

FORECASTING CAPABILITY OF THE TIME SERIES MODELS BEFORE AND AFTER THE ADOPTION OF THE IFRS IN BRAZIL

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ABSTRACT

This research approaches two research fields aiming to verify, in the Brazilian case, whether the adoption of international accounting standards (IFRS) and the consequent reduction of information asymmetry are contributing for the improvement of forecasting capability of assets in the capital markets. The studied will be carried out by using analyses of ARIMA, ARCH and GARCH time series for the IBOVESPA in the period ranging from 2004 to 2012, aiming to check the effect of accounting international standards in the suitability of forecasting models for the Brazilian capital market. The models suitability was verified by the forecasting error statistics: MAPE (Mean Absolute Percentage Error); RMSE (Root Mean Square Error) and TIC (Theil Inequality Coefficient). The results indicate that after the adoption of international standards, the forecasting models presented greater suitability in the period after the adoption of international standards.

Keywords: *IFRS; Time Series Forecasting Models; Accounting Information Quality; Information Asymmetry*

1. INTRODUCTION

The methodology of analysis of financial time series aiming the forecasting of assets future prices, based on quantitative methods, presents great relevance considering the volatility increase of financial markets due to recent economic crises, therefore granting ample debate in the field of the applied Social Sciences.

The forecasting models evolved as years went by, going from simple regression techniques to non-linear models and with the use of artificial intelligence, as highlighted in Gooijer & Hyndman's work (2006).

In the financial area, the use of time series forecasting quantitative models applied to capital market aiming to improve its exposure to risks is increasing. This subject has been object of study since Ball & Brown's work (1968), who sought to identify the relationship between profit and share price in the NYSE and prove the relevance of disclosed accounting statements.

Within this scenario, of evolution of capital markets and techniques of mathematical and statistical modeling, the accounting standards have also presented significant changes both in the international and national scenarios with the adoption of the IFRS "International Financial Reporting Standards", international accounting standards, by several countries, among them, Brazil.

The adoption of international accounting standards, International Financial Reporting Standards (IFRS), seeks the improvement in information quality and the reduction of information asymmetry in capital market (IUDÍCIBUS & LOPES, 2008).

In this respect, according to Ball (2006), besides the internal factors, the adoption of IFRS allows accounting information to reduce the information asymmetry between the investors and capital market.

In Brazil, this convergence started with the approval of the Law # 11,638/07, which put the Brazilian standard towards the international standardization. The change to the new accounting standards was performed in two steps in Brazil. First, there was the partial adoption in 2008/2009 and then, in 2010, the international standard became mandatory.

Thus, this work aims to verify whether the change in Brazilian accounting standards helped to improve the asset forecasting capability in the capital market using the time series methodology, therefore combining the research lines of the impact of the adoption of international standards and forecasting models.

To assess this matter, the IBOVESPA, Index of the Sao Paulo Stock Exchange (BMF&BOVESPA), from 2004 to 2012, were used. The data from 2007, 2008 and 2009 were excluded because, in this period, the adoption of IFRS was just partial, becoming mandatory after 2010. Moreover, the excluded period of the sample presents great impact of the 2008 international financial crises, which could alter the results of the research.

The results indicate that after the period of adoption of the international standards in Brazil, a better adjustment of the price forecasting models through time series methodology is verified. Therefore, it can be suggested that the adoption of the IFRS contributed for the improvement of the forecasting capability of the assets in the Brazilian capital market.

2. THEORETICAL REFERENCE

Time Series Models

With the increasing change in the organizations and the complexity of the activities, the companies start requiring a greater amount and quality of information to control their production process and help the decision-making process. The fast upswing of information technology, the opening of the markets and the clients' demands are making the companies have more transparency in the information disclosure, getting accounting to have a key role in the transformation of data in information for the market.

The ARCH studies represented an advance for the forecasting models. Before these models, the main study tool for the forecasting of time series was the ARIMA parametric models, consolidated by Box & Jenkins (1994).

The models of the ARCH (Autoregressive Conditional Heteroskedasticity family, presented in Engle (1982) for the modeling of inflation series, has the proposal to treat the average of time series variance analyzed, that is, model the sample conditional variance.

The concept of the model is that there is no correlation between the series return, but that the volatility presents memory along the sample, making its modeling possible with the use of a quadratic function, according to Wooldridge, (2008).

