Information Diffusion in Stock Markets– A Soft Computing Perspective

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Abstract—*Recently, Information diffusion is one of the emerging areas of studies. There have many areas viz. physics (particle diffusion), biology, chemistry, sociology, finance and economics (in the context of diffusion of ideas, people and of the price values), where the phenomenon of information diffusion has been studied and applied. There have been numerous studies undertaken in order to understand, the role of soft computing techniques in relation to information diffusion in the Stock Markets. The studies have ranged from understanding the dynamics of stock pricing, forecasting accuracy and the Co-movements in the stock prices. In this process, the role of soft computing tools and techniques has gained a paramount position.*

In this light, this review paper provides with the analytical review of the recently published research papers by reputed journals and institutions, in the area of information diffusion, in the emerging markets and the role of soft computing tools and techniques for the same. This paper provides a descriptive analysis of the factors which influence the information transmission in the Emerging markets. The research methodology used for analysis is descriptive for the paper.

The paper then provides a review, and discusses the role of information diffusion in stock markets of the Emerging countries. Various studies have been undertaken to understand factors responsible for transmission of information into the emerging markets. In this aspect, and the major findings of the reviewed paper are presented. Further the paper reviews the application of soft computing techniques in forecasting the stock price moments in emerging markets such as India. At the end, an outcome of the reviewed research papers is presented, which provides the insight in terms of the use of soft computing techniques for the study of stock price movements and its forecasting in Indian stock market.

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1. INTRODUCTION

Information diffusion is important area of study. The concept of information diffusion has been heavily retrieved from the fields of study such as 'Information Sciences', 'Data Sciences', 'Information revival', 'Multidimensional Data analysis', 'Information search' and alike. Manuel Castells (2010) has observed in his book, 'The Rise of the Networked Society', that due to consistent rise in the IT infrastructure globally and at the same time decline in the prices of the communication systems and technology, the online communities are not only developing fast as a virtual world but rather they are also integrating at the same time with other forms of interaction which is leading to the hybridized day to day life. In his book, he also talks about the financial crisis of 2008 and how it led to the technological transformation of the finance and the advancement of financial markets. The so called 'Information turbulence' which was reflected in the mortgage crisis which started in the United States in 2007 after the burst of a real estate bubble had an interlinking shocks to the whole financial system as experienced globally. The major outcome of this crisis has been, on the positive side, a more surge in the technological innovation, networking, as well as higher education of the global workforce. This all has led to the faster diffusion of resources, in terms of man, materials, machine and money on global scale. [6]

At the same time, there have been many studies undertaken in the past to assess the usefulness of the soft computing tools and techniques for forecasting in the stock markets. Anecdotal evidences in the research studies conducted by [[1][2][4]] suggest, that the recent advances in the soft computing techniques offered useful tools for forecasting in the stock markets which are considered as 'Noisy Environments'. They are in particular

useful in determining the non-linear behavior of the stock moments. These studies and many more have clearly demonstrated that by using soft computing techniques, a higher forecasting accuracy could be achieved. This research paper is divided into sections. In Section 2.1, the concept of 'Infomration' and 'Diffusion' and its application to various areas is broadly disscussed in order to enlighten the readers with the core idea about the terminology of these words. This would help and set the ground for further understanding of the following sections. In Section, 2.2, various studies signifying the importance of Information diffusion in the stock markets in the Emerging countries is covered. It is followed by Section

2.3, where the role of Soft Computing tools and techniques is assessed based on the anecdotal evidences gathered from the recently published survey papers. Finally, it is followed by Section 3, wherein, the outcome of the reviewed research papers is presented in terms of factors which are affecting the phenomenon of information diffusion as well as the best fit soft computing techniques available currently for the stock market prediction.

