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Volatility spillovers and determinants of contagion: Exchange rate and equity markets during crises☆

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ABSTRACT

We study the hourly volatility spillover between the equity markets of New York (DJI), London (FTSE 100) and Tokyo (N225) and their exchange rates (USD, EUR, GBP and JPY) for the period of 2001 through 2013 covering the non-crises period, the global financial crisis and the euro debt crisis. First, we find a general increase in spillover between the equity and exchange rate markets during the crisis periods. Second, pure contagion (attributable to irrational investors' behavior) and fundamental contagion (measured by macroeconomic fundamentals) explains the increased spillover between the FTSE 100, N225 to the DJI during the global financial crisis and from the exchange rate markets to the DJI during the euro debt crisis.

1. Introduction

A considerable body of evidence has been built upon the behavior and sources of financial asset return volatilities since the early studies of Baillie and Bollerslev (1991), and Lin et al. (1994). They show that volatilities vary across assets, asset classes, time periods and countries. This evidence has since been applied to different areas of finance including asset pricing, portfolio selection or market risk management.

International equity markets are highly integrated which may lead to high levels of cross-country investment flows as well as cross-market volatility interdependence (Bekaert and Harvey, 1995). Common research literature refers the seemingly unrelated cross-market volatility interdependence to volatility spillover effects. Since investors require foreign currencies to buy equity in international financial markets, exchange rate volatility can also influence the volatility of equity markets (Kanas, 2000).

In addition, the increasing periodicity of financial crises in recent years has given rise to considerable attention on the impact of crises on volatility spillover. Bekaert et al. (2005) and Bekaert et al. (2014) use the term "contagion" to describe the heightening of co-movements of markets as well as volatility spillover during crisis periods compared to non-crisis periods.

To explain contagion, the financial literature distinguishes between fundamental contagion and pure contagion. Dornbusch et al. (2000) provide evidence that contagion can be explained by economic fundamentals and use the term fundamental contagion. The idea of pure contagion has been alluded to in the seminal study by Lin et al. (1994), who attribute contagion to irrational investors' behavior which can lead to irrational phenomena like financial panics or herd behavior.

We apply a GARCH model to estimate the volatilities of the worldwide leading equity markets in the US, Europe and Asia in terms of market capitalization as well as turnover and of their corresponding exchange rates. In particular, we investigate the volatilities of the Dow Jones Index (DJI), FTSE 100 and Nikkei 225 (N225) and of the exchange rates between the currencies USD, EUR, GBP and JPY from 2001 to 2013. Furthermore, we use the estimated volatilities to study whether there is an increase in volatility spillover between the exchange rates markets and the equity markets during the global financial crisis and the euro debt crisis. Finally, we test whether fundamental contagion and pure contagion explain the increased spillover.

Previous research work like Coudert et al. (2011) focus on the volatility spillover effect in financial crises in general but do not examine their determinants. This study attempts to fulfill this research gap by investigating whether macroeconomic fundamentals like interest rates, trade balance and inflation or investors' behavior measured by liquidity as well as information asymmetry are influencing the

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volatility spillover during financial crisis periods.

During the financial crisis periods, we observe positive volatility spillover between the DJI, the FTSE 100 and the N225. In the same period, we show significant volatility spillovers from the exchange rate markets to the equity markets. In particular, JPY based currencies reveal negative significant volatility spillovers against the DJI and FTSE 100. Finally, we find that the volatility spillover between the FTSE 100, N225 to the DJI during the global financial crisis is explained by inflation, a measure of fundamental contagion, and information asymmetry, a measure of pure contagion. Similarly, the volatility spillover changes from the exchange rate markets to the DJI during the euro debt crisis is due to fundamental factors including interest rates, trade balance and inflation as well as pure contagion measured by imperfect information and information asymmetry.

The remainder of the study is organized as follows. In Section 2, we review the literature of volatility spillover and develop our hypotheses. In Section 3, we describe our data sample and present descriptive statistics. In Section 4, we describe the methodology. In Section 5, we present the results of the volatility spillover during the financial crises and determinants of the contagion. We conclude in Section 6.

2. Literature review and hypotheses

2.1. Volatility spillovers across different financial markets

There are two main theoretical frameworks as seen from the firm's and the investors' view to explain volatility spillover between equity and exchange rate markets. Sercu and Vanhulle (1992) provides a possible reason for the linkages between exchange rates and stock markets from the firm's view. They break the stock market down into single firms which import and/or export goods and are consequently influenced by currency movements. Thus, the international competitiveness of firms, their real income as well as stock prices which are interpreted as the present value of the firms' future cash flows, are affected by exchange rates. As a consequence, there is a correlation between exchange rate and stock price volatility.

