The Sao Paulo Stock Exchange and the Economic Stabilization

Track: Finance

Key Words: Economic Stabilization, Stock Exchange

Author:
William Eid Junior
Full Professor
Finance Department
FGV/EAESP
Escola de Administração de Empresas de São Paulo (The Sao Paulo Management School)
Fundação Getúlio Vargas
Av. Nove de Julho 2029
São Paulo SP 01313-902
E-mail: weid@fgvsp.br
Phone: 55 11 3023-0015
Fax: 55 11 3023-0675

The Sao Paulo Stock Exchange and the Economic Stabilization

Abstract: The inflationary stabilization recently observed in Brazil brings a lot of changes in all aspects of the country's economic life. In this work we look at the impacts on the stock market, specifically at Bovespa – the São Paulo Stock Exchange. We analyze the leading variables and statistics that describe Bovespa's behavior, such as volatility and systematic risk, comparing the four years preceding and the four years after 1994, when the Real Plan was implemented. In order to eliminate exogenous influences, we use control series made with international Stock Exchanges Indexes. The results show that after 1994 there was reduced volatility, increased trade volume, reduced efficiency of the Bovespa Index and no changes in systematic risk.

Key Words: Economic Stabilization, Stock Exchange

1 - Objectives

The central purpose of this paper is to analyze the impacts of the inflationary stabilization brought about after the introduction of the Real Plan on Bovespa's markets. Aspects such as volatility, return probability distribution, trade volume, volume per trade, market efficiency and systematic risk are at the paper's core. The paper is organized into five sections. This, the first one, deals with the paper's objectives and organization. The second section introduces the paper's hypotheses, the thirth deals with the methodology and data employed, the forth present the results found, and the fifth introduces conclusions.

2 - Hypotheses

In order to develop the study, the following hypotheses were formulated and subsequently tested:

- H1: A drop occurred in assets volatility levels.
- H2: Changes took place as regards the distribution of return on assets probabilities. Distributions became closer to normal distribution.
- H3: There were changes to daily traded volumes and average volume per deal.
  - H3a: Daily traded volumes increased.
  - H3b: Average volume per deal dropped.
- H4: Ibovespa's theoretical portfolio became more efficient as compared to a hypothetical international portfolio.
- H5: Assets systematic risk dropped after the stabilization.

3 – Methodology and data

The purpose of this study is to analyze the effects of the inflationary stabilization promoted by the Real Plan on the behavior of stock exchange trading. In order to do so, we will analyze the behavior of Ibovespa – Bovespa Index – in two periods: in the four years prior to June 30th, 1994, and the four years subsequent to that date[1].

In a study such as this, the construction of control series is required so as to enable operating with the spread between the analyzed variable and the control series, in such a manner as to permit checking whether the analyzed effect takes place in the analyzed market alone or whether it is a global effect. One of the control series used in this study, and labeled Latin American (LA) series, is based on the following Latin American stock exchange rates: Buenos Aires (MERVAL), Santiago de Chile (IPSA) and Mexico City (IPYP). Another series, labeled Central Markets (CM) will comprise the rates for the stock exchanges at New York (S&P500), Tokyo (NIKKEY225), Frankfurt (DAX), Paris (CAC40) and London (FTSE). This will provide us with series with which to analyze the return and volatility in both central markets (CM) and Latin American ones (LA). These series will be built by weighing each rate with the relative GDP of each country in 1997, as described below:

$$Control\ series\ return_t = \sum_{p=1}^{m} r_{pt}.w_p$$

$$r_{pt} = daily\ diário\ at\ country\ p's\ stock\ exchange\ on\ date\ t$$

$$w_p = \frac{GDP_p}{\sum_{i=1}^{m} DGDP_i}$$

$$GDP_p = Country\ p's\ Gross\ Domestic\ Product\ in\ 1997$$

$$m = number\ of\ countries\ comprising\ the\ control\ series$$

All series, including Ibovespa's, have been adjusted to the U.S. Dollar (US$) foreign exchange rate. With the Brazilian and control series, further series can be built to indicate the spread between the variation in the Brazilian market and other markets. This will give us the excess changes in the Brazilian market as compared to other markets for each of the

characteristics addressed. Where these excesses are significantly over zero, we will have an indication of the effects of stabilization.
In some analyses, the entire eight-year period will be divided into one-year periods to enable identification of changes in the behavior of the several indicators over time.
In all analyses, except the ones that deal with trade volume, the figures in point will be computed for Ibovespa and the control series. Subsequently, we will compute the figures referred to herein as excesses by subtracting from the control series the figures obtained from the sample assets.
The aspects to be addressed are:

3.1 Volatility:

Two volatility series will be built and estimated in two distinct ways: a) historic volatility as described in Hull (1998), using a 21-day window:

$$\sigma_{t\ annualized} = \sqrt{251}.\sqrt{\frac{\sum_{i=t-n+1}^{t}(r_i - \bar{r})^2}{n-1}}$$

$$251 = number\ of\ \text{business days in one year}$$

$$n = 21\ observations$$

$$r_t = daily\ return = \ln\left(P_t \big/ P_{t-1}\right)$$

$$\bar{r} = \frac{1}{n}.\sum_{i=t-n+1}^{t} r_i$$

$$P_t = asset\ closing\ price\ on\ date\ t$$

and b) conditional volatility through a Garch-class model as described in Mills (1994). Average and volatility of the excess return volatility (return on the asset minus return on control series) will be computed and compared for the periods prior and subsequent to the Real Plan through variance comparison F-tests, average volatility distribution comparison t-tests, and the spread between the average of two distributions, at a 5% significance level. One-year sub-periods will also be analyzed. Daily returns: also as described in Hull (1998), computed on ongoing bases.

