 – April 2008 and April 2009 – February 2011, because the alpha regression coefficient is not significantly below 0.05, hence the null hypothesis cannot be rejected. Gamma is not significant either; this indicates that the differences in Industrial Production between Brazil and the United States and Europe does not have a significant influence in explaining the high returns of the Brazilian stock market. The differences in Inflation rates between Brazil and the United States and Europe do not significantly influence the high returns of the Brazilian stock market. Except for the United States during the post financial crisis period of April 2009 until February 2011; during this period the difference in inflation rates between Brazil and America has a significant influence in explaining the higher returns in Brazil.

Chapter 6: Economic Interpretation of the Test Results

Although the performed tests indicate that the difference in GDP growth and inflation between Brazil and the chosen benchmark have no significant influence in explaining the stock market returns in Brazil, they do function though as indicators for the economical performance. Theory suggests a causal relation between financial development and economic growth. Levine and Zervos (1996a) analysed 41 stock markets in 24 different countries, they conclude that there is a strong correlation between economic growth and the development of the stock market. Rogers, Ribeiro and Securato (2008) found that the macroeconomic variables used in explaining the stock market performance of a country are GDP growth, inflation, the exchange rate, country's risk, the performance of international stock market and the domestic and external interest rates.[30]

GDP growth increases the added value of goods and services consumed. Companies have rising profits and this result in rising stock prices. Therefore GDP growth rates have a positive relation to the stock returns. In the test results it can be seen that the difference in Industrial Production between Brazil and the United States and Europe has a positive relation with the high returns in Brazil for the pre financial crisis time period. This means that the higher GDP growth of Brazil compared to the United States and Europe is positively related to the high returns in the Brazilian stock market. The performed coefficient test however indicates that this positive relation does not significantly exist. The regression coefficient is not significantly above 0. Hence, the difference in economic growth does not have a direct impact in explaining the high returns; this can be due to the fact that the growth rate differences are already incorporated within the stock returns.

Inflation means that prices of goods and services are rising, resulting in lower profits for companies and hence lower stock prices. Inflation is thus negatively related to the stock returns. As can be seen in the test results the difference in CPI between Brazil and the United States and Europe has a negative relation in explaining the returns in Brazil. For 2009-2011 the difference in inflation rates between Brazil and the United States are significant. For Europe, on the contrary this is not the case. This might be due to the relatively stable inflation in the United States, while in Europe the inflation was a lot more volatile. The average inflation in Europe is based on the inflation of the Euro holding countries; these countries all have different economical development and performance situations, which caused the more volatility of the inflation in the Euro area.

The economy of Brazil is the world's seventh largest by nominal GDP and eight largest by purchasing power parity. The Brazilian economy is an inward-oriented economy and it is flourishing. Last year the economy expanded by 7% and this year is it expected to grow

[30] Corporate Governance, Stock Market and Economic Growth in Brazil, by Rogers, Ribeiro and Securato in Corporate Ownership & Control, Vol. 6, Issue 2, Winter 2008

