The Effect of Chaotic Recurrence and Financial Events on Stock Market

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Abstract: Company´s market share price can be affected by financial events or be a consequence of the stock market chaotic trend. This effect also depends on company market capitalization. In technical analysis of the stock market, chaotic recurrence analysis can help to determine whether this impact comes from a market chaotic long-term trend or financial events. Therefore, the purpose of the study was to analyze whether the issuers´ share price reaction in the stock market is a consequence of financial events or a chaotic trend in the market. The share value of three representative companies in the Colombian stock exchange during the years 2006-2010 were analyzed. The companies were selected according to their market capitalization. The fall of the Colombian market index was taken as a breakpoint. Log transformations and a nonlinear recurrence analysis model were applied to these data. The recurrence analysis was fit to the data series before the fall of the Colombian market index and then to the entire time series. Model parameters, such as laminarity, determinism, recurrence, entropy, trapping time, delay and embedded dimensions were identified. Despite differences existed in recurrence plots, all of the quantitative recurrence analysis parameters were the same in all models, and the breaking point had no effect on them. The conclusion was that a strong chaotic recurrence exists, which shadows the effect of the market index fall.

Key-Words: Stock market; share price; chaos; financial crisis; recurrence analysis.

1 Introduction

Stock market is unstable by nature; the existent difficult to make predictions promotes different views to analyze market behavior, with many models trying to capture its characteristics. Predictions are made by artificial neural networks resulting in high precision [1] and risk in the market is modeled by systematic and idiosyncratic risk, being idiosyncratic volatility relevant [2]. Besides, the exchange rate has been associated to stock prices [3, 4] and, consequently, those events that affect both of them can disturb the trend in stock prices.

Chaos recurrence has been used in financial and economic analysis [5, 6]. In stocks markets, recurrence analysis has shown its utility [7, 8] and the analysis of the impact of events showed changes happen in the characteristics of recurrence plots and quantitative analysis [9].

2 Problem Formulation

According to the aforementioned, the purpose of this research was to evaluate the usefulness of recurrence analysis to determine the influence of a chaotic recurrence trend and a unique event on the share price in stock markets.

3 Problem Solution

The share price of three companies, in the Colombian stock exchange list of issuers, was a sample of cases; the companies were selected according to their market capitalization and the availability of data. The companies were Bancolombia (BC), Acerías Paz del Río (PR) y Coltejer (CT), which have different positions according to market capitalization. BC (Banking sector) is one of the leader companies in the country with a market capitalization of 13,735,209,334US$. PR (Metallurgical sector) is in an intermediate position with a market capitalization of 167,876,870.6US$. Finally, Coltejer (Textile sector) occupies one of the lowest positions in the list of market issuers, with a market capitalization of 66,500,000US$. The differences among companies help testing the reliability of the model.

Time series of the daily share price at the market negotiation close of the three companies, from January 1, 2006 to December 31, 2010, were the variables in the model. Besides, stock market COLCAP index was used to determine the breakpoint and to split the time series

into two halves.

The fall of the stock market COLCAP index determined a breaking point, which corresponded to the lowest value of the index during the years 2006-2010. This point was located on October 27, 2008, and it split the series into two halves. The first half comprising the data before the index fall and the second half comprising the data after the index fall; however, they are not equal in length. Time series were log transformed; then, recurrence analysis was conducted on the first half of the BC time series, to determine parameters of recurrence, determinism, laminarity, trapping time and entropy, along with the number of embedded dimensions and delay. Next, the same model (embedded dimensions and delay) was applied to first half of PR and CT time series. Finally, the model was applied again to the whole data series of the three companies.

Figures 1, 2 and 3 show the three companies share price during the years 2006-2010.