3.2 Daily Traded Financial Volume:

Averages before and after the Real Plan will be compared, as well as the evolution in sub-periods, through t-tests to compare average volatility distributions, and through the difference between the average of two distributions, at a 5% significance level.

3.3 Average Volume per Deal:

Calculated as the quotient of financial volume traded and the number of deals per trading day. Here, too, an averages analysis will be performed by means of t-tests to compare average volatilities distribution, and of the difference between the average of two distributions, at a 5% significance level.

3.4 Efficiency of the IBOVESPA portfolio

Construction of an efficient frontier is required to evaluate changes in the IBOVESPA portfolio's efficiency. This efficient frontier will be built with rates from stock exchanges the world over, thereby mimicking the efficient frontier of a well-diversified investor. An efficient portfolio is a portfolio made up of assets with the least return variance as compared to all other portfolios with the same expected return. An efficient frontier, in turn, is the universe of all efficient portfolios, which can be obtained by means of the following problem concerning the optimization of several expected returns (E(Rp)):

$$Minimize\ Variance(Rp) = \sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j \sigma_{ij}$$

$$subject\ \text{to conditions}:$$

$$E(Rp) = \sum_{i=1}^{N} x_i r_i$$

$$\sum_{i=1}^{N} x_i = 1$$

where Rp is the return on portfolio p, N is the number of risky assets, σ_i is the co-variance of the return on the i-risk asset and the j-risk assets, r_i is the return on the j-risk, and x_i is the percentage share of asset i in portfolio p. We note that, in this case, short selling is allowed, as x_i can be negative.

The first step to building the efficient frontier is to estimate average returns and the variance-co-variance matrix for the returns on the risky assets, which, in this study, are the rates for the countries that make up what, we have termed central markets. We subsequently solve the optimization problem above using the data thus obtained.

Huang and Litzenberger (1989) have demonstrated that the efficient frontier can be obtained from all convex combinations of two efficient portfolios. In this way, we calculate two efficient portfolios and subsequently draw the efficient frontier through the combination of these by varying the w proportion of the equations below:

$$E(Rq) = w.E(Ri) + (1-w)E(Rj)$$

$$\text{Variance}\ (Rq) = w^2\sigma_i^2 + (1-w)^2\sigma_j^2 + 2.w.(1-w)\sigma_{ij}$$

where Rq is the return on portfolio q, Ri is the return on efficient portfolio i, σ_i is the co-variance of the return of portfolios i and j, σ_i^2 is the variance of the return on portfolio i.

In order to build an efficient frontier where short selling of risky assets is not allowed, we add the following restriction to the original optimization problem:

$$x_i \geq 0, i = 1, \cdots, N$$

When short selling is restricted, we can no longer use the combination of two efficient portfolios to build the efficient frontier and, therefore, the optimization problem must be repeated for different expected returns (E(Rp)).

Once the efficient frontiers have been built for the central markets, both with and without risky assets short-selling constraints, we calculate the spread between the Bovespa rate (Ibovespa) and each of the frontiers. In this study, we chose to use the Euclidian spread:

$$\text{Euclidian Spread} = 100.\sqrt{(\text{Return}_{Ibovespa} - \text{Return}_{Frontier})^2 + (\sigma_{Ibovespa} - \sigma_{Frontier})^2}$$

If the spread between Ibovespa and the efficient frontier increases from one period to another, we can assume that Ibovespa became less efficient; if the opposite takes place, we state that the rate became more efficient.

3.5 Systematic Risk

Financial literature proposes two distinct ways of measuring systematic risk: a) use of diversification analysis b) regression under the so-called Market Model. Both will be used here. Regarding the former, the average standard deviation of the assets involved in the study will be compared with the same measurement for portfolios built with different numbers of component assets. This comparison will be drawn monthly and average figures will be computed. It is a notorious fact that portfolios with around 15 assets almost completely eliminate the non-systematic risk of assets. Therefore, comparison between the two average figures will enable observation of systematic risk changes. As regards the use of the Market Model, the control series made up of the New York (S&P500), Tokyo (NIKKEY225), Frankfurt (DAX), Paris (CAC40) and London (FTSE) indexes will be used as market. The regression below will be processed with monthly data:

$$R_{j,t} = a_j + \beta_j R_t + \varepsilon_t$$

where $R_{j,t}$ is the return on asset j at moment t and Rt is the market's return, that is the return on the control series comprising the indexes for central countries. β_j is the systematic-risk measure to be used for the purposes of comparison.

4 - Results

4.1 Volatility

Ibovespa's volatility dropped after the economic stabilization. The next table shows the results found when we analyze the historic volatility of the excess return as compared to Latin American markets and with central markets.

