Effects of the globalization in the Korean financial markets

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We study the effect of globalization on the Korean market, one of the emerging markets. Some characteristics of the Korean market are different from those of the mature market according to the latest market data, and this is due to the influence of foreign markets or investors. We concentrate on the market network structures over the past two decades with knowledge of the history of the market, and determine the globalization effect and market integration as a function of time.

I. INTRODUCTION

The slogan of the 1988 Seoul Olympics Games, and is also the slogan of the Korean stock market. The globalization means that foreign traders have an influence on the Korean market and its synchronization with world markets.

Interdisciplinary study has received much attention, with considerable interest in applying physics to economics and finances [1, 2, 3, 4, 5]. Since a financial market is a complex system, many researchers have developed network theory to analyze such systems. The concept of an asset tree constructed by a minimum spanning tree is useful in investigating market properties [6, 7, 8]. The MST of an asset tree can be extended to portfolio optimization [9].

Nowadays, many emerging markets experience the globalization that is making rapid progress, and the influence of developed markets is becoming stronger. Most markets synchronize with the US market and globalization is leading to characteristic changes in emerging markets [10].

Several results have been reported on the necessity to find a model appropriate to emerging markets, because the models for mature markets cannot be applied to emerging markets universally [11]. The Korea Stock Exchange (KSE) opened in 1956. At that time, only 12 companies were listed on the market. As the Korean economy has developed, the stock market has undergone many changes under the influence of factors inside and outside the market.

The Korea Stock Exchange (KSE) opened in 1956. At that time, only 12 companies were listed on the market. As the Korean economy has developed, the stock market has undergone many changes under the influence of factors inside and outside the market.

We deal with the daily closure stock prices for companies listed on the KSE from 4 January 1980 to 30 May 2003. The stock had a total of 6648 price quotes over the period. We select 228 companies that remained in the market over this period of 23 years. Fig. 1 shows the index for those companies. The representative KSE index, KOSPI, is an index of the value-weighted average of current stock prices. The index of Fig. 1 is a price-equally-weighted index, similar to use for the Dow Jones industrial average (DJIA). Many previous studies on the stock market assumed a certain number of trading days to constitute a year. However, it is not easy to apply such an assumption to our data set, because the Korean market opening time changed in 2000. Before 20th May 2000, the market opened every day except Sunday, and from Monday to Friday after 21st May 2000. Most of the data set falls into the former period, so we assume 300 trading days for one year. The x-axis values in Fig. 1 were calculated under this assumption.

The cross-correlation coefficients between stock i and j are defined as:

\[ \lambda_{ij} = \frac{< S_i S_j > - < S_i > < S_j >}{\sqrt{(< S_i^2 > - < S_i >^2)(< S_j^2 > - < S_j >^2)}} \]  

and form a correlation matrix \( \Lambda \).
FIG. 1: Index of 228 selected companies in the Korean stock market from 1980 to 2003.

FIG. 2: The mean, standard deviation, skewness, and kurtosis of the correlation coefficient in the Korean market as functions of time.

The top panel of Fig. 2 shows the mean correlation coefficient calculated with only non-diagonal elements of Λ. The second shows the standard deviation, the third, the skewness and the last, the kurtosis. It has been reported that when the market crashes, the correlation coefficient is higher [13]. In the US market, the effect of Black Monday (19 October 1987) was clearly visible for these four coefficients, with correlations among them also apparent [5]. However, crash effects on the Korean market (the late 1980s bubble crash and the 1997 Asian financial crisis) are visible, but not clear in comparison with the US market, and the Korean market coefficients do not have clear correlations.

We investigate more properties of the market through the MST that is a simple graph with \( N \) nodes and \( N - 1 \) links. The most important connection is linked when it is constructed. It is known that the US market network is centralized to a few nodes [19]. The hub of the US market is approximately General Electric (GE), and it is possible to make clusters (subsets of the MST) of the US market with industry categories or business sectors [9]. However, the Korean market has no comparable hub for the whole market, and the clusters are constructed with the MSCI index [17]. We regard this result as the effect of globalization and market integration. Thus, we obtained the MSTs from 1980 to 2003 with time windows of width \( T \) corresponding to daily data for \( T = 900 \) days and \( \delta T = 20 \) days. During this period there is no comparable hub, but we can form clusters with industry categories for some periods. Then we define the parameter grouping coefficient. The grouping coefficient of a

