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Analysis of stock prices of mining business

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ABSTRACT

Stock exchanges have a diversity of so-called business groups and much evidence has been presented by covariance matrix analysis (Laloux et al. (1999) [6], Plerou et al. (2002) [7], Plerou et al. (1999) [8], Mantegna (1999) [9], Utsugi et al. (2004) [21] and Lim et al. (2009) [26]). A market-wide effect plays a crucial role in shifting the correlation structure from random to non-random. In this work, we study the structural properties of stocks related to the mining industry, especially rare earth minerals, listed on two exchanges, namely the TSX (Toronto stock exchange) and the TSX-V (Toronto stock exchange-ventures). In general, raw-material businesses are sensitively affected by the global economy while each firm has its own cycle. We prove that the global crisis during 2006–2009 affected the mineral market considerably. These two aspects compete to control price fluctuations. We show that the internal cycle overwhelms the global economic environment in terms of random matrix theory and overlapping matrices. However, during the period of 2006–2009, the effect of the global economic environment emerges. This result is well explained by the recent global financial/economic crisis. For comparison, we analyze the time stability of business clusters of the KOSPI, that is, the electric/electronic business, using an overlapping matrix. A clear difference in behavior is confirmed. Consequently, rare earth minerals in the raw-material business should be classified not by standard business classifications but by the internal cycle of business.

1. Introduction

During recent decades, many physicists have devoted their full attention to the analysis of financial markets, especially since an enormous amount of computerized data has become available. Financial markets have complex internal structures in which many agents, traded products, and their interactions come together [1–4]. It is thus of very great importance to unveil the underlying structure of these market and understand its dynamics. Different from traditional industry classifications, some physicists have presented a correlation-based classification by using physics concepts, such as the random matrix theory, spin-glasses, and network analysis [5–9]. According to their work, a stock market has non-random information that plays a crucial role in classifying stocks into separate clusters. And these clusters are usually matched with those stocks by the standard industry classification with some deviations, by which some firms are clustered according to the magnitude of market capitalization. In order to study pairwise or collective behavior of multiple time series, the random matrix theory (RMT) and the principal component analysis (PCA) are widely used [10]. Also, for the case of non-stationary time series, a new method called by detrending cross-correlations analysis (DCCA) was proposed [11,12]. In this work, RMT and PCA were used.

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Generally, in the view of investors, the mineral industry is thought of as a method of hedging. In the case of gold, the investors view is that of the metal having a strong positive correlation with inflation. This fact shows that gold is one of the best ways to hedge against risk [13,14]. Although oil has a tendency to take a direction similar to that of the market, it is called a lagging index because there is a time gap of trends between the oil price and the market index price. Actually, these facts have already been analyzed by researchers in many fields, especially researchers in the fields of economics and finance. Contrary to previous investigations about minerals, rare earth minerals have not taken the spotlight for their importance of use in the high-tech industry. Some countries have started a protective trade to block the outflow of rare earth minerals. In this global situation, we have investigated the mining industry and have particularly focused on the rare earth mineral industry.

In this work, we analyze the cluster structure of the mining business and its time-evolutionary robustness. In general, the mining business has two effects, from within and from without. Raw-material prices move with the global economic environment while each mining firm has its own cycle, such as prospecting, exploration, development, production, and reclamation. The former induces a strong positive correlation among firms of the same kind but the latter accelerates their decoupling. These two factors compete to have an effect on price; the effect of the out-of-phase cycle of development overwhelms that of the global economy in ordinary times. However, for a period of global economic crisis, the situation is reversed. Also, in order to stress the characteristic behaviors of the rare earth mineral business, we attempt a comparative study with the electric/electronic business of the KOSPI (Korean Stock Exchange) and confirm that a business group of a secondary industry has a stronger coupling tendency over time than that of a business of a first industry.

This paper is organized as follows. In a subsequent section, we give a brief description of the dataset analyzed herein. The section of numerical results briefly introduces the methodology and presents the results of analysis. Concluding remarks are contained in the final section.

2. Data description

We use a database of 40 firms publicly listed on two regulated exchanges, namely the TSX(Toronto stock exchanges) and the TSX-V(Toronto stock exchange-venture). These markets are quoted day-by-day from the website of yahoo.finance.com during the period from January 2000 to December 2009. Stock codes and related mineral resources are listed in Table 1. Technically speaking, the price information of yahoo.finance.com is incomplete because the website does not reflect certain events such as increase of capital without consideration, paid-in increase of capital, or reduction of capital. We amend the prices and the adjusted prices are used for analysis. In addition, the 40 firms are in the pre-production stages because we focus a certain area of the mining industry, namely those firms associated with rare earth metals. Generally, production firms have a very strong positive correlation with the real economy and the commodity industry. The criteria for selection of the listed mining firms is following.: (1) Market capitalization is under fifteen million dollars. (2) They are in the stage of pre-production. (3) Involved minerals are in the rare earth mineral list only. The length of data-points is 2600 and for the analysis of time-stability, we divide the whole size into 8 overlapping segments, each of which has 750 data-points and moves by 250 days. We took 250 working days as one year. Therefore, each segment covers 3 years and proceeds by one year. Finally, for comparison, we select 24 firms from the KOSPI(Korean Stock Exchange) and they are affiliates of the electric/electronic business according to standard business classifications. Firms consists of 1500 data-points and are quoted day-by-day from the website of during the period, from 2001 to 2007.

3. Numerical results

3.1. Random matrix theory (RMT)

A correlation matrix **C**, in general, provides a useful information about the inter-dependence of its components. However, the finite-size of the database creates in the database an unavoidable noise. RMT was introduced to sort out genuine correlations among components from spurious ones. As proved in previous works [15–18], the deviating part of **C** shows some clues about the clusters of firms of a stock market. To compute a correlation coefficient, we first define the logarithmic return, $R_i(t)$, as follows:

$$R_i(t, \Delta t) = \log P_i(t + \Delta t) - \log P_i(t) \tag{1}$$

where $P_i(t)$ denotes the daily price of stock i at time t and therefore Δt represents one day. In order to get a relative correlation, we use the normalized return, $r_i(t)$, as follows:

$$r_i(t) = \frac{R_i(t) - \langle R_i \rangle}{\sigma_i}, \qquad \sigma_i = \sqrt{\langle R_i^2 \rangle - \langle R_i \rangle^2} \tag{2}$$

where σ_i is the standard deviation of the return and $\langle \cdots \rangle$ indicates a time average. A correlation matrix **C** is derived by the following relation

$$C \equiv \langle r_i(t) r_j(t) \rangle = \begin{pmatrix} 1 & \cdots & C_{1N} \\ \vdots & \ddots & \vdots \\ C_{N1} & \cdots & 1 \end{pmatrix}. \tag{3}$$