Thus, according to Morettin & Toloi, (1994), the ARCH methodology denotes the fact that volatility is a random variable conditional upon past returns, which can be represented by the equation (1):

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 \quad (1)$$

The ARCH models are used for shorter modelings, modeling the mean of the volatility presented by the series, being indicated for third order models. For longer models, an extension of the ARCH methodology, the GARCH models, with modelings for the volatility variance presented is used. (WOOLDRIDGE 2008).

The ARCH and GARCH models use the concept of conditional variance, allowing the modeling of the series conditional, allowing, as a result, a greater number of studies after the 80's (GOOIJER & HYNDMAN, 2006).

The GARCH (Generalized ARCH) model proposed by Bollerslev (1986) is a generalization of the ARCH, permitting the analysis of the heteroscedastic behavior of the series, combining, therefore, the modeling of the mean and volatility variance of the series.

The studies with the GARCH methodology are combined with several other tools aiming to enhance the power of analysis and forecasting of the models.

This model adds the order of the ARCH component (p) and the order of the GARCH component (q). Therefore, the GARCH model (p, q) describes series volatility (conditional variance) depending on constant and lagged information of the volatility. It can be demonstrated by the expression (2):

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^p \beta_j \sigma_{t-j}^q \quad (2)$$

In which the restrictions are given by:

$$\alpha_i + \beta_j < 1$$

Consequently, σ_t^2 follows a GARCH model (p, q), where q represents the order of the ARCH component and p the order of the GARCH component.

Supposing that the errors are usually distributed, the variance is given by the expression (3):

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2, \quad (3)$$

The α_1 coefficient measures the extension of how a shock in today's return affects the return volatility in the following observation. The term $(\alpha_1 + \beta_1)$ measures the persistence of the volatility, verifying its effect in future observation of the series.

The GARCH model presents great relevance for the literature of financial time series due to the high volatility presented by the markets, especially in the last few years.

IFRS Adoption

The IFRS is a set of accounting regulations issued by the International Accounting Standards Board (IASB), aiming to create a single model of international accounting regulations with high quality information for the users of such information (IASB, 2010).

The standardization of accounting regulations represents the greatest regulatory change for accounting (DASKE et al., 2008).

According to Ball (2006), the IFRS adoption, instead of individual regulations, presents traits of greater reliability in the information for the investors, since the IFRS regulations are of easy understanding between the analysts and investors and more rigid than the national regulations, making the reduction of information asymmetry possible.

In 2001, the European Commission decided for the adoption of international accounting regulation, with full adoption in 2005, allowing an adaptation period from 2001 to 2005.

According to data of Deloitte (2012), among the countries of the G 20, South Africa, Germany, Australia, France, Italy, United Kingdom, European Union and Turkey adopted the standards in 2005. Canada adopted them in 2010; South Korea in 2011, Argentina in 2012 and Mexico, 2012.

In Brazil, the IFRS adoption was determined by the approval of the Law 11,638/07, allowing the partial adoption in 2008 and indicating the complete transition in 2010 for Brazilian joint-stock companies (MIRANDA, 2008).

This change, for the adoption of new accounting standards, has as main motivation reach the objective of the IASB conceptual framework. According to the framework, high-class information is the IASB goal.

The verification of the improvement of the quality of accounting information presents an initial difficulty concerning the definition of the quality of accounting information construct. Lang, Raedy & Yetman (2003) used the result management as proxy of information quality. The study compares results of American companies, with the hypothesis that lower result management represents an improvement in the quality of accounting information.

Daske et al. (2008) presented results assessing the market value of companies and the liquidity of 26 countries after the IFRS adoption and registered result of liquidity and market value increase after the IFRS adoption.

Daske & Gebhardt (2006) carried out a study for European countries (Germany, Austria and Switzerland) verifying that the IFRS implantation led to improvement in accounting information quality when it reduced the error associated to the companies' profit forecasting by the market analysts.

For the Brazilian case, despite some divergent results, the studies show, in general, an increase in information quality, but highlighting the fact that the convergence period is still very recent (SANTOS; CALIXTO, 2010; LIMA, 2010).

Therefore, with the reduction of information asymmetry, the markets incorporate the available information in a more precise way, decreasing, as a result, the term associated to forecasting error, with a smoother series. Thus, it confers a better modeling of the series memory.