2. SECTIONS

2.1 Information diffusion definition, evolution and applications in different fields of study

Information diffusion is a phenomenon which is interdisciplinary in nature. In order to understand the various aspects of Information diffusion, it would be beneficial to understand the conceptual relevance of the terms "Information" and "Diffusion". According to Wikipedia [13], the basic understanding of the word *'Information' is to inform*. The idea being is to create knowledge and data in order to understand real things or abstract concepts. The concept of information where *message* plays a primary role has different meaning in different context which is grounded in the information theory.

The word 'Diffusion' is derived from the Latin word, '*Diffundere*', meaning to spread out. In this context, in the study of physics, the word 'Diffusion' is well defined. Accordingly, Wikipedia [14] has defined the word *'Diffusion' which refers to a process whereby the molecules intermingle as a result of their kinetic energy of random motion*. The concept of Diffusion is widely used in various disciplines such as physics (particle diffusion), biology, chemistry, sociology, finance and economics (in the context of diffusion of ideas, people and of the price values). However, it is apparent based on the core definition of 'Diffusion', in each case, the object (e.g. Idea or an atom) that is going through diffusion is '*spreading out*'; from the point or location where it is observed that the level of concentration is high to the point or location where the level of concentration is low. Chongfu (1997) [3], in his research paper has provided more understanding about the interdisciplinary aspect of the terms 'Information Diffusion' from the Data Science perspective. He has observed that generally data are defined as verifiable facts about the real word; whereas, the information in the form of data in organized in order to reveal a pattern and to facilitate further research. He further explains that, in general data is only part of the facts, and that the information which it carries tends to be incomplete. Thus, according to him, the datasets are insufficient to explain the real world accurately. In this context, he has observed that, the principle of information diffusion helps in filling the gap in incomplete data. This further makes the matter simple, or results clear. Finally, in this opinion, it is possible to give some help for simulating thinking procedure by some reasonable information diffusion function.

2.2 Information diffusion in Stock Markets of the Emerging Countries

There have been numerous studies under taken recently in the area of Information diffusion and stock markets, in particular, with reference to Emerging Countries. Some of the relevant studies are discussed in this section to give the context to this review paper.

A study was under taken by Kee-Hong Bae, et.al (2012) [5], to assess the influence of the global market information on the stocks of the emerging markets. The findings of this study were consistent with the well-established idea that the financial liberalization helps in making the emerging markets more efficient and which is reflected in the informational efficient stock prices. These results are consistent with the study conducted by Roland Fuss, (2005) [9], where he has observed the effects of financial liberalization on the asset price dynamics. His findings suggest that financial integration affects the return predictability and the stock indices become efficient once the stock market completes the liberalization process.

Likewise, a similar study was undertaken by Elton, et.al (2006) [8], to assess the effects of volatility in the Asian emerging markets in comparison to the more developed US market. The major finding of this study suggests that volatility asymmetry is an important component for equity returns in both of these markets. These findings were consistent with the existing literature which provides that the volatility in the Asian emerging markets is higher than that of the developed market (US). At the same time the study also confirmed the fact that the volatilities are accompanied by negative returns. This phenomenon was observed even long after the Asian crisis. This finding is consistent with the study undertaken by Derrabi & Leisure (2005) [7], where they have tried to assess the risk-return tradeoffs while investing in both developed and emerging markets. The findings of the study indicates that the emerging markets presents a greater specific risk in terms of portfolio asset allocation while developed markets have more systematic risk. Further, the findings of this study suggest that there is a low degree of correlation in relation to returns between these markets which positively contributes to the volatility and thus benefits investors by holding diversified portfolio in these markets.

Some of the recent research papers have focused on the factors (internal and external) which determine the rise and fall of some categories of stock indices through a cross-regional comparison (Shu-Hsien Liao, et.al. 2013) [10]. In this context, a recent study was undertaken by Wei Shen, et.al (2011) [11]. It observed the relationship between the stock market indices and other technical indicators for better forecasting. The study finds that for efficient forecasting of these indices, the non-quantitative factors should be considered in the forecasting. This could lead to better accuracy in the prediction of the stock market indices.