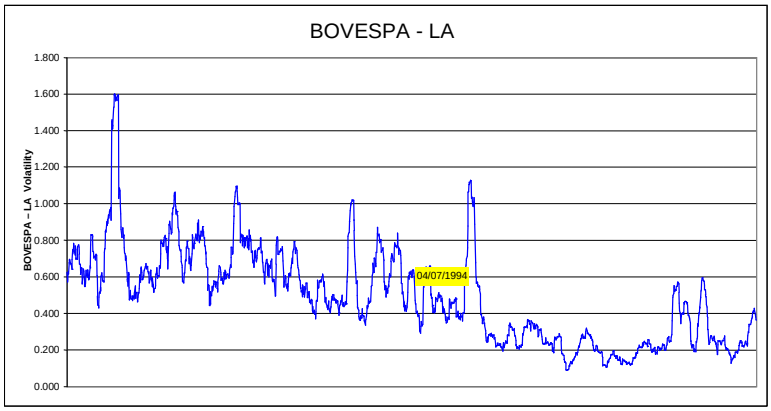
Historic Volatility		
Alfa = 5%	Drop	
Years	Central Markets	Latin America
4	41.3%	50.3%
3	41.9%	49.0%
2	26.9%	36.7%
1	0.0%	6.9%

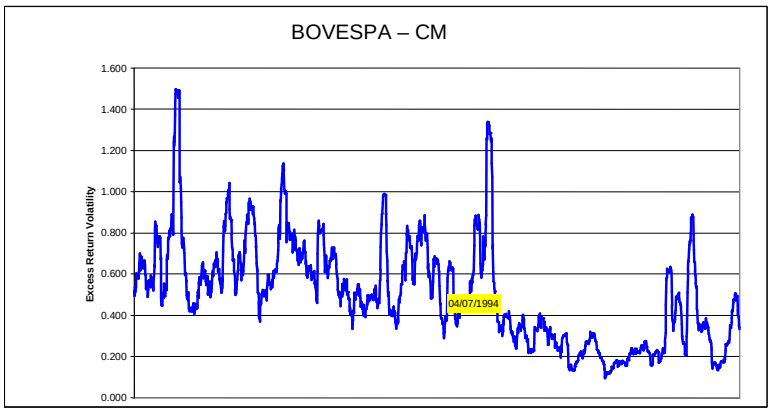
We note that, in general, the longer the observation window, the greater is the observed drop in historic volatility. The same applies to the conditional volatility analysis. For example, using as control series the series pertaining to central markets, we note a 41.3% drop in the Brazilian market's volatility under the 4-year window. The effects of stabilization appear to make

themselves felt over longer periods as, when a 1-year window is used, no drop occurs in relation to central markets and the drop as compared to Latin America is slight.
The table below illustrates the analysis of the conditional volatility of excess returns. A Garch (1,1) model was used to estimate volatility.

Conditional Volatility (GARCH (1,1))		
Alfa = 5%	Drop	
Year	Central Markets	Latin America
4	39.62%	48.2%
3	40.31%	47.0%
2	25.97%	35.2%
1	0.00%	8.3%

The same effect observed in the analysis of historic volatility occurs in connection with conditional volatility analysis. Again, we see that the effects of stabilization make themselves felt over longer time periods. Also in this case, the volatility drop is greater with longer analysis periods. In both cases, the F-tests to compare pre- and post-Real volatility distribution variances and the t-tests performed to compare pre- and post-Real average volatility distributions indicate significant results at 5% significance levels.
The charts below illustrate excess volatility as compared to Latin America (BOVESPA – LA) and Central Markets (BOVESPA – CM), respectively. Also, they permit observation of the relative reduction of the Brazilian market's volatility over time.

