MARKET VOLATILITIES BEFORE AND AFTER THE 2007-08 FINANCIAL CRISIS

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ABSTRACT

This paper investigates transmission of volatilities using exchange traded funds (ETFs) in the following countries: Germany, France, Italy, UK and USA. Utilizing daily data for over a 10-year period (January 2002 to August 2007 and March 2009 to March 2014) we employed a Generalized Autoregressive Conditional Heteroskedasticity model (GARCH) to analyze persistence as well as spillovers of volatilities. We divided the data into two separate periods: before the 2007-08 financial crisis, and after the crisis. We find that volatilities react strongly to market movements and their shocks fade away slowly. Furthermore, there is evidence of volatility spillovers among the sample countries

Introduction

Markets across the world experience a growing foreign presence. Investors, heeding the advise of money managers not to put all of their eggs in one basket have moved part of their portfolios to countries other than their own, The Wall Street Journal reports that about 20 percent of US nonfinancial shares were held by overseas investors in 2015 compared to about 10 percent in 2000 (WSJ-March 28, 2016). Similar trends are observed in the UK (54% foreign ownership in 2014), in Germany (64%) and Japan (32%). Expectedly, the growth in global integration of financial markets has given rise to studies that investigate the mechanism through which market movements and volatilities are transmitted around the world.

The main motivation in this paper is to explore volatility linkages between USA and selected European markets by utilizing broad equity market index based ETFs with the main objective of contributing to the literature on different periods of volatility as manifested by the 2007-08 financial crisis. In examining transmission and persistence of volatilities in county equity markets, we seek to understand both if there are differences in different time periods in terms of volatilities.

Literature review

Much of the earlier research in international stock markets concentrated exclusively on spillover of the co-movement between returns [2] [9] [17] [19]. These studies found low but increasing correlations

across some country equity markets providing attractive diversification opportunities. More recent research [5] [13] [16] demonstrated that more information is revealed in the volatility of stock prices. Henceforth, studying the transmission of stock market movements became a joint study of the spillover of prices as well as the volatility of prices. The interest in volatilities has also increased after the two recent stock market crashes (dot.com of 2000 and financial crisis of 2007-2008) which witnessed wide swings in asset prices. However, academic research on equity market volatility transmission has not been conclusive. For example, focusing on emerging markets, Schleicher (2001) indicated that equity markets' return co-movements were significant but not their volatilities. Li (2007) examined the linkages between Shanghai and Shenzhen stock exchanges of China, Hong Kong and the United States, and found no spillovers (return and volatility) between the stock exchanges in China and U.S. markets, although unidirectional volatility spillover from Hong Kong to those in Shanghai and Shenzhen markets was significant. Other studies examining the spillover of information both in terms of return and volatility include [8] [4] [12].

The present paper addresses several gaps found in the literature. First, instead of using stock market indices like most of the existing literature, we utilize ETFs in this study. We also study multi-directional flows whereas most of the literature focuses on uni-directional flows. Finally, the present paper also addresses the questions of "volatility persistence" in addition to "volatility transmission".

Data and Methodology

This study utilizes Exchange Traded Funds (ETF) instead of market indices. ETFs are arguably one of the most versatile of financial instruments that invest mostly in corporate and sovereign liabilities with the intension of replicating the returns of a market index. This paper utilizes iShares MSCI Capped/Core Equity ETFs (all Equity ETFs used in this research are issued by iShares). "iShares" is the largest ETF provider in the world. Selected ETFs seek to track the investment results of a particular index. The MSCI Index was created by Morgan Stanley Capital International. Each MSCI Index measures a different aspect of global stock market performance.

We divided the data into two separate periods: a five-year period before the 2008 financial crisis and five years after the crisis. The data period is from January 8, 2002 to August 31, 2007 and from March 2, 2009 to March 31, 2014 on the following ETFs: 1. *The iShares MSCI United Kingdom ETF* (EWU) 2. *The iShares MSCI Germany ETF* (EWG) 3. *The iShares MSCI France Capped ETF* (EWQ) 4. *The iShares MSCI Italy Capped ETF* (EWI) 5. *The iShares MSCI USA Core S&P 500 ETF* (IVV) [1].

