International Review of Financial Analysis 28 (2013) 70–78

Contents lists available at SciVerse ScienceDirect

International Review of Financial Analysis

Stock market correlations during the financial crisis of 2008–2009: Evidence from 50 equity markets

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ARTICLE INFO

Article history:
Received 10 August 2011
Accepted 9 January 2013
Available online 27 February 2013

JEL classification:
G01
G11
G15

Keywords:
Dynamic conditional correlation
Financial crisis
Interdependence

ABSTRACT

Using data from 50 equity markets we examine conditional and unconditional correlations around two major banking events during the financial crisis of 2008–09. To measure the value of covariance information on the augmented DCC model used in the study, a portfolio in-sample estimation is performed. We show that by taking into account the change in the level of variance in high volatility periods, the estimates of the conditional covariance are more efficient in capturing the dynamics of the stock markets variance. Furthermore, in a two-asset allocation framework, the model consistently generates relatively low portfolio variances, implying substantial benefits in portfolio diversification.

1. Introduction

Financial or economical crises can have serious consequences for investors and as a result the topic issue has attracted considerable amount of interests among academic researchers. For example, the crash of 1987 (Forbes & Rigobon, 2002), the Russian, Brasilian and Asian crises of 1997–98 (Forbes & Rigobon, 2002; Kenourgios et al., 2011), the terrorist attacks of 9.11 (Hon et al., 2004) and the "tech bubble" (Kenourgios et al., 2011) have been widely examined. More recently, scholarship has addressed the impact of the 2008–09 financial crisis on foreign exchange markets (Baba & Packer, 2009; Melvin & Taylor, 2009; Fratzscher, 2009), on fixed income markets (Dwyer & Tkac, 2009; Acharya et al., 2009; Hartmann, 2010) and on stock markets (Bartman & Bodnar, 2009; Dooley & Hutchison, 2009; Billio & Caporin, 2010; Chudik & Fratzscher, 2011; Schwert, 2011; Syllignakis & Kouretas, 2011). All these studies demonstrate that financial markets' volatilities increase substantially during crisis, which further implies that both financial markets' volatilities and correlations move together over time.[1] This co-movement diminishes the diversification benefits and it is commonly known to be apparent especially in the equity markets.

In this study we investigate the effects of two major banking events, i.e. JP Morgan Chase's acquisition of the Bear Stearns investment bank and the collapse of the Lehman Brothers Holding Inc. investment bank, on the time-varying correlations of international stock markets. Our objective is to examine the impact of these events on a total of 50 international stock markets from 6 different regions using an augmented dynamic conditional correlation (hereafter DCC) model. In particular, the model allows us to examine the effect of the financial crisis of 2008–09 on the conditional correlations across all investigated stock markets, while simultaneously controlling for changes in the conditional variances.

Our study contributes to the earlier studies on the financial crisis by examining time varying covariance structure between global stock indexes during the financial crisis. Like Syllignakis and Kouretas (2011) we also analyze dynamic correlations, but unlike them we do not focus on the contagion issue. Instead, we examine the dynamic correlations from the portfolio manager's point of view across global stock markets. Specifically, in addition to modeling the conditional covariance matrix we evaluate the performance of the estimated conditional correlations in the asset allocation framework, evaluating in-sample portfolio optimization and hedging performance.

We also extend the work of Syllignakis and Kouretas (2011) by reporting the results for all major economic areas, namely Developed Europe, G7, Asia Pacific, Middle East, Latin America, and Emerging Europe. Our study also adds to the earlier literature on DCC models by modeling simultaneously 50 stock index return series (i.e. the 49 stock markets' correlations against the U.S. market). The characteristics of the DCC models make it possible to take into account the effect of

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[1] The arrival of bad news causes significant increase in cross-market variances and correlations (Braun et al., 1995; Christiansen, 2000; Cappiello, Engle and Sheppard, 2003).

1057-5219/$ – see front matter
http://dx.doi.org/10.1016/j.irfa.2013.01.009

heteroscedasticity on the variance of the fifty return series over the estimation periods. By allowing correlation to change over time, we are able to demonstrate in a portfolio framework that the conditional model estimates outperform simple models.