3. METHODOLOGY

This research raised the state-of-art of the works on accounting information quality which have already certified the contribution of disclosing accounting statements and reports of explanatory notes in capital markets both in the world and in Brazil.

The IBOVESPA data used in the work were collected from the *Thomson Reuters*® database. The Index of the Sao Paulo Stock Exchange (BMF&BOVESPA) is formed by stocks of Brazilian companies, pondered by the paper turnover.

The period analyzed was from 2004 to 2013. However, the data of 2007, 2008 and 2009 were taken off the sample due to the international financial crises and the period of partial adoption of the IFRS in Brazil. Thus, the comparison is carried out between the periods: prior to the adoption of international accounting regulations in Brazil – 2004 to 2007 and after its adoption – from 2010 to 2013.

In the sample, the forecasting models with predictive windows were used, with daily data, both before and after the adoption of IFRS from a financial time series, demonstrated by the equation (4):

$$\{y_t\}_{t=1}^n = \{y_1, y_2, \dots, y_t, \dots, y_n\} \quad (4)$$

In which,

y_t = represents the value taken by the series along the time.

At a second moment, the returns were obtained by the expression (5):

$$R_t = \ln\left(\frac{y_t}{y_{t-1}}\right) \quad (5)$$

In which, R_t provides the n return values, obtained by the first difference of the original series.

The results of the models will be assessed with error measurement statistics, verifying, therefore, whether the forecasting errors of the IBOVESPA time series models were reduced after the implantation of the IFRS in Brazil.

For the elaboration of the forecasting models for the periods analyzed, tests were performed in order to guarantee the validity of the models used. For each one of the series, the series and residuals correlograms, the unit root tests, test of independence and square residuals analysis were observed.

The selection of the models followed Akaike & Schwarz's criteria. As presented by Gooijer & Hyndman (2006) these criteria are widely used in time series methodology. After these tests, the error statistics of the models was calculated.

The error statistics are calculated according to Gooijer & Hyndman (2006). These authors carried out a study raising the main accuracy measures of the time series forecasting models.

Within the research, the authors found several kinds of methods to check the quality of the model. There were three which were the most frequent and which showed to be the most efficient ones for the objective proposed: MAPE (Mean Absolute Percentage Error); RMSE (Root Mean Square Error) and TIC (Theil Inequality Coefficient):

Mean Absolute Percentage Error (MAPE): mean absolute value in percentage, verifying the error margin of the estimated value. The lower its value, the better the adjustment of the model, as demonstrated by the expression (6):

$$MAPE = \frac{100}{N} \times \sum_{i=0}^N \frac{x_i - \hat{x}_i}{x_i}, MAPE \geq 0 \quad (6)$$

In which;

- x_i : Observations of actual time series;
- \hat{x}_i : Estimated or forecasted time series;
- N : Number of non-absent data points.

Root Mean Square Error (RMSE): The measure uses the differences between the values forecasted by a model or an estimator and the values actually observed, which are called forecasting errors, when calculated for sample data, as presented in the expression (7):

$$RMSE = \sqrt{\frac{1}{N} \times \sum_{i=0}^N (x_i - \hat{x}_i)^2} \quad (7)$$

In which;

- x_i : Observations of actual time series;
- \hat{x}_i : Estimated or forecasted time series;
- N : Number of non-absent data points.

Theil Inequality Coefficient (TIC): This coefficient will always be between zero and one, the lower it is, the better the adjustment of the model, as demonstrated by the expression (8):

$$RMSE = \frac{RMSE}{\sqrt{\frac{1}{T}\sum(\hat{x}_i)^2 + \frac{1}{T}\sum(x_i)^2}} \in [0,1] \quad (8)$$

In which;

- x_i : Observations of actual time series;
- \hat{x}_i : Estimated or forecasted time series;
- N : Number of non-absent data points.

4. RESULTS

The preliminary analysis of the data presented in pictures 1 and 2, IBOVESPA value along the period analyzed, indicated that in the period prior to the adoption of international standards, the Brazilian capital market presented growth, with upward trend along the period analyzed. In the period after the IFRS adoption, it can be seen that the Brazilian market presented a downward trend, but with oscillations periods between growth and fall of the IBOVESPA.

