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Structural breaks in volatility spillovers between international financial markets: Contagion or mere interdependence?

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ABSTRACT

This paper conducts an investigation of volatility transmission between stock markets in Hong Kong, Europe and the United States covering the time period from 2000 up to 2011. Using intra-daily data we compute realized volatility time series for the three markets and employ a Heterogeneous Autoregressive Distributed Lag Model as our baseline econometric specification. Motivated by the presence of various crisis events contained in our sample, we detect time-variation and structural breaks in volatility spillovers. Particularly during the financial crisis of 2007, we find effects consistent with the notion of contagion, suggesting strong and sudden increases in the cross-market synchronization of chronologically succeeding volatilities. Investigating the role of mean breaks and conditional heteroskedasticity in the realized volatilities, however, we find the latter to be the main driver of breaks in volatility spillovers. Taking the volatility of realized volatilities into account, we find no evidence of contagion anymore.

1. Introduction

This paper investigates the volatility transmission between three major financial markets around the globe. The sample period runs from January 2000 to September 2011 and comprises intra-daily data for the Hang Seng Index, the Euro Stoxx 50 and the S&P 500 Index. Adopting a long term perspective allows us to analyze the impact of crisis events, such as the dotcom bubble, September 11, 2001, the financial crisis of 2007 and the European sovereign debt crisis since 2009, on volatility transmission across international stock markets.

Specifically, our study aims at answering three questions. Firstly, are the dynamics of volatility transmission structurally stable and constant over time? Secondly, can we find evidence for contagion during our sample period and in particular during the financial crisis of 2007? And thirdly, does measured contagion truly reflect breaks in stock market linkages as an increased synchronization of chronologically succeeding volatilities? In particular, what is the role for structural breaks and conditional heteroskedasticity in this context?

To address these questions empirically, we compute realized volatility time series based on non-overlapping trading hours, separately for each of the three financial markets analyzed. To cope with strong persistence in our volatility series, we adopt the framework of Corsi (2009)'s Heterogeneous Autoregressive Model of Realized Volatility (HAR-RV) for our empirical analysis. Taking the chronological order of trading in the different markets into account, this framework allows us straightforwardly to include measures of volatility transmission from foreign markets into domestic markets. Moreover, it enables us to measure cross-market volatility spillovers as effects of the realized volatilities in one market onto the realized volatilities in chronologically following markets. Proceeding in this way, we follow benchmark volatility spillover studies, such as Hamao et al. (1990), Lin et al. (1994) and Susmel and Engle (1994).

Given the relatively long sample period of our study, including various crisis events, it seems logical to investigate the structural stability of volatility transmission, as well as its typically assumed time invariation. Both aspects have only been rarely addressed in the literature so far. Further, our empirical framework allows us to identify strong and sudden breaks in measured spillovers as potential contagion effects. Indeed finding evidence for such effects, we investigate if they truly reflect strong and sudden upwards shifts in the synchronization of chronologically succeeding

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volatilities or if they constitute a measurement issue. In particular, we investigate to what extent structural breaks and conditional heteroskedasticity induce potentially misdiagnosed contagion.

The findings of our study are of importance for policy makers as well as institutional and private investors. From the perspective of international policy makers, volatility spillovers are foremost relevant in the context of financial crises propagation. A key concern is that in times of crises volatility transmission might suddenly deviate from its 'normal' pattern, possibly in a disproportionate and unpredictable way. This applies even more so as the goal of maintaining financial stability has gained a lot in importance in the aftermath of the financial crisis of 2007. Moreover, our results are relevant given the ever recurring discussions on financial regulation and institutional rules such as circuit breakers, transaction taxes or short-sale rules. Sound policy measures, however, should be based on a solid understanding of the transmission mechanisms in financial markets. Stock price volatility thereby plays a special role, reflecting market participants' uncertainty.

From the perspective of international investors, volatility transmission and contagion are highly relevant, too. To guarantee sufficiently diversified portfolios, they permanently have to monitor and assess changes in market linkages. An important question in this context is whether or not changes in these linkages are of persistent or only of transitory nature. Even for retail investors these points are of direct importance as the volume of financial products reflecting total market developments, such as exchange traded funds, is growing steadily.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and defines important terminology. In Section 3 we present our empirical framework including the data, our specific way to compute non-overlapping realized volatilities and the Heterogeneous Autoregressive Distributed Lag (HAR-DL) model. In Section 4, we present the results suggested from our long term investigation of volatility spillovers together with the results from structural break tests and rolling window estimations. Finally, in Section 5 we assess the impact of mean breaks and conditional heteroskedasticity in the realized volatilities on our regression results. Section 6 summarizes and concludes.