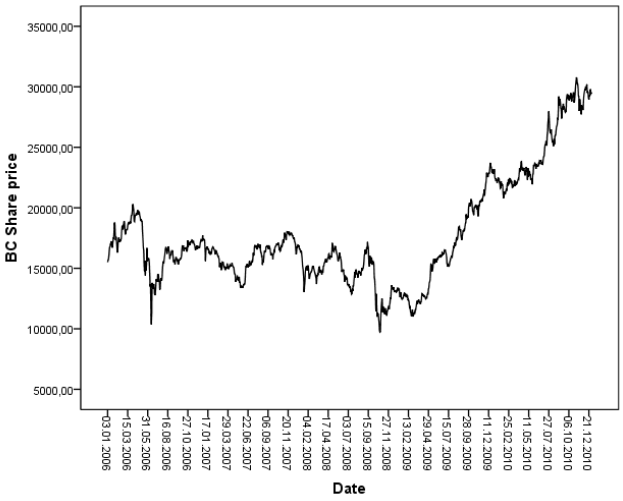

Figure 1. Price of the share value of BC (January 1, 2006 – December 31, 2010).

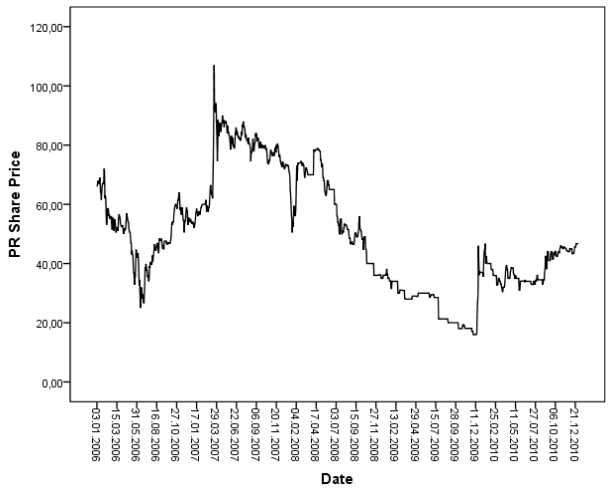

Figure 2. Price of the share value of PR (January 1, 2006 – December 31, 2010).

ISBN: 978-1-61804-280-4

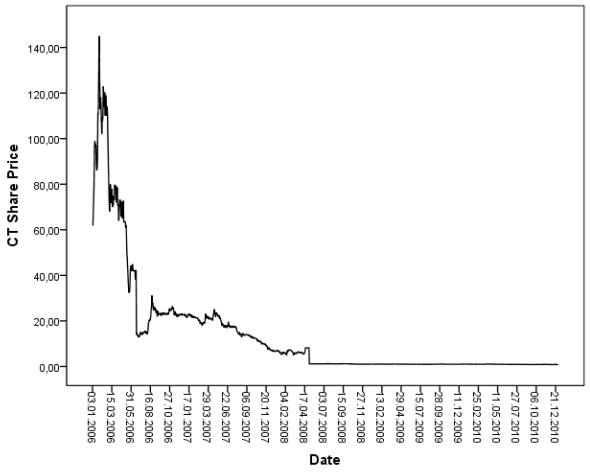

Figure 3. Price of the share value of CT (January 1, 2006 – December 31, 2010).

The variability of the times series is due to consecutive reaction to numerous events that affect them; only the BC data series shows some visual relevance of the breaking point. In order to reduce the range of the data scale, the data were log10-transformed; Figure 4 shows the new computed data series.

