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Convergence of fundamentalists and chartists' expectations: An alarm for stock market crash

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ABSTRACT

We construct a network of the Tehran stock market based on the cross-correlation of trading volume of stocks both for fundamentalists and chartists. In order to investigate the dynamics of expectations of fundamentalists and chartists over time we introduced a homogeneity coefficient. Our results show that in the Tehran Stock Exchange (TSE) which is an emerging market, chartists in comparison with fundamentalists more strongly believe the stocks' co-movements. We also found that in a bull market (booming period), the optimism of fundamentalists and chartists about the similarity of stocks' performance diverge from each other while in a bear market (recession period) both groups of traders have approximately same level of pessimism about the simultaneous collapse of stock prices.

1. Introduction

Complex networks provide a very general framework, based on the concepts of statistical physics, for studying systems with large numbers of interacting agents. The nodes of the network represent the agents and a link connecting two nodes indicates an interaction between them. In the complex networks framework, interactions have typically been considered to be binary in nature, meaning that either two nodes are connected or they are not. Imposing a binary interaction requires setting a threshold value for interaction strength, such that interactions falling below it are discarded [1].

Financial markets, where all listed companies are correlated with each other, have received attention as a typical complex system [2]. Mantegna was the first to use complex networks to study financial networks [3]. He used stocks as nodes and return correlation as a link between them. This idea was followed and extended by others [4–13]. The main problem with such a procedure is that resulting networks are usually very large and their analysis is rather complex. For solving this problem, many researchers have used the Minimal Spanning Tree (MST) method [11,14]. In this approach one constructs a tree according to the method introduced by Mantegna in studying the taxonomy of the financial market [15]. The approach requires an additional hypothesis about the topology of the metric space, the so called ultrametricity hypothesis. The spanning tree is a simply connected acyclic (no cycles) graph that connects all N nodes with $N - 1$ edges such that the sum of the included edge weights is minimum. Although introduction of MST significantly contributed to the reduction of complexity of correlation-based networks, but using this analysis leads to loss of essential information about the internal structure in networks.

Generally most researchers have used cross-correlation of stock price returns for constructing the stock markets network. This is because it is widely believed that in financial markets the performance of a company is compactly characterized by a single number, the stock price, which results from a large number of interactions between different market participants [1]. Despite this rationality, it should be noted that using stock price returns prevents extracting information from separate forces

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acting in financial markets, say fundamentalists and chartists investors, i.e. traders who act on the basis of fundamental analysis and those who act on the basis of technical analysis. The importance of the interplay of these two classes of investor has been stressed by several recent works to be essential in order to retrieve the important stylized facts of stock market price statistics [16–24]. Fundamental analysts watch deviations from an equilibrium level of the price as implied by a fundamental model. If the prices are above the equilibrium level the asset is sold and leads to a decline in the prices. This is while the chartists are more rely on trends. For example, if the technical analysts believe that there is no indication of a trend reversal they will keep on buying the asset which supports the price of that asset. What happens to the price of asset depends on the net effect of the forces supply and demand by fundamental and technical analysts.

The most significant aspect of this paper is using the separate data of trading volume of fundamentalists (institutional investors such as large funds) and chartists (individual investors) for each stock for constructing the stock market network. In other words, the cross-correlation of trading volume of each kind of investor (fundamentalist and chartist) for each stock is used as a connection criterion. The rationale behind this approach is that studying the topological differences of these two networks over time provides a better understanding of the attitudes of these two groups of traders toward the stocks co-movement.

The rest of the paper is organized as follows. In Section 2 the network construction procedure is described. Description of method and empirical results will be presented in Section 3 and finally the paper closes with the conclusion.

2. Network construction

If we consider a network of stocks, the nodes will be the individual stocks and a link between two nodes denotes that the two stocks being connected display some similarity. To construct the networks, the daily trading volume of both fundamentalists and chartists (i.e. institutional and individual trading volume) of each stock in every single day is used. Suppose that $V_i^k(t)$ and $V_j^k(t)$ are the daily trading volume of stock i and stock j on day t for investor group k where respectively $i, j = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$ and $k = f$ (fundamentalists) and c (chartists). The cross correlation coefficient between $V_i^k(t)$ and $V_j^k(t)$ is defined as

$$\rho_{ij}^k = \frac{\sum_t [(V_i^k(t) - \overline{V_i^k})(V_j^k(t) - \overline{V_j^k})]}{\sqrt{\sum_t (V_i^k(t) - \overline{V_i^k})^2} \sqrt{\sum_t (V_j^k(t) - \overline{V_j^k})^2}} \tag{1}$$

where the $\overline{V_i}$ and $\overline{V_j}$ are the means of daily trading volume time series and summations are taken over a one month period. We define our criterion for connecting a pair of nodes, based on a threshold value for the cross correlation. Since cross correlation is a measure of similarity and its value is between 0 and 1, we simply choose a positive fractional value as the threshold. Suppose the threshold is ρ. Then, the connection criterion for stock i and stock j is simply written as

$$\rho_{ij} > \rho. \tag{2}$$

3. Method description and empirical results

As mentioned earlier, the main purpose of present work is to assess the dynamics of expectations of fundamentalists and chartists in a financial market. To this end, the networks for both of these groups at the end of each month is formed. We define a *Homogeneity* coefficient as

$$H(t) = \frac{n_f(t)}{n_c(t)}. \tag{3}$$

Where $n_f(t)$ and $n_c(t)$ respectively represent the number of links of fundamentalists and chartists network for a given threshold at month t. Since this coefficient simultaneously measures the level of connection in the both networks at any given time, it is postulated that studying its dynamics is helpful for tracking the opinion of these two groups of investors over time relative to each other. When this ratio approaches to unity, it means that the opinion of two groups of traders about the correlation of stocks performance is getting closer to each other. On the other hand, divergence of this coefficient from 1 is a sign of expectations disparity. As we are to compare the topology of these two networks over time we hold the threshold constant by $\rho = 0.5$ for both groups. Data used are trading volume (institutional and individual trading volumes) for 150 stocks which were listed in the Tehran Stock Exchange (TSE) since Jan 2000 until Oct 2009.

Unlike other developed countries, the only important stock exchange in Iran is the Tehran Stock Exchange. There are some regional stock markets but the trading volume of these stock exchanges is very low so they can be ignored. To show the trend of the Tehran stock exchange, the plot of Tehran Stock Exchange Price Index (TEPIX) and trading volume of TSE for the period Jan 2000–Oct 2009 are respectively shown in Figs. 1 and 2.

Fig. 3 shows the dynamics of the *Homogeneity* coefficient over time. The main feature of this plot is that the coefficient for whole period is less than 1. This means chartists in comparison with fundamentalists generally more strongly believe in the co-movement of stocks. We also see the coefficient generally has an increasing trend indicating that the opinions of