around 4%. The relatively high commodity prices function as a boost for Brazil's export earnings and the continuously growing consumption needs of the Brazilians function as the main driver for their nation's economic rise. These factors explain why the Brazilian stock market was performing better during 2006 - 2008 than the European and American stock markets.
While the Brazilian economy entered another growth cycle, the European and American economies were stagnating. Consumer debt as well as mortgage debt were low at that time in Brazil, unlike in Europe and the United States. The Americans have been overspending for years, resulting in a gigantic national debt. Furthermore the Central Bank of Brazil has been very strict with regulations due to the Brazilian banking crisis in the 1990s. The financial crisis impacted all regions dramatically, but the difference between the impact on the Brazilian economy versus the European and American economy was that the problems in Brazil stem from international factors, not from domestic factors.
The global crisis was caused by the Americans, which resulted in a major lack of confidence of the public in the American economy, together with the overspending of the American government this toughened the recovery process. The financial crisis recovery in Europe was toughened by the situation of economic recess in some of the member countries. The global financial crisis led to a debt crisis in the European Union which is affecting consumer confidence and result in stagnating stock markets.
Brazil, inward-oriented, felt the financial crisis strongly in the industry sector, the export dropped significantly due to collapsing demands. But the service and retail sector were barely affected by the global financial crisis; the minimum salary was increasing over the inflation rate. Together with the rise in social security and social welfare spending by the government this led to a growth in real income and retail trade. Therefore, the problems faced by Brazil caused by the financial crisis stem from international factors; a lack of credit and collapsing demand for exports. The problems do not result from domestic financial mismanagement and therefore the Brazilian stock market was performing better during 2009-2011 than the American and European stock markets. Regardless that the Brazilian stock market is recovering quicker and performing better than the European and American stock market I can not conclude that there was a stock market bubble in Brazil during these periods. The tests performed indicate that the returns are caused by a difference in risk between the various stock markets and that they can be explained by some factors not incorporated in this model.

Chapter 7: Conclusion

The goal of this research paper was to detect if there was a stock market bubble in Brazil (the BM&FBOVESPA) during 2006-2011. This is done with the use of 2 statistical test systems. I compared the Brazilian stock market with the World Stock Market. The American and European stock markets were used as proxies for the World stock market. To eliminate stock specific anomalies I used the leading index of each stock market to increase the reliability, the Ibovespa (Brazil), the S&P500 (US) and Euronext-100 (EU). The patterns of these indices indicate there was a steep increase in the Brazilian stock market during the pre-financial crisis period (2006-2008) and during the post-financial crisis period (2009-2011). These graphs are in line with my hypothesis: There was a stock market bubble in the Brazilian Stock Exchange during 2006-2011.

An effective model to test for these stock market bubbles is developed, while controlling for systematic risk. With the use of Eviews and SPSS the regression coefficients are estimated. Besides controlling for differences in systematic risk, 2 other economic indicators were included that maybe could explain the high Brazilian returns, namely differences in GDP growth and inflation between Brazil and the United States or Europe.

In this research, 2 methods were used to detect stock market bubbles in the BM&FBOVESPA, one with graphs and one with statistical testing. The method with graphs indicates that there might be a stock market bubble in Brazil. The very strong increase in stock prices before and after the financial crisis suggests the existence of a stock market bubble. The statistical findings however contradict this; the statistical tests explain these high returns with the difference in systematic risk and some other factors. They deny the existence of a stock market bubble and consequently explain the high returns as the normal valuation of the people for the companies. According to the statistical tests the difference in monthly Industrial Production rates do not significantly influence the high Brazilian returns compared to its American and European counterparts. Furthermore the difference in monthly inflation between Brazil and the United States and Europe is expected to have an influence in explaining the high returns in the Brazilian stock market. Inflation is negatively related to the stock market returns, this is supported by the test results. But the difference in inflation only has a significant influence in explaining the high returns when comparing the returns on the Ibovespa to the returns of the S&P500 for the period 2009-2011.

If there is a stock market bubble, then alpha would be significantly above 0. As can be seen in the results the test probability for the individual alpha's exceed the significance level, consequently we can not reject the null hypothesis; that alpha is significantly greater than 0. This means that we can not conclude that there was a stock market bubble in Brazil during 2006-2008 or 2009-2011. The high returns in Brazil can be partly explained through the systematic risk, but there are more factors that might explain the high Brazilian returns.