### Table I: Industry categories of the Korea Stock Exchange in our data set

| Category number | Industry category                  | No. of companies |
|-----------------|-----------------------------------|-----------------|
| 1               | Fishery & Mining                  | 1               |
| 2               | Food & beverages                  | 24              |
| 3               | Tobacco                           | 0               |
| 4               | Textile                           | 14              |
| 5               | Apparel                           | 3               |
| 6               | Paper & wood                      | 10              |
| 7               | Oil                               | 0               |
| 8               | Chemicals & medical supplies      | 40              |
| 9               | Rubber                            | 6               |
| 10              | Non-metallic minerals             | 12              |
| 11              | Iron & metals                     | 10              |
| 12              | Manufacturing & machinery         | 13              |
| 13              | Electrical & electronic equipment  | 8               |
| 14              | Medical & precision machines      | 1               |
| 15              | Transport equipment               | 12              |
| 16              | Furniture                         | 0               |
| 17              | Electricity & gas                 | 1               |
| 18              | Construction                      | 21              |
| 19              | Distribution                      | 17              |
| 20              | Transport & storage               | 10              |
| 21              | Banks                             | 8               |
| 22              | Insurance                         | 11              |
| 23              | Finance                           | 4               |
| 24              | Services                          | 1               |
| 25              | Movies                            | 1               |
specified industry category \( C \) is defined as:

\[
g_C = \frac{n_C(i \in C)}{n(i \in C)}, \tag{3}
\]

where \( i \in C \) represents the nodes in category \( C \), \( n(i) \) is the number of links that are connected to node \( i \) and \( n_C \) is the number of links from the node included in category \( C \).

Table II shows 25 industry categories of the Korean stock market. In fact, there are rather more categories than 25. However, the standard for grouping is excessively detailed, and combinations of these categories are mostly used. The categories in Table II are reconstructed from Hankyoreh, a popular newspaper in Korea. Fig. 3 shows the grouping coefficient for each category over the whole period. We observe that categories 8, 18, 21, 22 and 23 form a well-defined cluster. We focus on the maximum grouping coefficient for each industry category. For example, there are only four companies in the finance category (23) and the maximum value of the coefficient is only 0.6 (=3/5) because of the characteristics of the MST. We take the maximum value when the nodes are linked linearly. Fig. 3b shows the ratio of the grouping coefficient to the maximum value for each category. Categories 18, 21, 22 and 23 are almost complete clusters in this plot.

We previously investigated characteristics of the Korean stock market using a data set from 2001 to 2004, and found that the market forms clusters when the Morgan Stanley Capital International (MSCI) index is exploited. However, Fig. 4 shows that some industry categories can be applied to form the clusters. We consider the history of the Korean market, including the globalization effect. Fig. 4 shows the grouping coefficient \( G \) for the whole market as a function of time. This coefficient is calculated with all of the nodes, and the ratio of connections between companies in the same category to the total number of links. Before the mid-1980s, the Korean market had developed according to a planned economy and had many restrictions on trading of stocks. At that time, the market was unstable because of the poor liquidity. This is one possible explanation for lower value in the early 1980s in Fig. 4. As the market prospered in the mid-1980s, clusters of industry categories also extensively formed.

The 1988 Seoul Olympics Games and the 1997 Asian financial crisis hastened globalization of the Korean market. In particular, globalization of the Korean market progressed to synchronization with external markets. This explains the decreasing coefficient in Fig. 4 after 1988. The index continues to show a decreasing trend, which means that the formation of clusters in the Korean market is related to the MSCI index. The MSCI Korea index has been calculated from 1988, when the grouping coefficient in Fig. 4 has almost a maximum value. The MSCI Korea index is a factor of the Korean market’s globalization and market integration. Because foreign traders strongly influence the Korean market, the MSCI index is a good reference for their trading.

\[\text{FIG. 3: Plot of grouping coefficients: (a) shows the value of } g \text{ and (b) shows the ratio of the coefficient to the maximum value of } g.\]

\[\text{FIG. 4: Plot of the grouping coefficient for all categories as a function of time.}\]

\[\text{III. CONCLUSIONS}\]

We have studied the Korean stock market network with the daily closure stock price. The analysis shows that the grouping coefficient changes with elapsing time. With globalization, the market is synchronized to external markets, and the number of clusters of industry categories decreases. Finally, the market forms clusters according to the MSCI index. We think the tendency of synchronization will be stronger and the clusters of the MSCI index or foreign factors will be firmer. Our future research will determine other properties of the globalization effect with other statistical analysis in the Korean market.

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FIG. 5: The asset tree of the time window from day 2501. In the US market, the hub is located at the center of the star structure and clusters are formed through the branches of this star structure \cite{9}. However, we cannot find this property, a comparable hub and star structure, in the Korean stock market, even though the grouping coefficient of this period has higher value than the other periods. The numbers refer to the category number in Table II.

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