Due to the behavior of the series analyzed and the results of the statistical tests carried out, we opted for the use of the return series for the analysis of the results. Pictures 3 and 4 present the behavior of the IBOVESPA series for the both the periods analyzed. The analysis of the period of post-adoption of the international standards indicated that the year of 2011 registered the greatest variation standard.

After the preliminary analysis of the data, table 1 shows the result of the error statistics of the forecasting models, before and after the adoption of international standards. By the result, it is seen that the error statistics present worse error statistics in the period prior to the IFRS adoption.

In the period prior to the adoption of international standards, the MAPE was of 155.09, the RMSE of 608.95 and the TIC of 0.84. When compared to the period after the adoption of international standards, the error statistics show a better adjustment of the model with MAPE of 106.15, RMSE of 806.14 and TIC of 0.92.

These results indicate that after the adoption of the international standards, there was the reduction of information asymmetry and consequent improvement in the forecasting capability of the time series models. These results are coherent with the studies performed by Lang, Raedy & Yetman (2003), Ball (2006), Daske & Gebhardt (2006), Daske et al. (2008) which indicate that the adoption of international standards reduced the information asymmetry and improved the informational content available to the market.

For the Brazilian case, the results of the work also go towards the same directions of the studies of Santos & Calixto (2010) and Lima (2010), which indicate positive effect of the adoption of international standards in Brazil.

The result of this work is important because it uses the time series methodology for the analysis of the effect of the adoption of international standards and finds results similar to the ones found with other analysis methodologies, allowing, therefore, greater confidence in the results obtained.

Nevertheless, it is important to analyze that the results apply to Brazil in the period of the data analyzed, and there may be other effects which influenced the forecasting capability of the time series models. Thus, we suggest the performance of similar studies for other countries in different moments of time, in order to mitigate the economic effects in the periods.

5. CONCLUSION

The adoption of the new accounting standard has as its main motivation to reach the IASB (International Accounting Standards Board) goal of generating high-class information for the users of accounting information.

According to Daske et al. (2008), the standardization of accounting regulations represents a greater regulatory change for accounting.

In Brazil, the IFRS adoption was determined by the approval of the Law # 11,638/07, allowing its partial adoption in 2008 and indicating the complete transition from 2010 on to joint-stock Brazilian companies.

The present paper analyzed the impact of the change in the Brazilian accounting standards in the forecasting capability of the time series models for the IBOVESPA index, from 2004 to 2012, with the exclusion of data of 2007, 2008 and 2009, since, in this period, the IFRS adoption was just partial, becoming mandatory after 2010.

The methodology of financial time series analysis presents great relevance considering the increase of the volatility of financial markets due to the recent economic crises. Thus, this work is important because it uses the time series methodology to analyze the effect of the adoption of international standards.

The results indicate that after the period of the adoption of international standards in Brazil, a better adjustment of the price forecasting models by the time series methodology is seen. Therefore, it can be suggested that the IFRS adoption contributed for the improvement of the forecasting capability of the assets in the Brazilian capital market.

The results are similar to the ones found in the studies carried out for the European case in the studies of Lang, Raedy & Yetman (2003), Ball (2006), Daske & Gebhardt (2006), Daske et al. (2008) which indicate that the adoption of international standards reduced the information asymmetry and improved the informational content available to the market.

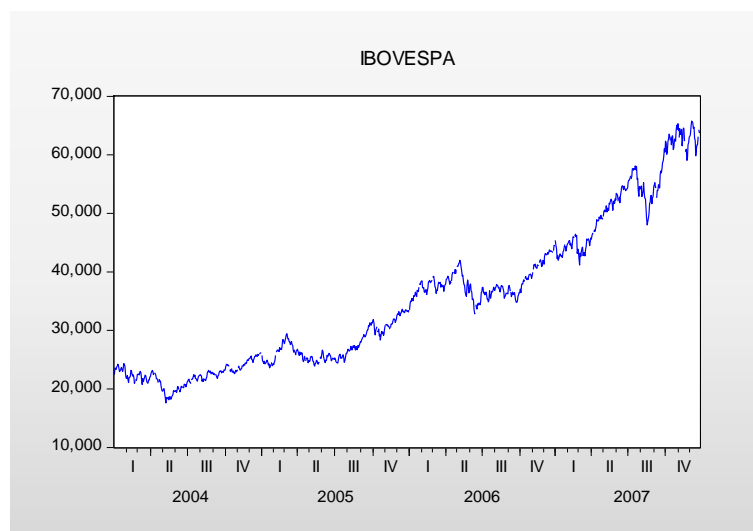
However, the results align with Santos & Calixto (2010) study for the Brazilian case, indicating a reduction of information asymmetry in the Brazilian market after the adoption of international standards.

