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# Testing and modeling jump contagion across international stock markets: A nonparametric intraday approach ☆

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ABSTRACT

We investigate the contagion hypothesis between the United States and three European markets (Germany, the United Kingdom, and France). We focus on realized volatility, which we break down into continuous and jump parts, and we test the contagion hypothesis between jumps during overlapping and non-overlapping hours. We find a significant relation between jumps and realized volatility and spillover effects between jumps. The U.S. market plays the leading role during overlapping hours, but regional contagion is more obvious during non-overlapping hours. Interestingly, jump contagion effects exhibit asymmetry and non-linearity, and vary according to regimes. Accordingly, we improve jump modeling and spillover.



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## 1. Introduction

The standard financial literature highlights the potential benefits arising from international portfolio diversification in terms of risk reduction and market efficiency. However, while these theories were confirmed in the 1970s, several controversial findings have emerged from research studies since the 1980s. Indeed, with the arrival of recent information and communication technologies, the development of electronic trading systems and databases, access to information in continuous time, and more sophisticated marketing tools, trading costs have come down and access to the international market has widened. Consequently, interaction between investors has also increased, and financial markets display greater correlation, which has naturally reduced the benefits of diversification. Furthermore, the analysis of stock market dynamics during calm periods and in times of financial crises (i.e., the stock market crash in October 1987, the Asian crisis in 1997, the Internet Bubble in 2000, the subprime crisis of 2007, the recent global financial downturn in 2008, etc.) indicates that comovements between markets are more widespread during crises. Indeed, during turbulent periods, shocks seem to be transmitted across borders and financial markets.

The correlations and comovements between stock markets can be analyzed using at least two different forms: contagion and integration. Different definitions have been delineated for contagion. Forbes and Rigobon (2002) define contagion as a significant increase in cross-market linkages following an exogenous shock. *Shift contagion* describes comovements induced by a further crisis. We also identify the contagion derived from fundamentals and the contagion induced by mimetic behavior.[1]

Several researchers have studied the contagion hypothesis between financial markets using different methodologies. Contagion has been examined[2] in different ways using tests of returns, trading volume, and volatility spillover. Three approaches are noteworthy. The static return correlation is used to investigate comovements between different financial markets in the first approach used by Jaffe and Westerfield (1985), Longin and Solnik (1995), Calvo and Reinhart (1996), Karolyi and Stulz (1996), Forbes and Rigobon (2002), and Chiang, Jeon, and Li (2007). These authors do not reject the contagion hypothesis. Trading volume correlation is used as a proxy for financial market interaction in the second approach, which is used by King and Wadhwani, (1990), Lee and Rui (2000), Chen, Firth and Rui (2001), Lee and Rui (2002), and more recently by Jawadi and Ureche-Rangau (2013), among others.[3]

The analysis of volatility spillover is central to the third approach; however, the study conclusions are mixed. Hamao, Masulis, and Ng (1990) examined the interdependence between three markets: the London, NYSE, and Tokyo stock exchanges. Using a univariate GARCH model, the authors highlighted price volatility spillover from New York to Tokyo, London to Tokyo, and New York to London. However, no spillover effects were detected in other directions. Koutmos and Booth (1995) extended the Hamao, Masulis, and Ng (1990) study by using a multivariate EGARCH model, which takes the asymmetric response of volatility to events into account. They showed that volatility spillover is far more pronounced when the news transmitted from one market to another is relatively bad. Susmel and Engle (1994) examined hourly volatility spillover between NYSE and London, also using ARCH models, but did not report strong volatility spillover between the two markets. Kanas (1998) examined volatility spillover across the Frankfurt, London, and Paris stock markets. The author highlighted reciprocal spillover between London and Paris, and between Paris and Frankfurt, and a unidirectional spillover from London to Frankfurt. Kim, Moshirian, and Wu (2005) examined the impact of the establishment of the euro on stock market integration. Using a bivariate EGARCH framework, the authors highlighted an increase in both regional and global stock market integration following the introduction of the euro. Baele (2005) analyzed the interaction between the U.S. market and several west European markets, identifying spillover effects from the U.S. market to European

[1] See Jawadi (2011) for a literature review on contagion.

[2] See Dungey, Fry, Gonzalez-Hermosillo, and Martin (2005) for a literature review on methodologies testing contagion between financial markets.

[3] A concise literature review on volatility spillover across stock markets is provided in Jawadi, Louhichi, and Idi Cheffou (2015), while Jawadi and Ureche-Rangau (2013) include a recent review on trading volume and volatility interactions for developed and emerging countries.