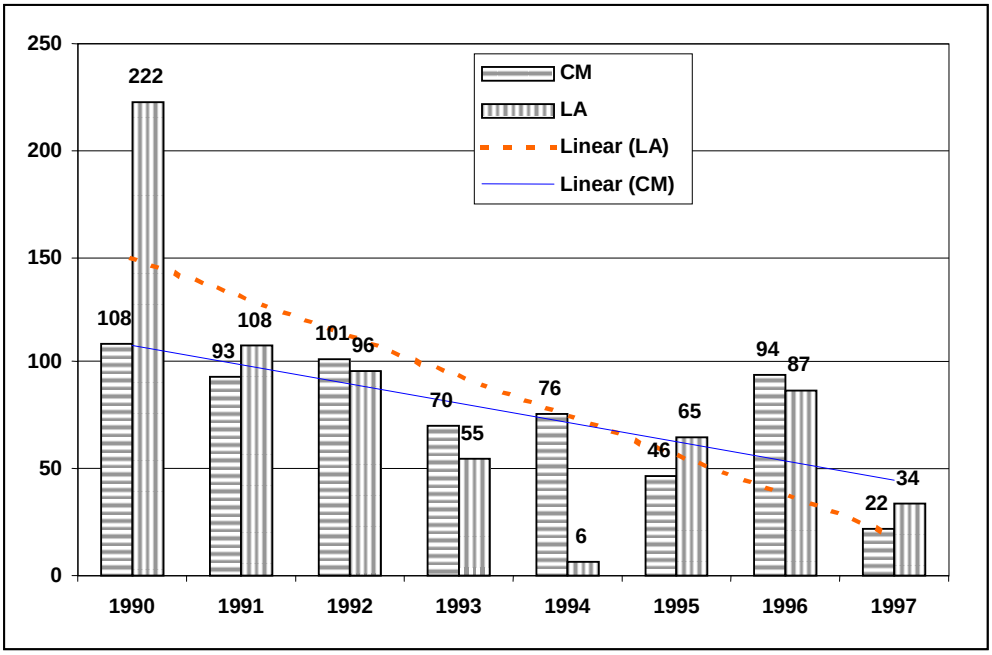




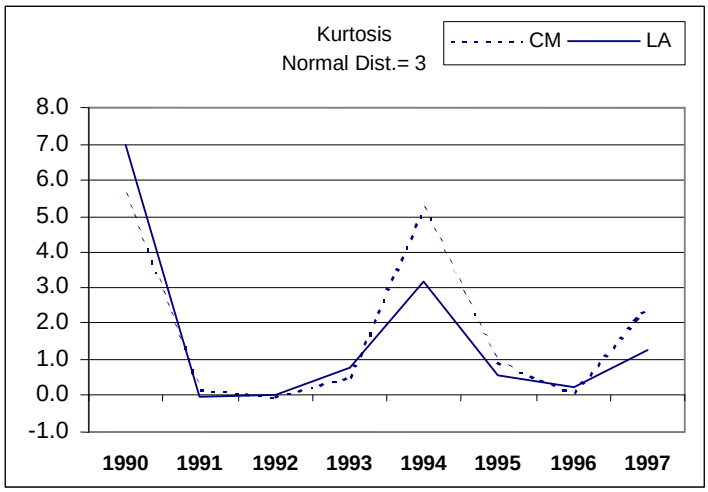
The chart dated 04/07/1994 shows the moment of implementation of the Real Plan and, therefore, the beginning of inflation stabilization in Brazil. We also see, here, a clear drop in excess volatility levels in both cases after the Real Plan was introduced.

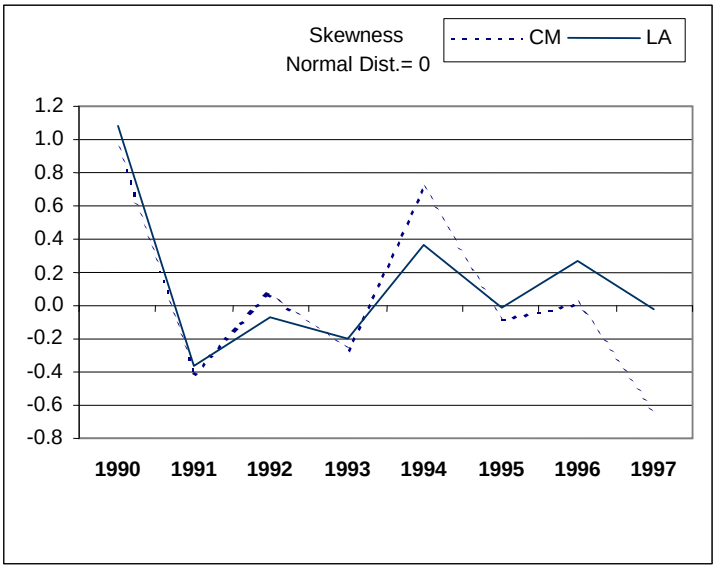
4.2 – Returns distribution

The test used to identify the normality of a series was the Jarque-Bera test, which uses the third and four moments, skewness and kurtosis, to identify deviations from normality. The statistics obtained have χ^2 distribution and the distribution is close to normal if a Jarque-Bera statistic under 5.99 is obtained, at a 5% significance level. The chart below indicates this statistic's behavior for excess returns over time



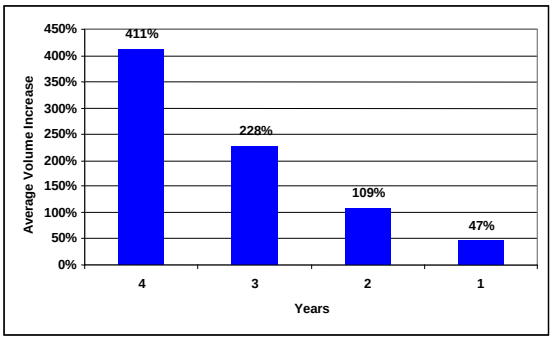
We note that the excess returns series, whether in relation to Central Markets (CM) or Latin American ones (LA) do not, in general, have characteristics consistent with normal distribution. The one exception pertains to the Latin American series in 1994. All others are quite distant from normal distribution. We can, however, note a trend towards greater proximity to normal distribution, represented by the two lines found in the chart. Returns in 1996 do not allow a very conclusive analysis, as the series again become distant from normality. In the remaining years however, this trend can be identified.
The results of the Jarque-Bera test can be confirmed by observing the skewness and kurtosis coefficients of the excess returns over time. The charts below indicate the distance of expected figures from normal distribution at these moments.