Chapter 8: References

A Random Walk Down Wall Street, By Burton Malkiel, Revised Edition, 2007

Anatomy of Stock Market Bubbles, By Gyorgy Komaromi, ICFAI Books, 2006

Testing for Stock Market Bubbles Using Non Linear Models and Fractional Integration, By J. Cunado, L. A. Gil-Alana and F. Perez de Gracia, Applied Financial Economics, Vol.17, page 1313-1321, 2007

The Behavior of Stock Market Prices, By Eugene F. Fama, The Journal of Business, Vol. 38, 1965

Stock Market Bubbles, By Michael James, http://www.EzineArticles.com

What is an Asset Price Bubble: An Operational Definition, By Siegel, European Financial Management, Vol.9, No. 1, page 11-24, 2003

Stock Market Bubbles in the Laboratory, By David P. Porter, Vernon L. Smith, The Journal of Behavioral Finance, Vol. 4, No. 1, page 7-20, 2003

The Quality of Financial Statements: Perspective from the Recent Stock Market Bubble, By Stephen H. Penman, Department of Accounting, 2002

Reaction of the Brazilian Stock Market to Positive and Negative Shocks, By Otavio R. De Medeiros, Department of Accounting, 2005

Long-range Correlations and Non Stationarity in the Brazilian Stock Market, By R.L.Costa and G.L.Vasconcelos, Laboratorio de Fisica e Computacional, published in Elsevier Science, Nr 2, 2008,

Stock Market Linkages: Evidence from Latin America, By Gong-meng Chen, Michael Firth and Oliver Meng Rui, Journal of Banking & Finance, Vol. 26, Issue 6, pages 1113-1141, 2002

A Behavioral Fuzzy Model for Analysis of Overreaction and Underreaction in the Brazilian Stock Market, By Renato A. Aguiar, Roberto Moura Sales and Lucy A. Sousa, 2005

Brazilian Market Reaction to Equity Issue Announcements, By Otavio R. De Medeiros and Alberto S. Matsumoto, Brazilian Administration Review, Vol 2, No. 2, pages 35-46, 2005

A Simple Procedure for Detecting Periodically Collapsing Rational Bubbles, By Zacharias Psaradakis, Economic Letters, Vol. 72, pages 317-323, 2001

Intrinsic Bubbles: The Case of Stock Prices, By Kenneth A. Froot and Maurice Obstfeld, Journal of American Economic Review, Vol. 81, pages 1189-1214, 1991

Rational Speculative Bubbles: An Empirical Investigation of The London Stock Exchange, By Chris Brooks and Apostolos Katsaris, Bulletin of Economic Research, Vol.55, pages 319-346, 2003

Co Integration and Test of Present Value Models, By John Y. Campbell and Robert J. Shiller, Journal of Political Economy, Vol. 95, No 5, pages 1062-1088, 1987

Intrinsic Bubbles in the American Stock Exchange: The case of the S&P500 Index, By Kamel Naoui, International Journal of Economics and Finance, Vol. 3, No 1, 2011

Econometric Test of Asset Price Bubbles: Taking Stock, By Refet S. Gurkaynak, Finance and Economics Discussion Series, No. 4, 2005

Event Studies in Economics and Finance, By A. C. Mackinlay, Journal of Economic Literature, Vol. 35, No. 1, 1997

Risk Aversion, Uncertainty Information and Market Efficiency, By Keith Brown, W.V. Harlow and Seha M. Tinic, Journal of Financial and Quantitative Analysis, 1988

The Behavior of Secondary European Stock Markets to Positive and Negative Shocks, By Yochanan Shachmurove, International Journal of Business, Vol. 7, No 2, 2002

Corporate Governance, Stock Market and Economic Growth in Brazil, By Pablo Rogers, Karem C. S. Ribeiro and Jose Roberto Securato, Corporate Ownership & Control, Vol. 6, No. 2, 2008

Websites:
http://www.bmfbovespa.com.br/en-us/home.aspx?idioma=en-us
http://www.capital-flow-analysis.com/investment-tutorial/case_1h.html#down, Professional Capital Flow Analysis, By Schroy 2006
http://stats.oecd.org/index.aspx, Monthly Economic Indicators, Main Economic Indicators
http://www.oecd.org/dataoecd/48/35/2371876.pdf

Appendix

Chapter 1: Eviews output for the Ordinary Least Squares Regression:

1. **$Rt(Ibovespa) = \alpha + \beta * Rt(S\&P500) + \gamma * (IP_{BRA} - IP_{US}) + \lambda * (CPI_{BRA} - CPI_{US}) + \varepsilon$**
   For the time window January 2006 – April 2008
   α is resembled by C
   β is represented by RSP500
   γ is represented by IND_PROD_BRA_US
   λ is represented by CPI_BRA_US

Dependent Variable: RIBOV
Method: Least Squares
Date: 07/28/11 Time: 15:46
Sample: 1 28
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.027876	0.013532	2.060084	0.0504
RSP500	1.589690	0.497192	3.197337	0.0039
IND_PROD_BRA_US	-0.000207	0.009637	-0.021507	0.9830
CPI_BRA_US	0.001164	0.034895	0.033346	0.9737

R-squared	0.304814	Mean dependent var	0.032261
Adjusted R-squared	0.217916	S.D. dependent var	0.078708
S.E. of regression	0.069606	Akaike info criterion	-2.360382
Sum squared resid	0.116278	Schwarz criterion	-2.170067
Log likelihood	37.04535	Hannan-Quinn criter.	-2.302201
F-statistic	3.507710	Durbin-Watson stat	2.117100
Prob(F-statistic)	0.030664		

2. **$Rt(Ibovespa) = \alpha + \beta * Rt(Next\text{-}100) + \gamma * (IP_{BRA} - IP_{EU}) + \lambda * (CPI_{BRA} - CPI_{EU}) + \varepsilon$**
   For the time window January 2006 – April 2008
   α is resembled by C
   β is represented by REURONEXT
   γ is represented by IND_PROD_BRA_EU
   λ is represented by CPI_BRA_EU

Dependent Variable: RIBOV
Method: Least Squares
Date: 07/28/11 Time: 15:48
Sample: 1 28
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.023279	0.013386	1.739056	0.0948
REURONEXT	0.942023	0.263376	3.576725	0.0015
IND_PROD_BRA_EU	0.007227	0.009417	0.767422	0.4503
CPI_BRA_EU	-0.036568	0.031114	-1.175319	0.2514

R-squared	0.400663	Mean dependent var	0.032261
Adjusted R-squared	0.325746	S.D. dependent var	0.078708
S.E. of regression	0.064629	Akaike info criterion	-2.508738
Sum squared resid	0.100246	Schwarz criterion	-2.318423
Log likelihood	39.12234	Hannan-Quinn criter.	-2.450557
F-statistic	5.348094	Durbin-Watson stat	1.781420
Prob(F-statistic)	0.005779		

3. **$Rt(Ibovespa) = \alpha + \beta * Rt(S\&P500) + \gamma * (IP_{BRA} - IP_{US}) + \lambda * (CPI_{BRA} - CPI_{US}) + \varepsilon$**
For the time window April 2009 – February 2011
α is resembled by C
β is represented by RSP500
γ is represented by IND_PROD_BRA_US
λ is represented by CPI_BRA_US

Dependent Variable: RIBOV
Method: Least Squares
Date: 07/26/11 Time: 15:43
Sample: 1 23
Included observations: 23

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033855	0.016412	2.062811	0.0531
RSP500	1.351196	0.194582	6.944106	0.0000
IND_PROD_BRA_US	-0.000401	0.005770	-0.069567	0.9453
CPI_BRA_US	-0.110189	0.037341	-2.950902	0.0082

R-squared	0.773415	Mean dependent var	0.040924
Adjusted R-squared	0.737638	S.D. dependent var	0.098629
S.E. of regression	0.050519	Akaike info criterion	-2.976172
Sum squared resid	0.048491	Schwarz criterion	-2.778695
Log likelihood	38.22598	Hannan-Quinn criter.	-2.926507
F-statistic	21.61788	Durbin-Watson stat	1.940187
Prob(F-statistic)	0.000002		

