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Spillover of fear: Evidence from the stock markets of five developed countries

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ABSTRACT

This study investigates the spillover effect in five leading stock markets (i.e., the United States, the United Kingdom, Germany, Japan, and France). It estimates the spillover indices of these countries and finds that information transmission between these stock markets increases considerably after 1998. Germany and the United States are the main stock markets conveying information to other international markets. Germany primarily influences the French stock market, and the United States significantly influences many other stock markets. Results show that the US stock market shows three periods during which its net spillover effect exceeds zero: the period prior to 1997, the dot-com bubble from 2000 to 2002, and the subprime mortgage crisis and Lehman Brothers bankruptcy from 2007 to 2008. The fear index correlates significantly with the spillover of the US stock market into other markets. The spillover effect of the US stock market demonstrates asymmetry and the likelihood to spread positive fundamental information and non-fundamental information (e.g., fear).

1. Introduction

During the 1990s, various crises occurred in emerging market economies. These crises were called the "Tequila effect" (in 1994), the "Asian flu" (in 1997), the "Russian cold" (in 1998), and the "Brazilian fever" (in 1999). They usually began as country-specific shocks and then spread to other countries. Recently, the increasing number of markets influenced by financial recession, information transmission speed, and asset price decline rates has become a major concern in related fields. These increases may have been caused by the prevalence of transnational investments.

Following the US subprime mortgage crisis, the collapse of Lehman Brothers, and the European sovereign debt crisis, which altogether resulted in a global financial recession, discussions on whether transnational investments remain a viable solution for evading investment risks or whether global systematic risks are escalating substantially have become increasingly prevalent.

This study establishes a spillover index using stock market data from the five leading economies in the world (i.e., the United States, the United Kingdom, Germany, Japan, and France) to estimate the level of information transmission in these stock markets. Subsequently, by analyzing the spillover effect in these stock markets, this study clarifies the dynamic co-movements that constitute the transmission process between and among markets. It then uses the results to determine the reasons behind the worldwide increase in correlation between stock markets.

According to the portfolio theory proposed by Markowitz (1952),[1] risks pertaining to investment portfolios can be classified as either systematic or non-systematic. Non-systematic risk can be mitigated through diversification. However, this management technique cannot be used to reduce systematic risk because non-systematic risk is present in all types of investment assets.

During the 1990s, irrational investor behavior attributable to home bias resulted in the over-investment of national assets and the lack of transnational investments (Cooper & Kaplanis, 1994; French & Poterba, 1991; Tesar & Werner, 1995).[2] Given the reduced activity among stock markets at the time, transnational investment portfolios facilitated risk evasion. By contrast, the risk-evasion benefits of investing in multiple stock markets have recently been greatly reduced because the regional financial crises in Europe and the United States induced a worldwide financial recession.

A number of researchers have analyzed various aspects of the international comovement of stock returns in recent years (e.g., Bekaert & Harvey, 1995; Dumas, Harvey, & Ruiz, 2003; Forbes & Chinn, 2004). A significant number of these studies analyzed whether macroeconomic

[1] Markowitz introduced the portfolio selection concepts in 1952; these concepts were later used to develop the fundamental portfolio theory. The core objectives of this theory are to evade risk, increase investment proficiency, and identify portfolios according to all options that produce the greatest return on investment at the lowest possible risk. Portfolio theory stipulates that the key to effective investment allocation depends on the correlation between investment objectives.

[2] Strong and Xu (2003) find that fund managers from the United States, the United Kingdom, continental Europe, and Japan exhibit significant comparative optimism toward their home equity markets. French and Poterba (1991), Cooper and Kaplanis (1994), and Tesar and Werner (1995) also documented that, although the barriers to international investment have fallen dramatically, foreign ownership of shares remains extremely limited.

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variables help explain changes in the international comovement of stock returns. Some studies proposed a link between macroeconomic variables and the international comovement of stock returns (Erb, Harvey, & Viskanta, 1994; Ragunathan, Faff, & Brooks, 1999), whereas others reported evidence that this link is weak (Verma & Ozuna, 2005; Kizys & Pierdzioch, 2006).

If the inadequacies of transnational investments previously exhibited are related to the irrational behavior of institutional investors (i.e., home bias), then the close comovement of stock markets recently generated by rapidly circulating international hot money can also be associated with irrational investor behavior. Majority of previous studies used macroeconomic factors to determine the comovement of stock markets and typically analyzed the impact of rational investor behavior on the market. By contrast, the present study investigates whether irrational trader behavior could explain between-market correlations.

Masson (1997) asserts that a loss in investor confidence as a result of circulating negative information may cause investors to overestimate investment risks of a specific country. If such overestimation contributes to herding behavior, that particular country may experience considerable investment capital outflow, thus leading to a financial crisis. Investor behaviors exhibited during recent financial recessions are extremely similar to the herding behavior proposed by Masson (1997). In particular, the spread of negative sentiment across many capital markets exacerbates the decline in asset price.

The volatility index (VIX), also referred to as the "investor fear gauge," is a measure of market expectations of stock return volatility (Whaley, 2000). The Chicago Board Options Exchange (CBOE) VIX, or fear index, is commonly used to measure investor sentiment. In practice, the VIX is also examined to observe whether investors' perceptions of a possible financial recession have intensified.