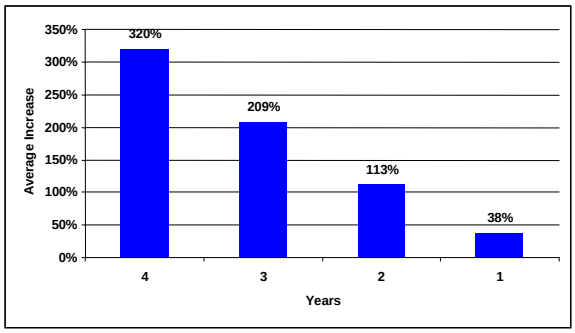
4.3 Daily Traded Financial Volume

Here, we compare traded volumes converted into U.S. dollars at the R$/US$ exchange rate of the date in question prior and subsequently to the introduction of the Real Plan. The next chart indicates the evolution of volume in connection with the period under analysis.



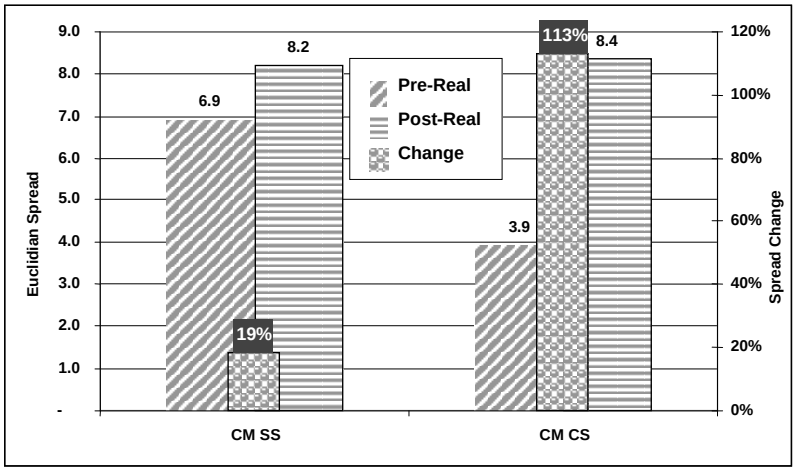
Note that when the average volume in U.S. Dollars in the four-year prior to the Plan is compared to the volume in the four subsequent years, the increase is in excess of 400%. Again, the increase in greater over time, as when the year prior to implementation of the plan is compared to the year after that, growth is limited to 47%.

As regards average volume per deal, the phenomenon is repeated, with greater averages as time advances. The next chart illustrates the phenomenon:

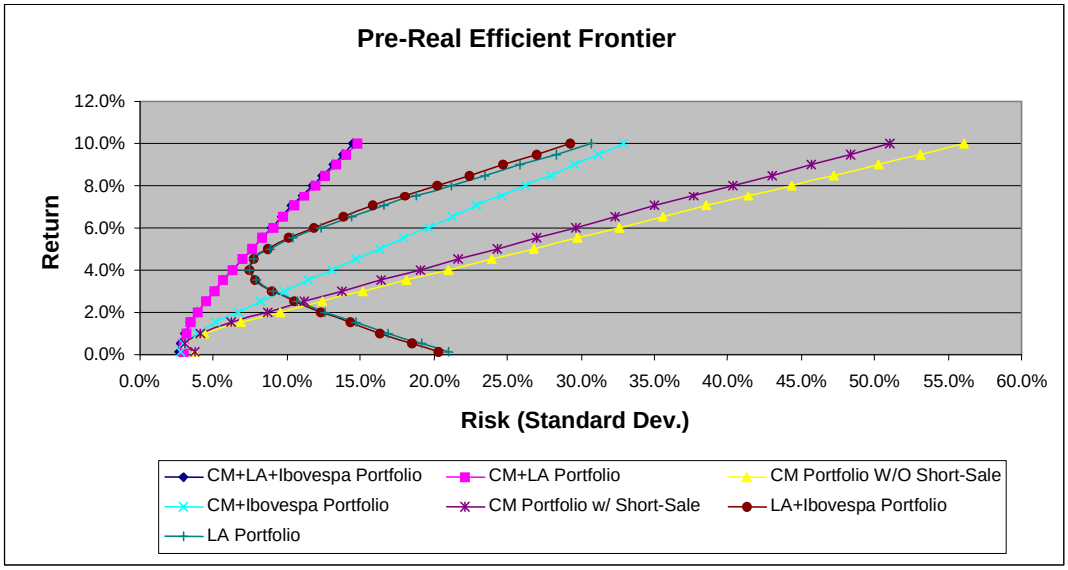


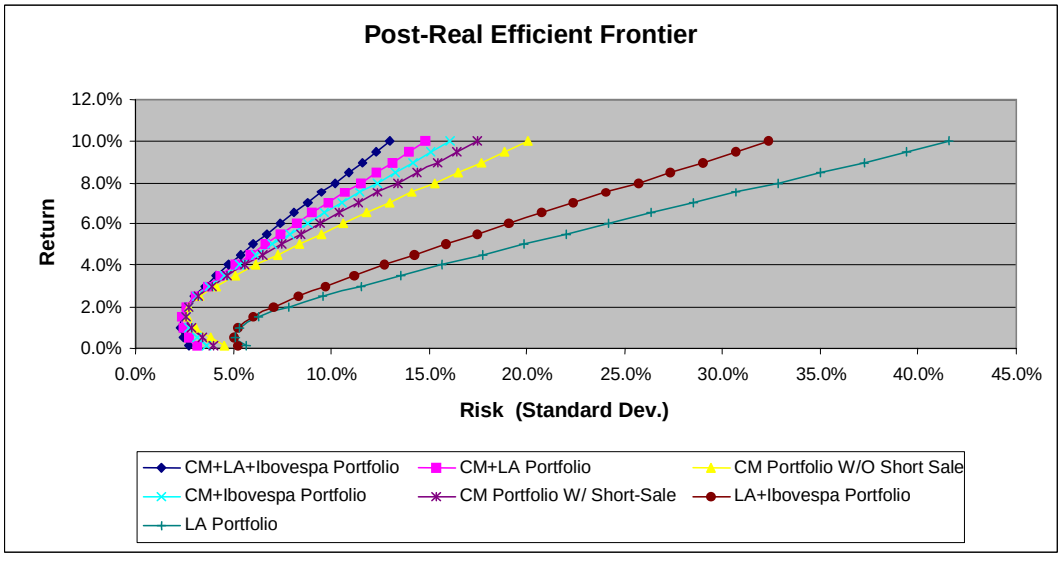
4.4 Market Efficiency

After implementation of the Real Plan and the installation of an inflation environment better aligned with the reality in central countries, the Brazilian stock market became less efficient as compared to a hypothetical portfolio made up of a group of central markets rates. The next chart shows that, both with and without the short-selling constraint (CM SS = no short selling allowed; MC CS = short-selling allowed) in the construction of efficient frontiers, Ibovespa became more distant from the global efficient frontier.



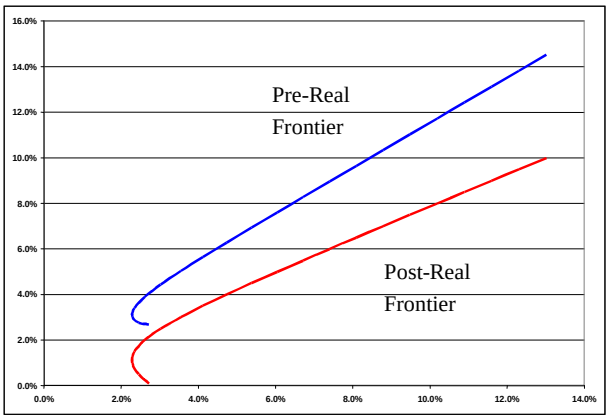
In the case of the short-selling constraint (MC SS case), the Euclidian spread increases by 19%. In the absence of this constraint, the spread increased by 113%, showing a loss of efficiency by the Brazilian market as compared to central ones.
It is also worth noting that the central markets are more efficient than Latin American ones within the medium variance environment. The two charts below show the efficient frontiers drawn with different markets combinations, the first one depicting the pre-Real period and the second one in regard to period after the implementation.





In addition, we also note that insertion of Ibovespa into a hypothetical portfolio, be it made up of Latin American markets only or of all the markets, makes these portfolios more efficient after the Real plan than before. This phenomenon is made clear when we analyze, on the charts, the frontiers for the LA and LA+Ibovespa Portfolios, as well as those for the CM+LA and CM+LA+Ibovespa Portfolios. The greater leftward shift of the frontiers containing Ibovespa after the introduction of the Real Plan is clear.

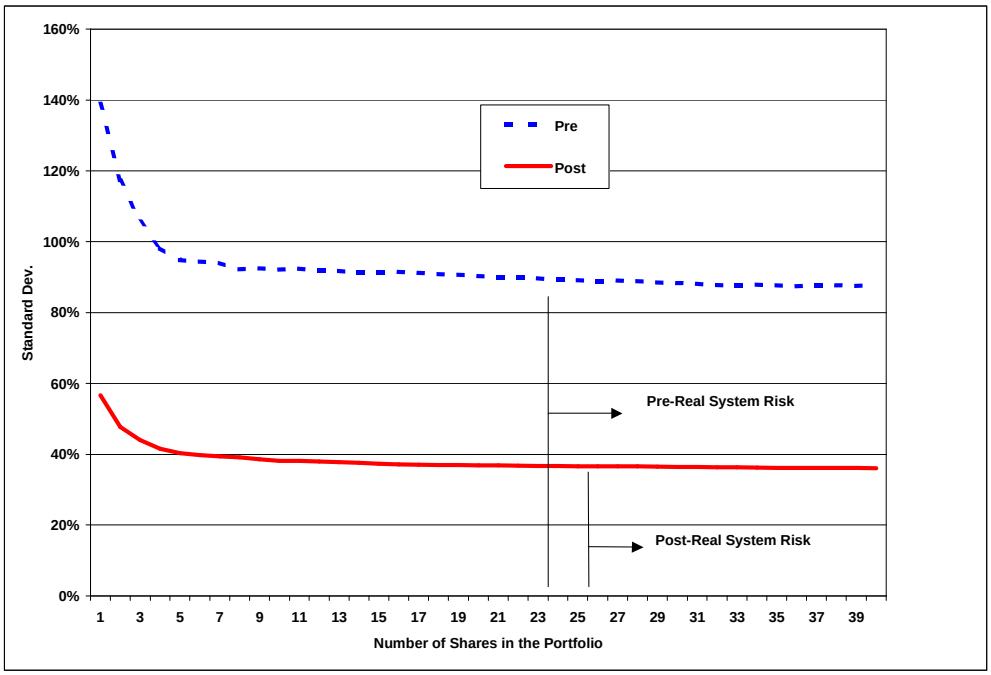
Analysis of the charts also shows another interesting result: global markets became less efficient after 1994. The global frontier, made up of all markets (MC+AL+Ibovespa Portfolio) shifted to the left and down in the chart, indicating that investors get less return for the same level of risk after 1994. The next chart illustrates this behavior, showing two global frontiers: before and after July, 1994. It clearly shows the frontier's downward shift. In this way, investors get less return for a given risk level in the period after the Real than they did previously.