Our empirical findings show that the impact of the Lehman Brothers' collapse resulted in significant increases in correlations, whereas the acquisition of Bear Stearns had negligible effects on correlations. We find that the effect of the Lehman Brothers' collapse on global stock markets is prominent for all the regions, which is evident from both the unconditional and conditional correlation estimates. Furthermore, when evaluating the performance of the conditional correlations in the asset allocation framework, in which portfolio optimization and hedging performance are considered in-sample, we find that the augmented DCC model outperforms all the other models. The augmented DCC model constitutes the lowest portfolio variances within all crisis periods implying that the augmented DCC model is efficient in capturing the dynamics of the stock market variances during high volatility periods.

2. Data and preliminary analysis

The study is carried out with 50 different stock market indexes from six different regions. The data set is obtained from Datastream. The data periods investigated are as follows; (*preBS*) one year before the Bear Stearns event (March 15, 2007, to March 14, 2008), (*postBS*) 6 months thereafter (March 17, 2008 to September 12, 2008) and (*postLB*) 6 months after the Lehman Brothers' collapse (September 15, 2008 to March 16, 2009). Following, for example, Forbes and Rigobon (2002) and Hon et al. (2004), we use two-day rolling-average returns denominated in dollars in our analysis. Two-day average returns are utilized mindful that the markets around the world are not open at the same times.

As a first step, we follow Hon et al. (2004) and conduct a simple correlation analysis to examine the relationship of each of the 49 countries with the U.S. stock markets. As a next step, we examine the impacts of Bear Stearns and Lehman Brothers on global stock markets by using an augmented dynamic conditional correlation (DCC) model. We report the results dividing the countries into six different regions, namely G7, Developed Europe, Emerging Europe, Asia-Pacific, Latin America and Middle East. Table 1 presents the countries investigated in the study, with descriptive statistics on the two-day rolling average stock index returns.

Next, we constitute the Fisher transformed correlations as in similar to Hon et al. (2004). These transformed correlations are then compared between the periods defined. For the analysis, the statistical values of the Fisher z transformations for the Pearson product moment correlations are obtained as follows:

$$\hat{\rho}_{i,t} = 0.5\left[\ln\left(\rho^{*}_{i,t}+1\right)-\ln\left(\rho^{*}_{i,t}-1\right)\right] \quad (1)$$

where $\hat{\rho}_{i,t}$ and $\rho^{*}_{i,t}$ denote the transformed and untransformed Pearson product moment correlations for country i, respectively. The transformed pairs of correlations enable us to perform a test to decide whether the two correlations have different strengths. To obtain approximately standard normal distributed z-statistic values the difference is formed as follows:

$$z = \left(\hat{\rho}_{1,t}-\hat{\rho}_{2,t}\right)/\sqrt{1/(n_1-3)+1/(n_2-3)} \quad (2)$$

where n_i is the sample size.

In Table 2 we report the results of the preliminary analysis of the unconditional correlation analysis. Significant test statistic values indicate the difference in return series correlation strength between the compared time periods. Column z-stat (1) presents the test statistics comparing the unconditional correlations between the *preBS* and *postBS* periods. The results suggest that the unconditional correlations decline after the event of JP Morgan's acquisition of Bear Stearns. The decline in correlation can be observed within the period of *postBS* for all the countries (the only exceptions are Korea, Taiwan, and Japan).

Column z-stat (2) in Table 2 presents the test statistics comparing the unconditional correlations between the *preBS* and *postLB* periods (i.e. a comparison of the post period correlations against the 12-month period) and Column z-stat (3) gives the test statistics between *postBS* and *postLB*.

Table 1
Descriptive statistic on two-day rolling average stock index returns.