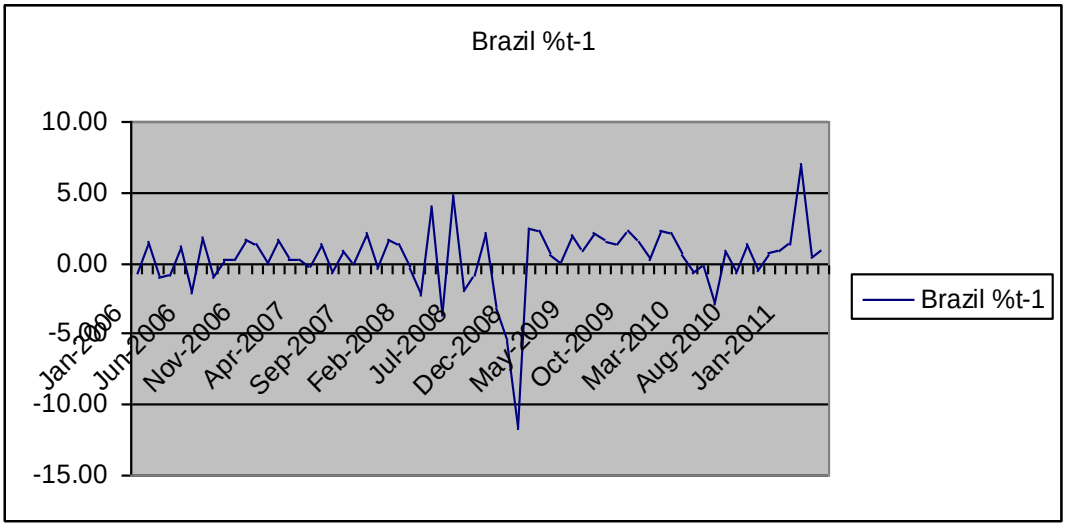
4. **$Rt(Ibovespa) = \alpha + \beta * Rt(Next\text{-}100) + \gamma * (IP_{BRA} - IP_{EU}) + \lambda * (CPI_{BRA} - CPI_{EU}) + \varepsilon$**
For the time window January 2006 – April 2008
α is resembled by C
β is represented by REURONEXT
γ is represented by IND_PROD_BRA_EU
λ is represented by CPI_BRA_EU

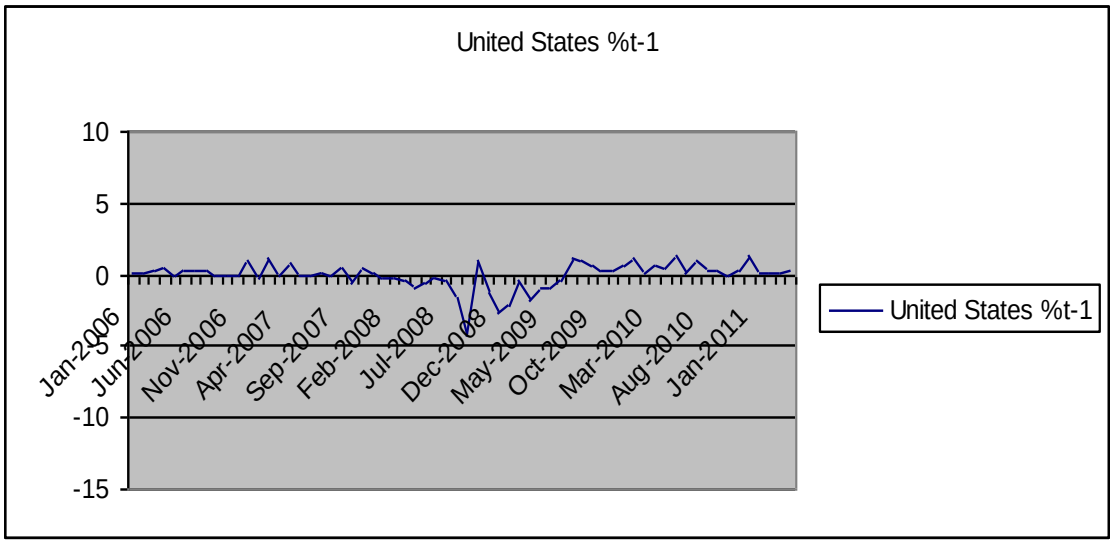
Dependent Variable: RIBOV
Method: Least Squares
Date: 07/26/11 Time: 15:44
Sample: 1 23
Included observations: 23