2.3 Use of Soft Computing tools and techniques for Information Diffusion in Stock Markets

Atsalakis, et.al (2010) [2], conducted a survey on the Stock market forecasting techniques. As part of this survey, they classified 150 papers based on the stock market models and its comparative performance in order to find the best fit model. The findings of their research work suggest that, selecting input variables and the suitable type of model was a common problem in terms of forecasting stock returns (data preprocessing). The most commonly used techniques in data preprocessing was natural logarithmic transformation of stock prices. At the same time, the most commonly used conventional models for stock market forecasting included, Generalized Autoregressive Conditional Heteroskedasticity models (GARCH), Stochastic Volatility (SV) models, Random Walk (RW), Buying and Hold (BandH) strategy, Autoregressive Integrated Moving Average (ARIMA), Autoregressive Moving Average (ARMA), Autoregressive (AR), and Moving Average (MA). However, from the total surveyed 150 papers, only 63 papers provided the justification for the best fit techniques / model.

Similar study was conducted by Atsalakis, et.al (2009) [1], where he has surveyed more than 100 published articles in order to determine the best fit available soft computing techniques for forecasting stock market indexes and stock prices. In this survey, it was observed that in order to predict the behavior of the stock prices and the movements of these stock prices in the market, the soft computing techniques are widely accepted. Most of the surveyed articles focus on stock return forecasting for single stock market index or of the combination of different stock market indexes. At the same time, most of the studies focused on forecasting returns of a single stock or multiple stocks. The survey finds that in relation to the input variables used in each model, it differed. The most commonly used input variables included, stock index opening or closing price, and their daily highest and lowest values. This reflected the fact, that the soft computing methods primarily make use of simple input data for prediction purpose. In relation to the soft computing technique, the survey observed that, about 60 % of the articles reviewed, used Feed Forward Neural Networks (FFNN) and the recurrent networks for stock market prediction. The study also found that few of the articles used Neuro-fuzzy networks as a soft computing technique for the stock market forecasting purposes.

Likewise, a methodological review was conducted by Debashish Das, et.al (2013) [4], wherein, they investigated the best available data tools and techniques for stock prediction. The findings of their study suggest that, data mining and neural network can be effectively used in order to uncover the non-linearity affecting the stock market. The findings further indicated that the Neural Network method in combination with an expert system is a best fit method for stock market prediction. In this context, their methodological review made it quite clear, when the data is of unpredictable nature, like in the case of stock market data, the combination of data mining and neural network seems to be an effective solution.

3. CONCLUSION AND FUTURE DIRECTIONS

An attempt was made through this review paper to provide a broad perspective of the concept of information diffusion and its interdisciplinary nature (Section 2.1). Further, in Section 2.2, a descriptive analysis was provided, of the factors which influence the information transmission in the Emerging markets. Among the various factors observed in the literature studies, we find that the key factors which influence the information transmission in the Emerging markets include, but not limited to; foreign investments, Investors risk–return trade-offs, Behavior of short and long term horizon price changes, Market returns and Volatility asymmetry.

Similarly, Section 2.3, provided with the descriptive analysis of the use of soft computing tools and techniques for the information diffusion in the stock markets. Based on the anecdotal evidences of the literature reviewed, we find that Neural Networks help in uncovering the non-linearity of the stock market; however, there was a concern on lack of use of Standard Paradigm to determine the effectiveness of different methods of neural networks. In this context, the reviewed papers suggested that a use of hybridized knowledge based data mining and neural network technique for effective stock market prediction would be a promising solution. At the same time, we find that most of the research papers reviewed demonstrated that the soft computing techniques outperform the conventional models in most of the cases, as they return better results in terms of higher accuracy in forecasting, however, the apparent limitation of these models is difficulty in terms of defining the structure which currently is still based on trial and error procedure.

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