Region/country	Mean	Std. dev.	Skewness	Kurtosis	LB(16)
Asia Pacific					
Australia (AUST)	−0.001	0.018	−0.318	6.068	173.997***
China (CHIN)	0.000	0.020	−0.207	5.624	182.171***
Hong Kong (HGKG)	0.000	0.015	−0.205	6.577	186.321***
Indonesia (INDF)	0.000	0.020	−0.494	7.570	298.176***
India (INDI)	0.000	0.020	−0.022	6.798	236.703***
Korea (KORE)	−0.001	0.021	−0.313	11.49	217.811***
Malaysia (MALF)	0.000	0.011	−0.339	4.787	193.503***
New Zealand (NZEA)	−0.001	0.015	−0.498	5.357	171.903***
Pakistan (PAKI)	−0.001	0.017	−0.677	5.988	404.502***
Philippines (PHLF)	0.000	0.016	−0.381	5.676	228.005***
Singapore (SING)	0.000	0.015	−0.282	5.230	205.519***
Sri Lanka (SRIL)	−0.001	0.013	2.355	18.625	365.755***
Taiwan (TAIW)	0.000	0.014	−0.068	3.974	281.963***
Thailand (THAF)	0.000	0.016	−0.636	9.022	254.814***
Middle East					
Bahrain (BAHR)	−0.001	0.013	−2.79	23.815	260.993***
Egypt (EGYT)	0.000	0.016	−1.626	12.793	246.925***
Israel (ISRA)	0.000	0.010	−0.708	5.940	193.362***
Jordan (JORD)	0.000	0.011	−0.967	8.178	307.815***
Kuwait (KUWA)	0.000	0.014	−0.784	8.747	295.148***
Morocco (MORC)	0.000	0.011	−0.695	7.117	247.024***
Latin America					
Argentina (ARGT)	−0.001	0.021	−0.745	7.349	187.209***
Brazil (BRAZ)	0.000	0.024	−0.374	6.634	182.477***
Chile (CHIL)	0.000	0.015	−0.220	9.663	234.08***
Columbia (COLM)	0.000	0.016	−0.637	6.316	198.519***
Mexico (MEXF)	−0.001	0.019	−0.329	6.610	197.748***
Peru (PERU)	0.001	0.021	−0.224	5.498	182.403***
Developed Europe					
Austria (ASTR)	−0.002	0.021	−0.272	7.935	189.668***
Belgium (BELG)	−0.002	0.017	−0.961	8.320	227.832***
Denmark (DNMK)	0.000	0.016	−0.401	7.452	202.998***
Ireland (EIRE)	−0.002	0.022	−0.532	5.910	188.609***
Finland (FIND)	−0.001	0.018	0.009	4.860	162.223***
Greece (GDEE)	−0.001	0.018	−0.371	6.812	209.517***
Netherlands (NETH)	−0.001	0.015	−0.478	6.855	175.16***
Norway (NWAY)	−0.001	0.022	−0.528	6.029	167.088***
Portugal (PORD)	−0.001	0.014	−0.090	8.467	251.794***
Spain (SPAN)	−0.001	0.016	−0.262	7.300	196.805***
Sweden (SWDN)	−0.001	0.019	0.194	5.597	166.81***
Switzerland (SWIT)	−0.001	0.012	−0.159	7.330	172.86***
G7					
Canada (CNDA)	0.000	0.017	−0.606	8.626	177.225***
France (FRNC)	−0.001	0.015	−0.019	6.907	170.54***
Germany (GERM)	−0.001	0.015	−0.165	6.431	156.842***
Italy (ITAL)	−0.001	0.016	−0.166	6.752	203.363***
Japan (JPAN)	−0.001	0.013	0.155	6.878	150.766***
United Kingdom (UTDK)	−0.001	0.016	−0.105	7.378	170.601***
United States (US)	−0.001	0.013	−0.344	7.307	112.217***
Emerging Europe					
Czech Republic (CZCH)	0.000	0.020	−0.057	11.927	183.217***
Hungary (HUNG)	−0.001	0.024	−0.064	12.104	221.622***
Poland (PLND)	−0.001	0.021	−0.199	6.892	221.661***
Russia (RUSS)	−0.001	0.027	−0.238	12.82	277.679***
Turkey (TURK)	0.000	0.023	−0.214	5.229	220.543***

Notes: LB(16) refers to Ljung–Box statistic with up to 16-day lags. ***, ** and * denote statistical significance at 0.1%, 1% and 5%, respectively.