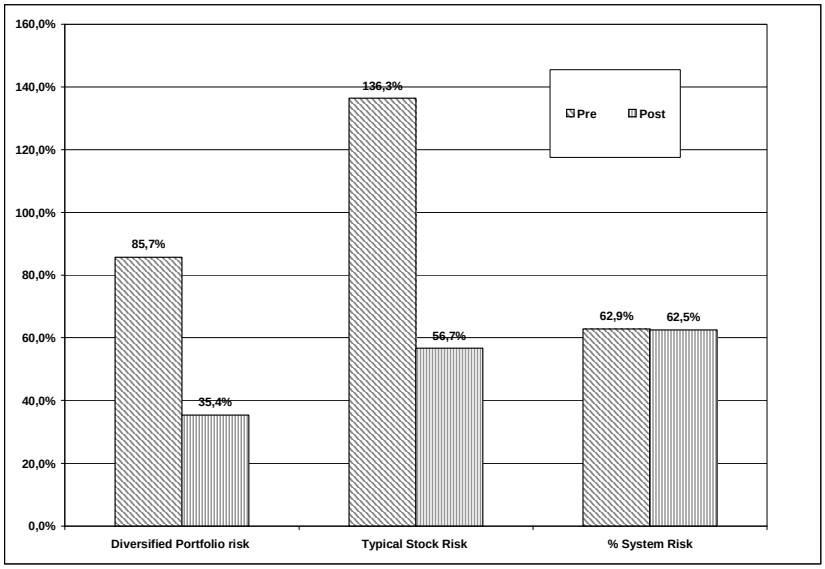
4.5 Systematic Risk: Diversification

The first procedure used to measure the share systematic risk holds in the total risk of a typical stock in the Brazilian market was that of random diversification, as proposed by Evans and Archer (1967). Under this procedure, two investment portfolios of different sizes are built ad their standard deviation is computed. As the number of assets in each portfolio increases, the effect of diversification is felt, with the reduction of the standard deviation. For this study, drawing of lots, and for each portfolio size generated portfolios comprising from 1 to 40 stocks, 40 portfolios were generated. The 57 most liquid stocks in the period that were still active in 1997 were used to construct the portfolios. Monthly return on these was computed for both windows: 4 years before and after the introduction of the Real Plan.

The chart below shows the behavior of the portfolios' standard deviation by number of component stock in the two periods addressed: pre- and post-Real.



Let us make an initial observation: the general risk level of assets at Bovespa dropped perceptibly after 1994. The standard deviation of a typical stock was 139% before 1994 and dropped to 57% afterwards.
However, the composition of the total risk of stocks remained constant, as illustrated by the next chart. Despite the great drop in the total risk of stocks after 1994, the share of total risk attributed to systematic risk remained constant, in the vicinity of 62%.
Studies such as Solnik's (1973) indicate that, unlike what is usually assumed, a greater systematic risk does not have its roots on a country's economic instability, but may relate to the concentration levels at its market. This concentration can be analyzed by means of the composition of market indexes. In the case of Ibovespa and during the period in point, this concentration remained high, justifying the steady systematic risk level.



4.6 Systematic Risk: Market Model

By regressing the monthly returns on Ibovespa against the portfolio made up of central market rates in the pre- and post-Real periods, the results presented in the table below were obtained:

	Pre-Real	Post-Real
Constant	0.06	0.00
Beta	2.98	1.67
Beta t	3.10	3.39

Ibovespa's beta coefficient relative to the market dropped remarkably, showing that, as compared to the other markets, the Brazilian market's systematic risk was reduced by 44%. Note that the betas are statistically significant in both periods. The constants, however, at 95%, are not statistically different from zero. If the figures were significant, we might infer that a drastic drop occurred in the risk-premium offered by the Ibovespa portfolio as compared to those available to investors in central markets.

VI - Conclusions

Our core purpose was to point out what effects the stabilization of inflation rates might have had on the Brazilian stock market. The first conclusion is that stabilization did have effects on the stock market. In order to analyze these effects, we must review the paper's initial hypotheses. The table below introduces the results as regards each of them.

	Hypothesis	**Result**
H1	A drop occurred in assets volatility levels.	Cannot be rejected; we have observed a reduction of both historic and conditional volatility
H2	Changes took place as regards the distribution of return on assets probabilities . Distributions were closer to normal distribution.	Cannot be rejected ; distributions are not normal, but there is a trend towards greater proximity to normal distribution
H3a	Daily traded volumes increased	Cannot be rejected; daily traded volumes did increase
H3b	Average volume per deal dropped	Rejected, average daily volume has increased
H4	Ibovespa's theoretical portfolio became more efficient as compared to a hypothetical international portfolio	Rejected; IBOVESPA's theoretical portfolio became less efficient relative to the global portfolio

H5	Assets systematic risk dropped after the stabilization	Rejected, systematic risk share in stocks remained unchanged.