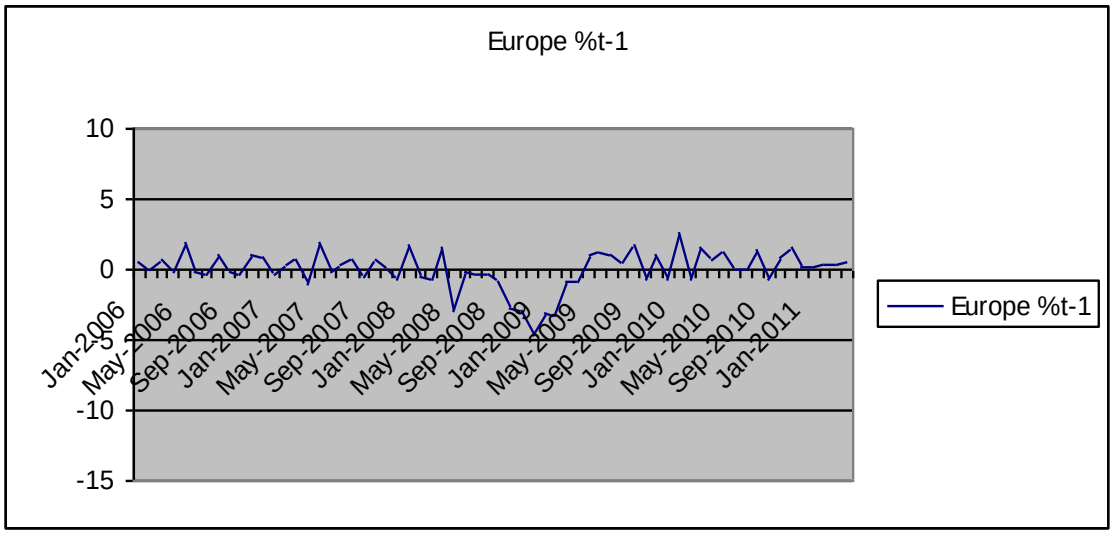
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.024311	0.014164	1.716411	0.1023
REURONEXT	1.035981	0.143092	7.239945	0.0000
IND_PROD_BRA_EU	-0.005406	0.005837	-0.926094	0.3660
CPI_BRA_EU	-0.021562	0.023274	-0.926436	0.3658

R-squared	0.743294	Mean dependent var	0.040924
Adjusted R-squared	0.702761	S.D. dependent var	0.098629
S.E. of regression	0.053772	Akaike info criterion	-2.851361
Sum squared resid	0.054937	Schwarz criterion	-2.653884
Log likelihood	36.79065	Hannan-Quinn criter.	-2.801696
F-statistic	18.33820	Durbin-Watson stat	2.372856
Prob(F-statistic)	0.000008		