By concentrating the analysis on ETF data, we can mitigate if not entirely avoid some substantial problems that arise in traditional academic research such as exchange rates volatility, divergences in the national tax systems, diversities in stock exchange trading times and bank holidays, restrictions on cross-border trading and investments, transaction costs. Designed to mimic the movements of MSCI indices, ETFs provide an easy pool of international diversification products for an investor.

To measure the dynamic relationship of the volatility of a process, we used generalized autoregressive conditional heteroskedastic (GARCH) models. The reader is referred to Engle (1982) and Bollerslev (1986) for additional information on GARCH models.

Turning to the anlaysis of the data, we observe that the highest volatility (in terms of standard deviation) before the crisis is exhibited by Germany (1.409) and France (1.232). However, the highest volatility

after crisis is exhibited by Italy (2.046) and France (1.779). On the other hand, the USA market has the lowest volatilities of all markets in all periods (before crisis 0.928; after crisis 1.144).

To analyze persistence in volatility we used GARCH (1,1) model. As it is shown in table 1, UK has the highest ARCH coefficient (.0754) but on the other hand, has the lowest GARCH coefficient (0.9009) indicating strong shocks in the short term but at the same time these strong short term shocks do not contribute to long run volatility persistence. Long term (cumulative) effect of past shocks on returns is measured by the GARCH parameter ß, which usually ranges between 0.85 and 0.98. In this study, ß ranges from a low value of 0.9009 in UK to 0.9417 in the USA. Looking at both ARCH and GARCH effects, Germany and Italy have the highest α plus β values, indicating that the effects of the volatility shocks fade away slowly.

Table 1: Volatility persistence (before crisis)

coefficient	**France**	**Germany**	**Italy**	**UK**	**USA**
Constant (α_0)	0.0213 (0.006)	0.0179 (0.006)	0.0153 (0.018)	0.0225 (0.001)	0.0101 (0.001)
ARCH(-1) (α_1)	0.0719 (0.000)	0.0612 (0.000)	0.0559 (0.000)	0.0754 (0.000)	0.0412 (0.000)
Garch(-1) (β_1)	0.9096 (0.000)	0.9245 (0.000)	0.9279 (0.000)	0.9009 (0.0000	0.9417 (0.000)
$\alpha_1 + \beta_1 < 1$	0.9816	0.9858	0.9838	0.9763	0.9829
AIC	2.954852	3.167921	2.723878	2.698522	2.413785
SIC	2.970961	3.184029	2.739986	2.714630	2.429893
ARCH-LM test statistic (Obs*R-squared)	0.104526	0.053135	9.8E-09	0.057840	2.487145
Prob. Chi-Square(1)	0.7465	0.8177	0.9999	0.8099	0.1148

After the crisis, as it is shown in table 2, USA has the highest ARCH coefficient (.0956) but on the other hand, has the lowest GARCH coefficient (0.8786) indicating strong shocks in the short term but at the same time these strong short term shocks do not contribute to long run volatility persistence. In this study, the GARCH parameter ß ranges from a low value of 0.8786 in the USA to 0.9412 in UK (it was opposite before the crisis). Looking at both ARCH and GARCH effects, UK and France have the highest α plus β values, indicating that the effects of the volatility shocks fade away slowly.

Table 2: Volatility persistence (after crisis)

coefficient	**France**	**Germany**	**Italy**	**UK**	**USA**
Constant (α_0)	0.0296 (0.003)	0.0251 (0.003)	0.0522 (0.030)	0.0128 (0.056)	0.0272 (0.006)
ARCH(-1) (α_1)	0.0531 (0.000)	0.0502 (0.000)	0.0604 (0.000)	0.0497 (0.000)	0.0956 (0.000)
Garch(-1) (β_1)	0.9358 (0.000)	0.9392 (0.000)	0.9249 (0.000)	0.9412 (0.000)	0.8786 (0.000)
$\alpha_1 + \beta_1 < 1$	0.9889	0.9884	0.9853	0.9909	0.9742
AIC	3.817694	3.749731	4.077046	3.257519	2.755373
SIC	3.833812	3.765849	4.097194	3.277667	2.775521
ARCH-LM test statistic (Obs*R-squared)	0.225402	0.994916	1.313910	0.089895	7.111477
Prob. Chi-Square(1)	0.6350	0.3185	0.2517	0.7643	0.0077

Volatility transmission

To detect transmission of volatility between stock markets, we use the Augmented GARCH model as developed by Duan (1997) . The findings are indicated in the Table 3 and 4.