Regarding financial recessions, the transmission mechanism between returns is commonly referred to as the contagion effect. King and Wadhwani (1990) were the first to propose that the drastic increase in correlation between stock markets of various countries can be explained by applying the contagion effect. They find that the degree of correlation between the United States, the United Kingdom, and Japanese stock returns increased after the 1987 stock market crash. Forbes and Rigobon (2002) proposed the following definition of contagion: a significant increase in cross-market linkages from a shock that affects a country or group of countries. Tests based on this definition of contagion indicate the effectiveness of international diversification in reducing portfolio risk during a crisis. Forbes and Rigobon (2002) and Caporale, Cipollini, and Spagnolo (2005) detected the contagion effect by carrying out parameter stability tests based on conditional correlation analyses. However, these tests only assess whether evidence of contagion exists by checking for the presence of a structural break in the level spillover and do not describe the international transmission mechanism.

Other studies analyzed the international comovement of stock returns to explain the contagion effect. Dungey, Fry, González-Hermosillo, and Martin (2005) used data from Asian and Australian equity market returns from 1995 to 2001 and adopted the framework of a latent factor model. Their evidence shows that comovements in Asian and Australian equity markets are largely determined by interdependent linkages arising from common systemic factors.

Forbes and Rigobon (2002) define the contagion effect as follows: if the correlation between markets exists because of fundamental factors, then the contagion effect is non-existent. Other previous studies also assert that the correlation between international stock markets is attributable to macroeconomic factors (e.g., Erb et al., 1994; Ragunathan et al., 1999). However, none of these studies explain the presence of the contagion effect. Diebold and Yilmaz (2005) obtained dissimilar results when analyzing volatility spillovers across markets during and after two crises (i.e., East Asia and Russia). They find a substantial increase in volatility spillovers across markets as a result of increased market integration in the 1990s.

Unlike previous studies, the present study analyzes the correlation between investor fear and the spillover effect in various stock markets. In preparation, this paper initially establishes the spillover indices for the stock markets of the United States, the United Kingdom, Germany, Japan, and France to estimate the magnitude and interaction directions of the return on investment (ROI) in various stock markets. Subsequently, this study examines whether the fear index influences the spillover effect to identify the transmission of investor sentiment within these five stock markets.

This paper is structured as follows. The methodologies used are briefly introduced in Section 2. Section 3 reports the data and estimation results. Finally, Section 4 provides a summary of the main findings and several conclusions.

2. Methodology

This study elucidates the nature of the international transmission mechanism. We follow the methodology proposed by Diebold and Yilmaz (2012) by estimating the spillover indices among stock markets in five major developed countries. Diebold and Yilmaz (2009) proposed a new approach for analyzing the spillover across markets, using a measure based on forecast error variance decompositions from vector autoregressions (VARs). Diebold and Yilmaz (2012) extended their earlier work and proposed spillover indices across asset markets under a more generalized VAR framework in which variance decompositions are invariant to variable ordering. This methodology concisely describes the extent of return spillovers in markets. The advantages of such spillover indices indicate the contributions and directions of shocks from one market to another.

Diebold and Yilmaz (2012) introduced return spillover measures based directly on variance decompositions invariant to the variable ordering based on VARs fitted to returns or volatilities. In the current paper, stock price index returns are used to estimate the generalized VAR framework.

A covariance stationary N-variable VAR(p) model is presented as follows:

$$y_t = \sum_{i=1}^{p} \psi_i y_{t-i} + \varepsilon_t \tag{1}$$

where $\varepsilon \sim (0,\Sigma)$ is a vector of independently and identically distributed disturbances. The model can be rewritten as a moving average representation:

$$y_t = \sum_{i=1}^{\infty} A_i \varepsilon_{t-i}, \tag{2}$$

where A_i is $N \times N$ coefficient matrices that obey $A_i = \phi_1 A_{i-1} + \phi_2 A_{i-2} + \cdots + \phi_p A_{i-p}$, with $A_i = 0$ for $i < 0$ and with A_0 being an $N \times N$ identity matrix. This methodology parses forecast error variance into parts attributed to various shocks. Generally, for each return i, we add the shares of its forecast error variance coming from shocks to return j, where $\forall j \neq i$. Variance decompositions can then be used to assess the fraction of the error variance in forecasting y_i resulting from shocks to y_i, where $\forall j \neq i$ for each i. The own variance share is defined as the fraction of the H-step-ahead error variances in forecasting x_i that results from x_i, for $i = 1,2,\cdots,N$. Alternatively, the cross variance share is defined as the fraction of the H-step-ahead error variances in forecasting x_i that results from x_j, for $i,j = 1,2,\cdots,N$ such that $i \neq j$. This study uses a five-variable, second-order VAR model ($p = 2$) and 10-step-ahead forecasts ($H = 10$).

The calculation of variance decompositions requires orthogonal innovations. Diebold and Yilmaz (2012) circumvented these problems by exploiting the generalized VAR framework of Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998), hereafter referred to as KPPS.

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