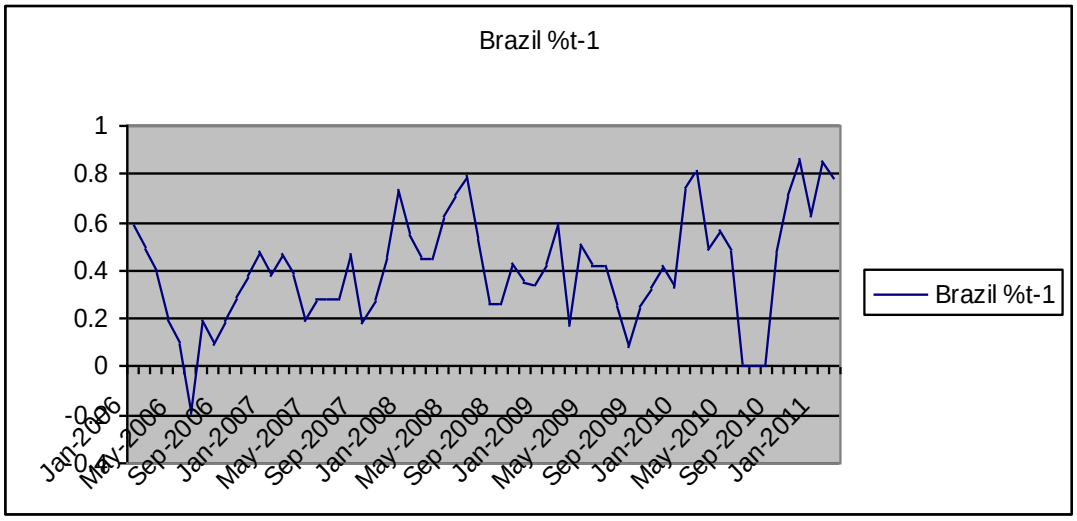
Chapter 2: Industrial Production Graphical Development January 2006 - February 2011