Table 3: Volatility transmission (before crisis)

$\sigma^2_{t(France)} = 0.021 + 0.072e^2_{t-1(France)} + 0.909\sigma^2_{t-1(France)}$
$\sigma^2_{t(Germany)} = 1.398 + 0.123e^2_{t-1(Germany)} + 0.549\sigma^2_{t-1(Germany)} - 0.170r^2_{t-1(UK)}$
$\sigma^2_{t(Italy)} = 0.027 + 0.049e^2_{t-1(Italy)} + 0.886\sigma^2_{t-1(Italy)} + 0.047r^2_{t-1(USA)}$
$\sigma^2_{t(UK)} = 0.036 + 0.065e^2_{t-1(UK)} + 0.844\sigma^2_{t-1(UK)} + 0.068r^2_{t-1(USA)}$
$\sigma^2_{t(USA)} = 0.008 + 0.034e^2_{t-1(USA)} + 0.934\sigma^2_{t-1(USA)} + 0.013r^2_{t-1(UK)}$

Table 4: Volatility transmission (after crisis)

$\sigma^2_{t(France)} = 0.932\sigma^2_{t-1(France)} + 0.024r^2_{t-1(Italy)} + 0.050r^2_{t-1(UK)}$
$\sigma^2_{t(Germany)} = 0.029 + 0.074e^2_{t-1(Germany)} + 0.928\sigma^2_{t-1(Germany)} - 0.028r^2_{t-1(France)} + 0.039r^2_{t-1(USA)}$
$\sigma^2_{t(Italy)} = 0.052 + 0.060e^2_{t-1(Italy)} + 0.925\sigma^2_{t-1(Italy)}$
$\sigma^2_{t(UK)} = 0.042e^2_{t-1(UK)} + 0.928\sigma^2_{t-1(UK)} + 0.028r^2_{t-1(USA)}$
$\sigma^2_{t(USA)} = 0.027 + 0.096e^2_{t-1(USA)} + 0.879\sigma^2_{t-1(USA)}$

As for volatility transmissions, the analysis indicate important variations in volatility transmissions among different time periods. For example, the French market does not have volatilitly spillovers in the pre-crisis period However, post crisis Italian and British volatilities are transmitted to France. For the German market volatilities from the following markets are transmitted: UK (pre); France and US (post) respectively. For Italy, only US (pre) but no other market (post). For UK, the only volatility transmissions come from the US. This is true for both periods under study. Finaly, the UK market is the only one that with volatility spillovers to the US market. It is important to emphasize that during the crisis, the US market volatilities are transmitted to all other markets, while the US market is affected only by volatility of the UK market. Post crisis, the only two markets not experiencing volatility spillovers from other markets are Italy and USA.

Conclusions:

This paper studied the transmission of ETF volatilities among five equity markets (US and 4 major European markets) using daily data from January 2002 to March 2014. A generalized autoregressive conditional heteroskedasticity (GARCH) model was used to identify the source and magnitude of volatility spillovers in two different time periods: Before 2007-2008 financial crisis and after the crisis.

Highest volatility before the 2007-08 crisis was exhibited by Germany and France. The highest volatility after the crisis was exhibited by Italy and France. The US market had the lowest volatilities of all markets in all periods. The study of volatility persistence found that in the short run, the UK market is spikey but volatilities do not persist very long. On the other hand, while short term results do not place Germany and France among the volatile markets, whatever volatility there tends to persist a long time.

We found significant volatility transmissions: Post crisis**,** the only two markets not experiencing volatility spillovers from other markets are Italy and USA. The UK market has volatility spillovers from USA. The German market has volatility spillovers from France and USA, and the Franch market has volatility spillovers from Italy and UK. These results are in line with the findings of other studies, such as [20] [10] [11] [15] [13] that find significant return and volatility spillovers in India, Brazil and S. Africa. As discussed previously, higher foreign ownership rates may be responsible for magnifying spillovers since substantial declines in one market can force some investors (especially those who are highly leveraged) to sell other assests in other markets to cover their losses.

Since volatilities can proxy for risk, there are lessons in terms of further examining pricing securities, hedging and other trading strategies. As hedging becomes another area of interest for investors its importance is expected to grow. New ETFs are created daily to be used as a hedge against a risk of market meltdown. The main idea would be to allow investors to benefit from sudden spikes in volatility while keeping the ETFs overall costs down (Economist, 2012).

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