Quantifying Stock Market Complexity *via* Visibility Graph

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After the discover of the so called small world networks, in mid 60's and the simultaneously development of the modern computation, the understanding the society organizes as a complex system have improved the usual approach to study financial markets, and even a new research area has emerged, Econophysics, which stared to apply the usual methods of statistical mechanics, that have experienced an enormous success during the 1970's with several robust and very flexible methods, most of times combining computational, analytical and visualization techniques in interdisciplinary studies. The introduction of stochasticity on the analysis have improved a lot the prediction power and also the understanding of the stock market local dynamics, leading to the development of trading algorithms and the use of robots become quite usual, even mandatory, in investment companies. However, no matter how much the understanding of the experts about the market improved, every time a new crisis implodes the current "best theory" about the market dynamics. Thus, in last years, an effort have been made to establish estimators of market stability and robustness, which classify markets and countries titles, a real "allmight judge" for the financial wealth of the stocks, as well for enterprises as for countries. But one of the most recent global crisis related to the derivatives crisis in USA have evinced that even these "judges" made gross mistakes. Thus, quantifying complexity in Financial Markets become one of most defying and important open tasks currently to the society, in order to try to avoid the catastrophic effects of this emergent phenomena known as *global crisis*. In this work, we present an original approach combining an information entropy measure calculated from the weight distribution of the graphs generated applying the Visibility Graph technique in the stock market return rate time series of several countries. Basically, considering finite size time-windows, we analyze the temporal evolution of the Shannon-Fisher index $\mathcal{SF}$, which displays a remarkable and consistent correlation with crisis periods, no matter the country analyzed. We also calculate the pair correlation function to the combined $\mathcal{SF}$ index temporal evolution considering 34 countries, and build a "global market network" connecting the most correlated countries above a given threshold value for the pair correlation. Varying this threshold, we can verify the emergence of clusters between countries which coincide with the expected ones – the Euro zone or the Asiatic countries for example – but some unexpected and interesting associations also are revealed. Finally, we show some promising results using the $\mathcal{SF}$ index as an estimator to evaluate the market robustness against crisis.