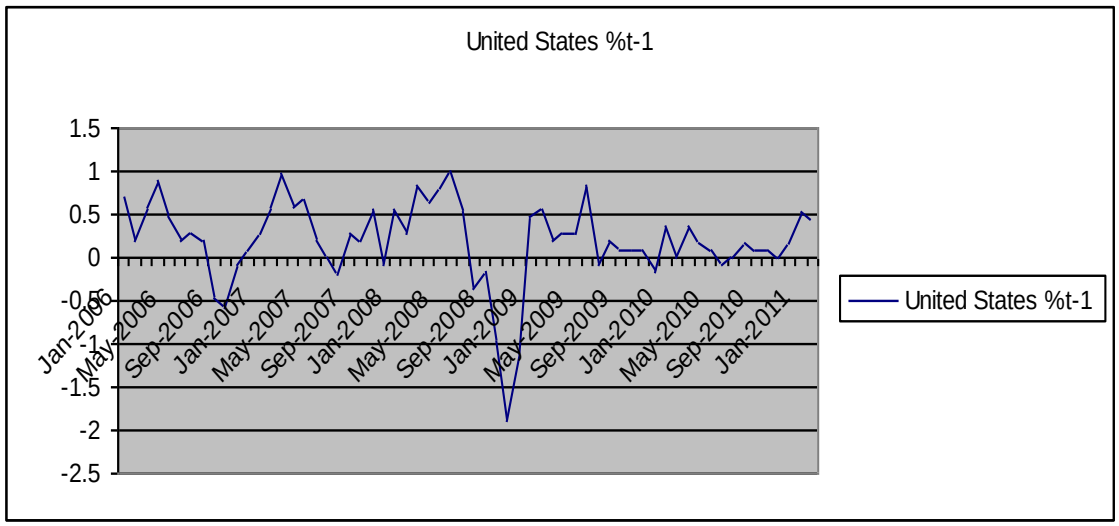


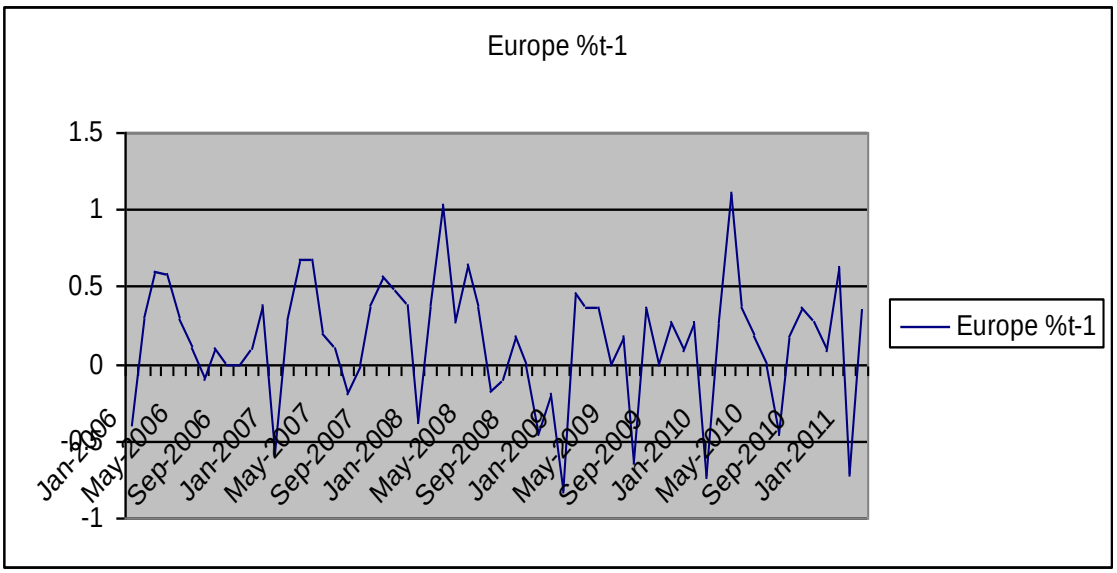




Chapter 3: CPI Graphical Development January 2006 – February 2011

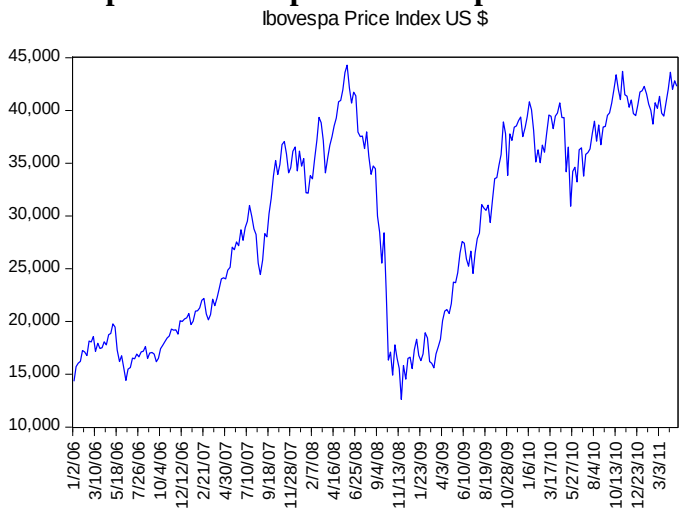




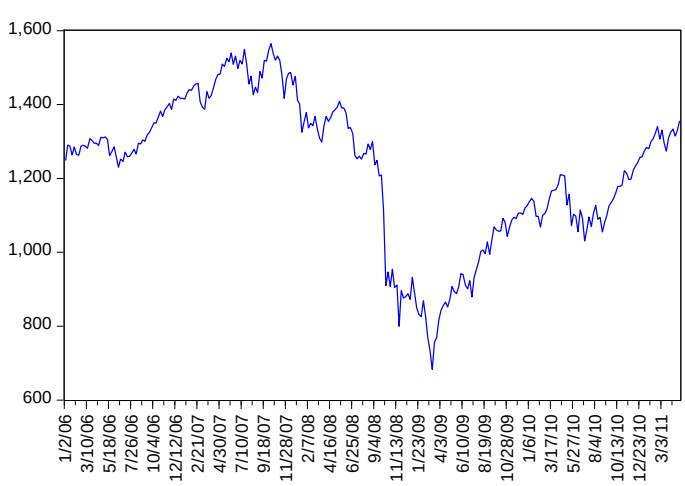


Chapter 4: Graphical Development Indices

1A Graphical Development Ibovespa 2006-2011



1B Graphical Development S&P500 2006-2011



1C Graphical Development Euronext-100 2006-2011