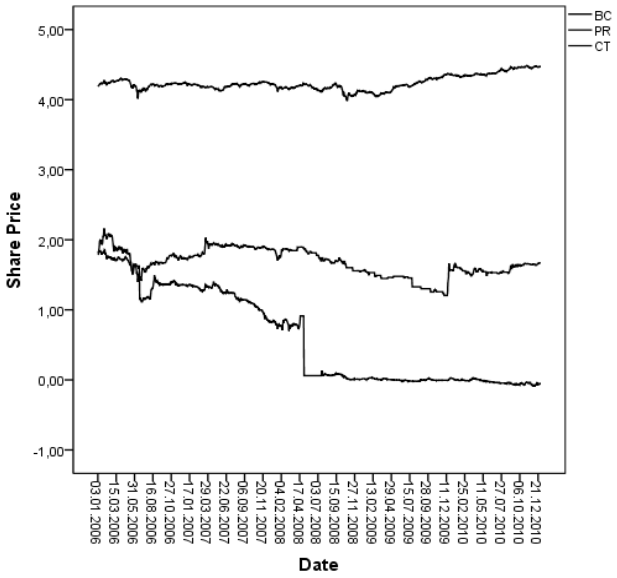

Figure 4. Log_{10} of the share price at close of BC,PR and CT (January 1, 2006 – December 31, 2010).

The quantitative recurrence analysis applied to the first half of these series yielded the parameters showed in the Table 1 under the label “Excluding the index fall”; all of the parameters are equal. The model includes a delay of 18 and 8 embedded dimensions. It is identified by a method of minimum, rescaling of absolute (No rescaling), and 5 points on the diagonal lines to determine a trend.

ISBN: 978-1-61804-280-4

Table 1. Recurrence Analysis Parameters (excluding and including the index fall).

	Excluding the index fall			Including the index fall		
	BC Close Price (Log_{10})	PR Close Price (Log_{10})	CT Close Price (Log_{10})	BC Close Price (Log_{10})	PR Close Price (Log_{10})	CT Close Price (Log_{10})
Dimensions	8	8	8	8	8	8
Delay	18	18	18	18	18	18
% Recurrence	100.00	100.00	100.00	100.00	100.00	100.00
% Determinism	99.798	99.798	99.798	99.798	99.798	99.798
% Laminarity	99.798	99.798	99.798	99.798	99.798	99.798
Trapping time	52.000	52.000	52.000	52.000	52.000	52.000
Entropy	6.570	6.570	6.570	6.570	6.570	6.570

The same model was applied, again, to the whole data series of the three companies; it yielded the parameters showed in Table 1 under the label "Including the index fall". These parameters had the same value as before.

Despite the existent differences in the recurrence plot, quantitative analysis yielded the same results in all the applications on the time series. However, the underlying logic is that, once the model parameters are identified, before the index fall, if this fall had an effect on the series, it would substantially alter the parameters. In case it had not, the parameters would remain the same. In this occasion, no effect was observed.

The model is the same for the three series, before the breaking point, showing that, despite visually differences exist in the recurrence plot, parameters remain the same. This finding means that, with regard to recurrence, the series are the same.

Some parameters, such as method, number of points on line, and rescaling could favor this effect, as they are more relaxed than in other applications of recurrence analysis [15, 17]. However, they are the same than in others, where they allow for differences [13, 14].

Therefore, the parameter selection led to the equality of the results in the application of the recurrence model. The results are also the same when the model is applied to the whole time series. At his point, it must be taken into account that the whole series include the breaking point, which is the market reaction to an event, so the results show that the recurrence trend in the series is stronger than this specific reaction.

4 Conclusion

The results do not mean that stock market has no reaction at all, but that the recurrence trend shadows the effect of the event. In this sense, the identification of the trend can help to prevent the effect of financial crisis. The model gives a good identification of the recurrence in the data of three companies with different market capitalization, thus generalizing the results.

Nevertheless, the selected model parameters may constrain the time series in a way that favors the identification of strong recurrence association, and make the data series less sensitive to unique events.

Finally, this approach can have a good application in predicting the long-term behavior of the markets. It has the advantage of preventing reaction to specific event, because they are embedded in the sequence of existent events modeled by the recurrence association.

The application of recurrence complex models to stock markets can offer a different interpretation of the behavior of these markets. In this case, instead of separating the prediction into long and short-term analysis, this methodology can help to integrate both approaches within a wider view.

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