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International risk transmission of stock market movements☆

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ABSTRACT

The Great Recession of 2007-2009 originated in the United States has brought to the surface the need for measuring and monitoring the transmission of extreme downside market risk. This paper investigates the international risk transmission mechanism between the US and major Asian stock markets. By applying two recently introduced test statistics based on cross-quantilogram function, we confirm the existence of risk spillover from the US to major Asian stock markets, as well as the feedback effect. Furthermore, we apply the multivariate quantile regression model (VAR for VaR) to quantitively uncover these tail-interdependency patterns, showing how the extreme downside risk transmits between the US and Asian markets. Our results suggest these stock markets are highly integrated in terms of risk transmission. The shocks in the US market substantially increase the Value at Risk (VaR) in the Asian markets, except China and Russia. On the other hand, price drops in the Asian markets also have a weaker but significant predictive power for risk in the US market. By investigating the time-varying pattern of the risk interdependency structure, we further show a rising trend of cross-country risk linkages over time. We also document considerable asymmetric patterns in the international transmission mechanism of stock market movements, highlighting the underlying weakness of adopting volatility to measure the market risk.

1. Introduction

Measuring and monitoring the distributional interdependence between different stock markets is a primary concern among academic researchers, policy makers, and business practitioners. The Great Recession of 2007-2009 that originated in the United States has further heightened the need for research that evaluates the transmission mechanism of extreme downside market risk. Given the rising trend of global financial market integration, understanding the international risk-transmission mechanism not only helps improve portfolio-allocation strategies for market participants seeking international investment opportunities, but also leads to the best policy responses for the regulation institution and local government to control the cross-border market risk, thereby maintaining financial stability.

A series of studies have analyzed the relationship between national stock markets. One common feature of the existing literature is that they focus on the market interdependency structure within the first and second moments, and use volatility to measure the market risk (e.g., Eun and Shim, 1989; Engle and Susmel, 1993; King and Wadhwani, 1990; King et al., 1994; Lin et al., 1994; Forbes and Rigobon, 2002; Diebold and Yilmaz, 2009; Beirne et al., 2010; Jayasuriya, 2011; Long et al., 2014; Alotaibi and Anil, 2015; Huo and Abdullahi, 2017). Volatility describes the degree of variation of financial series, and is an important measure in finance. However, regarding the market risk, volatility can only capture a small fraction of extreme downside market movements. Using volatility as the risk measure has at least two major drawbacks. First, volatility treats the market gains and losses in a symmetric way, but the market risk apparently only relates to the occurrence of the left tail of the financial return distribution. Second, volatility fails to capture the fat-tail feature of financial series, which is a widely reported fact in many empirical studies. In other words, even in the absence of the spillover in the mean and volatility, one market can still affect other markets through the interactions in the higher moments. As a result, instead of volatility, a more sensible measure is needed to capture the market risk, and allows us to further investigate the risk spillover across international equity markets. In the field of banking and finance, the Value at Risk (VaR) concept, originally proposed by J.P. Morgan in 1994, has become a standard measure of the downside market risk today. The advantage of this measure is that it directly links the market risk to the left quantile of the conditional return distribution. It has further become an essential tool for market regulators to ensure financial stability and conduct the macroprudential policies (e.g., the Basel Committee on Banking Supervision). To date, however, in-depth analyses of the interdependency structure of

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national stock markets examined by means of VaR are scarce. The objective of this paper is to engage in a more comprehensive analysis of the international risk-transmission mechanism, with a particular emphasis on quantifying how risk transmits between the US and major Asian markets.

As is well known, the United States is the largest and most powerful economy in the world. With more than 10,000 listed companies and a $26.33 trillion market value, the US stock market is also viewed as the most efficient and most representative developed stock market in the world.[1] The Asian markets, on the other hand, especially the emerging markets, are the most vigorous economies and global growth engines in recent years. Thanks to the fast-growing status of these countries' economies, their financial markets have also experienced an astonishing development. For now, China and Japan are documented as the second and third largest markets with respect to the market cap, with $6.00 and $4.38 trillion market values respectively. They have offered plenty of investment opportunities in recent years. Besides, these markets interact heavily with the US market. Fig. 1 plots the daily return of the US S & P 500 Composite Index as well as two representative Asian indices, the Shanghai Stock Exchange Composite Index and Japan NIKKEI 225 Index. It clearly shows that the financial crisis initiated in the US housing market triggered the stock market turmoil in the US from 2007 to 2009. In the same period, both China and Japan also suffered a substantial stock market crash. Based on the facts listed above, understanding the risk spillover between the US and Asian financial markets has important implications for academic researchers, policy makers, and business practitioners. This paper aims to trace out the dynamic risk-interdependency structure between the US and Asian markets. In particular, we address the following issues: Does the US stock market indeed influence major Asian markets in terms of extreme downside risk? Is there any market whose movements are causally prior to the US market? What will happen quantitatively to the Asian stock markets if the US stock market experiences a shock? How does one construct a multivariate VaR measure for the Asian markets using the information in the US market? Does the risk-interdependency structure change over time? Is there any different response pattern between losses and gains given the external shocks?

