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Changes in Cross-Correlations as an Indicator for Systemic Risk

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The 2008–2012 global financial crisis began with the global recession in December 2007 and exacerbated in September 2008, during which the U.S. stock markets lost 20% of value from its October 11 2007 peak. Various studies reported that financial crisis are associated with increase in both cross-correlations among stocks and stock indices and the level of systemic risk. In this paper, we study 10 different Dow Jones economic sector indexes, and applying principle component analysis (PCA) we demonstrate that the rate of increase in principle components with short 12-month time windows can be effectively used as an indicator of systemic risk—the larger the change of PC1, the higher the increase of systemic risk. Clearly, the higher the level of systemic risk, the more likely a financial crisis would occur in the near future.

In finance, systemic risk is the risk associated with the whole financial system, as opposed to any individual entity or component[1]. It can be defined as any set of circumstances that threatens the stability of the financial system, and so potentially initiates financial crisis[2]. It generally holds that the larger systemic risk, the larger are the threats to financial stability. An example is a bank runs associated with a large group of clients deciding to withdraw their deposits immediately, creating shortage of cash that might lead to multiple bank failures and cascades into a global financial crisis[3]. Systemic risk is commonly defined as the probability of a series of correlated defaults among financial institutions, occurring over a short time span, which in turn trigger a widespread liquidity and loss of confidence in the financial system as a whole[2,4]. The 2008–2012 global financial crisis makes researchers re-cognize the importance of the measurement and forecast of systemic risk.

The empirical studies on systemic risk are loosely divided into three categories[2,5]. Two of them are directly related to the performance of banks. The first one involves bank contagion, and is mostly based on the auto-correlation of the number of bank defaults, bank returns and fund withdrawals[6–14]. The other one is focused on bank capital ratios and bank liabilities, and show that aggregate variables such as macroeconomic fundamentals, which provide evidence in favor of the macro perspective on systemic risk on the banking sector[15–18].

The third group of empirical studies on the systemic risk put emphasis on contagion, spillover effects and co-movement in financial markets[3,19,20,22–29]. These studies are based on cross-correlations and causality relationships among securities and currency price time series. Most of the studies are carried out on financial sectors such as banks, brokers, insurance companies and hedge funds[22–25]. Many measures of the systemic risks are based on principal components analysis (PCA) or Granger-causality test[24–26]. For example, Kritzman *et al.*[25] proposed a systemic risk measurement called the absorption ratio based on PCA, Billio *et al.*[2] used the first two eigenvalues to detect the systemic risk from banks, brokers, insurers and hedge funds. They also proposed an indicator named dynamic causality index (DCI) calculated from Granger-causality test to measure the degree of systemic risk. Kaminsky and Reinhart[24] used a simple vector auto-regression model to run Granger-causality test between the interest and exchange rates of five Asian economies before and after the Asian crisis. Previous work has shown that the first PC is closely related to the average correlation. Billio *et al.*[2] reported that four financial sectors including hedge funds, banks, brokers, and insurance companies become highly interrelated and less liquid prior to crisis periods. Recently, some of the security cross-correlation studies report that the first principal component substantially increases during financial crisis[19,20]. The same studies reported that the volatility cross-correlations exhibit long memory[21], implying that once high volatility (risk)[30,31] is spread across the entire market, it could lasts for a long time.