This theory of the correlation between exchange rate and stock price volatilities from the firm's view is also consistent with the theory from the investor's view. Karoui (2006) explains that investors who had already invested in stocks will seek other financial markets which may be more profitable if their local currency depreciates compared to the foreign currency. Thus, the correlation between exchange rates and stock prices will be negative. On the other hand, investors who have not yet invested will find the stocks cheap and buy them. Consequently, the effect leads to a positive correlation between exchange rates and stock prices. In sum, firms and investors' behavior drive the sign of the correlation of exchange rates and stock prices. Empirical evidence supporting the return and volatility spillover relation between financial markets are presented in Baele (2005) and Diebold and Yilmaz (2009). These studies examine the short-term relations among security prices across the three major markets Tokyo, London, and New York. Using an ARCH model, they reveal a significant correlation between the timing of mean as well as volatility spillovers amongst these markets.

Engle et al. (1990) apply a similar framework to exchange rate markets and examine two types of volatility spillovers which are known as heat waves and meteor showers. Their results provide evidence that the heat wave hypothesis has to be rejected and volatility exhibits not only country-specific autocorrelation. On the other hand, they document the dynamic effect of country specific news on the conditional volatility in the subsequent markets which validates the meteor shower hypothesis. This is in accordance with Baillie and Bollerslev (1991), who use hourly data on four major exchange rates to show that exchange rate volatility features similar patterns over different hours of the day and appears to be highly serially correlated. However, their findings also point out some heat waves, or market-specific news characteristics.[1]

Moreover, the volatility spillover effect between different types of asset markets within the same economy has been empirically examined. For example, Kansas (2000) investigates the connection of the conditional second moments between stock returns and exchange rate changes for the US, UK, Japan, Germany, France and Canada. He finds evidence of volatility spillover from stock returns to exchange rate changes for five of the six countries considered (except Germany). He also finds that the volatility spillovers are symmetrical surrounding releases of bad news and good news.

2.2. Volatility spillover changes in financial crises

Lin et al. (1994) show that markets around the world fall with surprising uniformity in financial crises. These cross-market connections often significantly increase after a shock to an individual country (or group of countries), as measured by the degree to which asset prices or financial flows move together across markets relative to this co-movement in tranquil times.

Dornbusch et al. (2000) shows that fundamental contagion such as macroeconomic shocks have repercussions on an international scale and local shocks transmitted through trade links, competitive devaluations, and financial links are possible channels for the spillover of crises between different markets. In contrast, pure contagion is related to liquidity problems, imperfect information and informational asymmetries and it has been shown that it leads to irrational phenomena like financial panics, herd behavior, loss of confidence and increased risk aversion of investors.

In the context of liquidity problems, Hernández and Valdés (2001) utilizes a model which combines illiquid countries with investors who potentially need liquidity in order to change their portfolio. If they do not find the liquidity in one country, then they will seek liquidity in a second country and this can cause volatility spillover. In addition, depositor panics or contractual links between banks, as well as bank failures, can shrink the common pool of liquidity, thereby creating or exacerbating aggregate liquidity shortages (Diamond and Rajan (2005)). As shown by Boyson et al. (2010), shocks to liquidity of hedge funds can also increase the probability of contagion.

This is in line with the theory of imperfect information in which a common information shock is taken as a basis and investors may believe that a financial shock in one country could lead to similar shocks in other countries whereby the trading activity and volatility in each market simultaneously increase (Fleming et al., 1998). Particularly, an information shock alters expectations in one market leading investors to adjust their holdings in other markets without taking account of changes in macroeconomic fundamentals. As a result of the existence of correlations between returns, portfolio rebalancing occurs because of the ensuing changes in hedging demand (Kallberg et al., 2005). It is also consistent with the model of Kodres and Pritsker (2002) in which contagion occurs through cross-market rebalancing due to investors' transmission of idiosyncratic shocks from one market to others by adjusting their portfolio exposures to shared macroeconomic risks. The model can generate contagion in the absence of news, as well as between markets that do not directly share macroeconomic risks and depends on the amount of information asymmetry in each market.

Calvo and Mendoza (2000) reconfirm the information asymmetry theory but they allege two different types of investors: those who gather the relevant information, and those who just follow the crowd. Under this market-contagion scenario, speculative trading and noise trading (in the sense of Black (1986), De Long et al. (1990) or Kyle and Xiong (2001)) may occur in the international context. Thus, price movements driven by fads and a herd instinct may be transmittable across borders

[1] For further studies see Hong (2001) and Melvin and Melvin (2003).