In attempting to answer the questions above, we first construct two recently introduced test statistics, which are based on the cross-quantilogram function, to examine the existence of risk spillover. Hong et al. (2009) propose a class of kernel-based tests to detect the extreme downside risk spillover between financial markets. These statistics have a convenient asymptotic standard normal distribution and can be used to check a large number of lags, thus we can detect risk spillover that occurs with time lags or that has weak spillover at each lag but carries over a very long distributional lag. Han et al. (2016) further establish the asymptotic distribution of the cross-quantilogram and the corresponding test statistics, where the consistent confidence intervals are derived by the stationary bootstrap. This bootstrap approach allows us to examine the micro-structure of quantile dependence between two series. In our study, we apply these two tests to detect extreme downside risk spillover between world financial markets. The data for this study consist of daily stock market index closing prices from the US S & P 500 Composite Index and 10 major Asian stock indices. The data sets span from January 1, 2000, to December 31, 2014.

After confirming the existence of the risk spillovers, we further apply a bilateral vector autoregressive model (VAR) for Value at Risk (VaR) (White et al., 2015) to quantitatively trace out the dynamic risktransmission mechanism between the US and Asian markets. The idea of VaR naturally lends itself to the concept of quantile regression. Compared to the more traditional method that models the whole multivariate distribution, the quantile approach has at least three appealing features. First, it directly models the quantile and links it to the market risk. As a result, it avoids the indirect risk measure based on estimating the time-varying first and second moments. Second, quantile regression is known to be robust to outliers, which is particularly important for analyzing financial time series. Third, quantile regression is a semi-parametric approach and therefore imposes little distributional assumption on the underlying data generating process (DGP). The multivariate quantile regression framework of the VAR for VaR model can be regarded as a multivariate extension of univariate conditional autoregressive value at risk (CAViaR) model of Engle and Manganelli (2004). This multivariate method is especially useful to account for reverse causality, and investigate the dynamic interdependency structure across world financial markets. Given the fast-growing status of the Asian financial markets and rising degree of global financial integration, it turns out to be essential to capture the feedback effect from Asian markets to the US in terms of risk transmission.

The empirical findings of our analysis are expected to shed new light on the interdependency structure of national stock markets, in general, and the international risk-transmission mechanism of stock market movements, in particular. Our results first indicate the existence of the substantial risk spillover from the US to major Asian markets, as well as the feedback effect. Hence, we show the importance of accounting for the reverse causality and construct a unified multivariate framework to analyze the international risk-transmission structure. After estimating the multivariate quantile regression model, we quantitatively uncover the tail-interdependency patterns between these markets. We show that these markets are highly integrated in terms of risk transmission. The pseudo impulse response functions suggest that the shocks in the US market substantially increase the VaR in the Asian markets, which is in line with its dominating power across the world stock markets. In addition, price drops in Asian markets also have a significant predictive power for risk in the US market. This finding indicates the fast-growing status of Asian financial markets. In this study, we construct a multivariate VaR measure for Asian markets in the quantile regression framework. By investigating the time-varying patterns of risk-interdependency structure, we further show a rising trend of cross-country risk linkages over time. We also document a substantial asymmetric property in the international transmission mechanism of stock market movements, highlighting the underlying weakness of adopting volatility to measure the market risk.

Our paper mainly relates to two strands of studies. First, as mentioned above, we complement the studies investigating the first and second moment relationships between the stock markets. We extend these papers by directly focusing on the quantile interdependency structure of the stock return distribution. In practice, the occurrence of left quantile has the clear economic meaning as the market risk. Second, our paper also relates to the research using quantile regression. The finance literature has frequently employed quantile regression to study the quantile interdependence between the financial series (e.g., Bassett et al., 2002; Chuang et al., 2009; Tsai, 2012; Baur et al., 2012; Baur, 2013; Ciner et al., 2013; Gebka and Wohar, 2013; Mensi et al., 2014). In addition, studies have also used quantile regression to construct the new VaR measure (e.g., Engle and Manganelli, 2004; Rubia and Sanchis-Marco, 2013). Lee et al. (2012) and Li et al. (2010) further apply quantile regression to firm-level data, examining the effect of diversification on firm performance and obtaining bankruptcy prediction, respectively. Our paper contributes to these studies by investigating the two-way quantile interdependency patterns between the US and major Asian stock markets, using two recently developed statistics based on the cross-quantilelogram function. More importantly, we extend quantile analysis used in early studies to the multivariate framework, and adopt the VAR for VaR method to explicitly capture these multilateral distributional relationships. To the best of our knowledge, this paper is the first study which

[1] The market-cap figures are reported by World Development Indicators, World Bank, 2014. The $26.33 trillion accounts for 36.51% world total market cap. The dollar refers to the US dollar.