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Physica A 361 (2006) 263–271

PHYSICA A

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# Characteristics of the Korean stock market correlations

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Received 14 March 2005; received in revised form 16 June 2005

Available online 8 August 2005

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## Abstract

We establish in this study a network structure of the Korean stock market, one of the emerging markets, with its minimum spanning tree through the correlation matrix. Based on this analysis, it is found that the Korean stock market does not form the clusters of the business sectors or of the industry categories. When the MSCI (Morgan Stanley Capital International Inc.) index is exploited, we find that the clusters of the Korean stock market is formed. This finding implicates that the Korean market, in this context, is characteristically different from the mature markets.

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*Keywords:* Correlation-based clustering; Emerging market; Minimum spanning tree; Econophysics

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## 1. Introduction

The stock price of a given company is a mutual inference of various information, such as company revenue, competition performance, currency policy, business barometers, political situation, and so on. In other words, when the price is estimated, there are numerous complicated factors that must be considered. In the stock market, all companies are interconnected and consequently their stock prices

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are correlated. This correlation, known as the potential of deep inner impact, forms the stock market network.

Network theory has been extended into a wide range of subjects [1–4]. Barabási and Albert (BA) introduced the scale-free network which is constructed by the growth rule and the preferential attachment rule [5]. We consider the preferential attachment rule as the connectivity of an influential company in stock market—a more influential company has more connections with other companies. The interaction strengths between nodes are important in many network systems. Non-binary scale-free network [6] which takes a continuous weight between 0 and 1 is a proper choice for modeling a stock market. We regard companies as nodes (vertices) of the network, interacting relations between stocks as links (edges) and correlation coefficients as weights.

The minimum spanning tree (MST) is widely used to study the stock market since Mantegna first constructed the network based on the correlations [7]. The minimum spanning tree is generated by selecting the most important links. We construct a correlation matrix of  $N$  stocks. This matrix is symmetric and diagonal with  $\rho_{ii} = 1$ . The MST is determined by the distance matrix  $D$  where  $d_{ij} = \sqrt{2(1 - \rho_{ij})}$ . There have been several attempts to identify the cluster structure [8–10]. The MST is very useful to observe the network topology and identify clusters of the market including the stock and foreign exchange (FX) market [11,12]. Bonanno et al. introduced the topological properties of the MSTs through the real and model markets' dataset [13]. Onnela et al. investigated the dynamical properties of the American market correlations and taxonomy analysis in detail. The S&P500 forms clusters with the business sectors and the portfolio optimization with these clusters is successful. The MST also can be applied to the portfolio analysis in practice [14].

While there has been an abundance of literature concerning mature markets—especially, the US market—relatively little work has been published for emerging markets such as those of Korea, BRICs and Eastern Europe. Emerging markets often lack liquidity and reliable data, so they are generally unstable. These factors make the study of emerging markets more complex. Even the universal features for mature markets cannot be extended to emerging markets for every cases [15]. It seems that the model appropriate to emerging market should be exploited.

In this paper, we aim to explore the topological characteristics of the Korean market as a representative emerging market. We construct the non-binary network by following the method introduced and applied for S&P500 companies by Kim et al. [16]. We study the taxonomy and network topology of the Korean market with it.

## 2. Properties of the Korean Stock Market

The Korean stock market is much smaller than the US stock market. There are two stock markets in Korea—the Korea Stock Exchange (KSE) and the KOSDAQ. There are 700 and 900 listed companies and total capitalizations are \$400 billion and \$30 billion, respectively. For NYSE and NASDAQ, there are thousands of listed

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