Some conclusions arise from the analysis of these results. The first pertains to the total risk of Bovespa stocks. After the Real Plan was introduced, stocks risk dropped. Economic stabilization apparently brings about reduced risk. On the other hand, the stable share of systematic risk relative to total risk indicates that the former does not have its roots in macroeconomic instability but, rather, in some other structural market factor, such as concentration. We also note that the beta for the Ibovespa portfolio dropped from the pre- to the post-Real period, indicating better alignment with the global market's behavior.

Another interesting conclusion has to do with the spread from normality in the behavior of stock returns. Even though a trend towards greater proximity with the normal excess returns distribution was observed, we note that the series under analysis are rather distant from this distribution. Since most basic econometric procedures assume normality in series and this is not the case here, additional caution must be used in dealing with financial series.

As for financial volume, we have observed an increase in its absolute U.S. dollar-denominated amount. Some provisos must be offered. First, the fixed foreign exchange rate during the post-Real period may have distorted this result. But even assuming a 100% depreciation, a great increase in traded volume would have taken place. We suggest new studies be made to lead to better understanding of this phenomenon. As for average volume per deal, a surprising observation was made: unlike our initial hypothesis, indicating a reduction of this measure, since we suspected that stabilization would bring about an increase in the number of participants in the stock market, a substantial increase was found, indicating even greater concentration in terms of participants in the market.

Another interesting result pertains to the reduced efficiency of the theoretical Ibovespa portfolio relative to the global one. We might suppose that global markets became more efficient during the analyzed period and that the Ibovespa portfolio underwent no changes. But empirical evidence fails to support hits: in fact, other markets became less efficient, as can be seen from frontiers analysis in the pre- and post-Real periods. Therefore, the fact is that the Ibovespa portfolio followed this drop in efficiency, but more intensely.

In this paper, we sought to observe the effects of economic stabilization on the Brazilian variable income market. The use of international control series enables us to assume that the effects of exogenous phenomena have been eliminated. It is possible, however, that other endogenous effects other than reduced inflation levels may have contributed to the effects noted here. Other studies, taking account of effects such as, say concentration in financial institutions, the more intense introduction of foreign institutions into the Brazilian economy, and others, must be carried out to more clearly identify the effects of inflation stabilization on the Brazilian stock market.

7 - References

BLACK, J., BRADLEY, J.F., *Essentials Mathematics for Economists*, 2ª Ed, Wiley, 1994.

ERRUNZA, V., LOSQ, E., How Risky Are Emerging Markets*? Journal of Portfolio Management*, fall, 1987, p.62-67.

EVANS, J., ARCHER, S.H., Diversification and the reduction of dispersion: an empirical analysis, *Journal of Finance*, 1968.

GIACCOTTO, C., SFIRIDIS, J.M., and Hypothesis Testing in Event Studies: The Case of Variance Changes, *Journal of Economic and Business*, v.48, 1996, p.349-370.

GRANGER, C.W.J., TERÄSVIRTA, T., *Modeling Nonlinear Economic Relationships*, Oxford Press, 1993.

HARGIS, K. - The Internationalization Of Emerging Equity Markets: Domestic Market Development Or Retardation?, Working Paper, South Carolina University, 1996.

HARGIS, K., MALONEY, W.F., Emerging Equity Markets: Are They For Real?, Working Paper, South Carolina, 1996.

HARGIS. K., Time-Varying Transmission Of Prices And Volatility: Latin American Equity Markets 1989-1994, Working Paper, South Carolina, 1995.

HARVEY, A.C., *Time Series Models*, 2ª ed., Harvester, 1993.

HUANG, C-F., LITZENBERGER, R.H., *Foundations for Financial Economics*, Prentice-Hall, Englewood Cliffs: New Jersey, 1989

HULL, J. C., *Introduction to Futures and Options Markets*, 3ª ed., Prentice Hall, 1998.

INTERNATIONAL MONETARY FUND - *International Financial Statistics* — May 2000

JONG, F., KEMNA, A., KLOEK, T., A Contribution to Event Study Methodology with an Application to the Dutch Stock Market., *Journal of Banking and Finance*, v.16, 1992, p.11-36.

MILLS, T.C., *The Econometric Modeling of Financial Time Series*, Cambridge, 1994.

SEWELL, S.P., STANSELL, S.R, LEE, I., PAN, M.S., Nonlinearities In Emerging Foreign Capital Markets, *Journal Of Business, Finance & Accounting*, v.20, n.2, Jan., 1993, p.237-248.

SHARPE, W.F., ALEXANDER, G.J., BAILEY, J.V., *Investments*, 5ª ed., Prentice Hall, 1995.

SOLNIK, G., Why not diversify internationally rather than domestically?, *Financial Analyst Journal*, July, 1974, p. 123-135

[1] In January 1999 Brazil has devaluated the Real. We consider this a heavy endogenous economic phenomenon with we cannot isolate in order to observe the effects of stabilization. That's why our sample period ends at December 1998.