Finally, it is important to analyze that the results found apply to Brazil along the period analyzed and, thus, it is important to carry out similar studies for other countries in other periods to isolate the economic effects of the analysis of the results found.

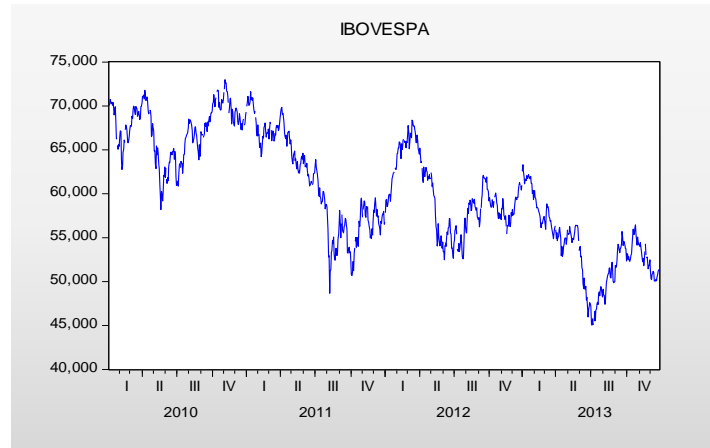
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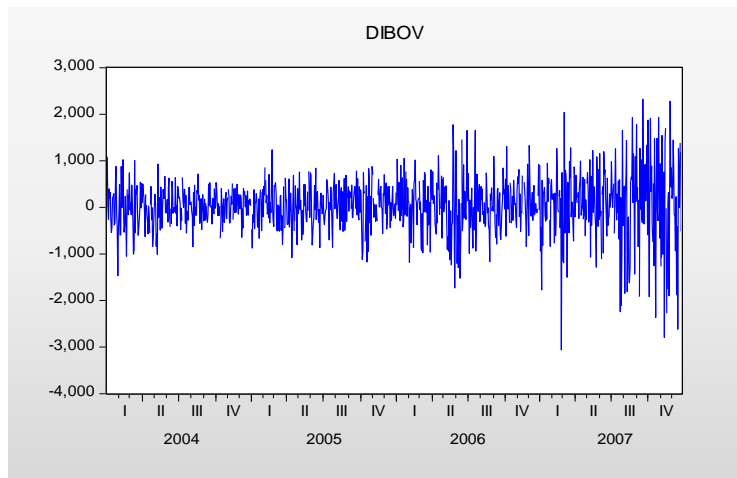
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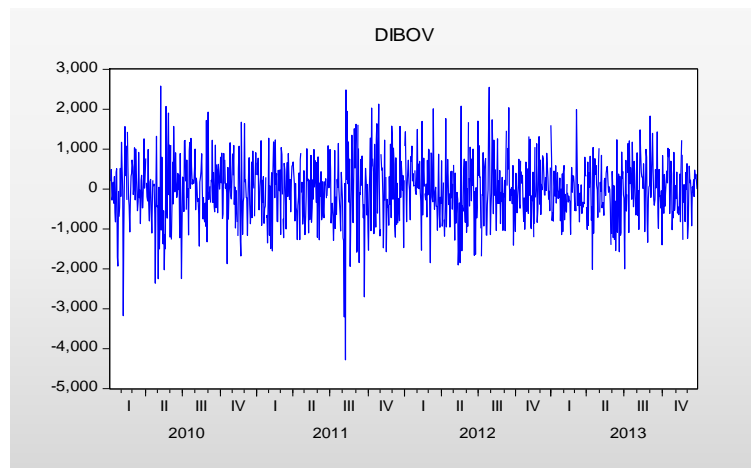
Picture 1 - IBOVESPA (2004/2007)



Picture 2- IBOVESPA (2010/2013)



Picture 3 – IBOVESPA Return (2004/2007)



Picture 4- IBOVESPA return (2010/2013)

Models Results		
	Before IFRS (2004/2007)	After IFRS (2010/2013)
MAPE	155.09	106.15
RMSE	608.95	806.14
TIC	0.84	0.92

Table 1 – Models Results