2. Related literature and terminology

The literature on transmission processes between international financial markets has developed a terminology which is, unfortunately, not used in a coherent way. Therefore, we begin with a short introduction into the terminology and the literature specifically relevant in the context of our study.

2.1. Interdependence and contagion

Generally, the terms stock market 'relations', 'linkages' and 'interdependence' are used synonymously to each other. Recent authors though, such as Forbes and Rigobon (2002), Corsetti et al. (2005), Billio and Caporin (2010), Baele and Inghelbrecht (2010) or Gebka and Karoglou (2012), subdivide stock market 'linkages' or 'relations' into 'interdependence' and 'contagion'. 'Interdependence' thereby stands for a state of 'continuous', 'normal' or 'tranquil-period' relation between markets. In this state, Kallberg and Pasquariello (2008) and Baele and Inghelbrecht (2010) assume market linkages to be driven by fundamentals. Measured stock market linkages can then be entirely explained by common observed factors due to real or financial linkages. Phenomena such as sudden expectation shifts or herding are excluded. However, high levels of comovement and some limited time-variation in measured linkages are well in line with the notion of 'interdependence'. This is acknowledged, for example, by Forbes and Rigobon (2002), Billio and Caporin (2010) and Baele and Inghelbrecht (2010), who state that fundamentals vary over time, too.

In contrast to that, the state of 'contagion' is characterized by strong and sudden changes in measured market linkages. To be more precise, by contagion we refer to a significant increase in comovement across markets after a shock. This definition goes back to Forbes and Rigobon (2002) and has also been employed, for example, by Caporale et al. (2005), Pesaran and Pick (2007), Baele and Inghelbrecht (2010) and Billio and Caporin (2010).

These studies consider contagion in the context of cross-market comovement in returns. The above definition is, however, sufficiently general to capture comovement in second moments of returns, leading to what is known as volatility contagion. Such a broad view on contagion has also been taken in the papers of Chakrabarti and Roll (2002), Chiang and Wang (2011) or Beirne et al. (2013).

One particular important aspect following from the work of Loretan and English (2000) and Forbes and Rigobon (2002) is that contagion measured by correlation in returns is potentially influenced by the presence of conditional heteroskedasticity in the return series. An immediate consequence of this important finding is that correlation-based identification of contagious events using unadjusted return data can lead to potentially wrong conclusions about the structural stability of market relations.

2.2. Volatility spillovers

Following Weber and Strohsal (2012), financial economics offers at least two perspectives on volatility, which can straightforwardly be extended to the phenomenon of volatility trans mission. The first one considers volatility transmission as the consequence of potentially (auto)correlated information flow. The second one regards volatility transmission as reflecting spillovers of uncertainty or valuation insecurity among market participants. Studies directly investigating these effects are Hamao et al. (1990), Lin et al. (1994), Baur and Jung (2006), Savva et al. (2009) or Dimpfl and Jung (2012). Typically, these authors find significant and substantial cross-market volatility spillovers. Further, they often find a dominant role of the US market as a source for volatility transmission.

Most closely related to the approach taken here are studies considering the consequences of important events, threshold- or regime-dependence and structural breaks. Employing dummy variables and various sample splits, e.g. Theodossiou et al. (1997) and Climent and Meneu (2003) investigate stock market spillovers and the consequences of the Asian crisis in 1997. Similarly, Gebka and Serwa (2006) study breaks in spillovers between the US and South East Asian stock markets in 1997. Employing a threshold vector autoregressive model with a calm and turmoil state, they find strong evidence for breaks in causality patterns and contagion. Regime-dependence is taken up by Ramchand and Susmel (1998) and Bialkowski et al. (2006). These authors estimate Markov switching models. Further Gebka and Karoglou (2012) employ batteries of structural break tests to analyze breaks in financial market linkages and to identify potential break dates on a purely data-driven basis.

Recently, though, beginning with Ewing and Malik (2005), a strand of literature has developed, which is specifically concerned with the consequences of structural breaks in volatilities. Huang (2012), for example, employs the Iterated Cumulative Sums of Squares (ICSS) algorithm developed by Inclan and Tiao (1994) within their GARCH model. Using weekly futures data, they analyze stock market relations between the US, UK and Japan from 1989 to 2006. They find structural changes in variance not to occur simultaneously in the different markets. Moreover, they find measured volatility spillovers to be much weaker or even to disappear