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FLIGHT-TO-QUALITY OR CONTAGION DURING U.S. SUBPRIME CRISIS: EVIDENCE FROM VIETNAM'S FINANCIAL MARKETS

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Abstract: This study investigates whether contagion or flight-to-quality occurred in Vietnam's financial markets during the US subprime crisis in 2007. We apply the asymmetric dynamic conditional correlation model (ADCC-GARCH (1,1)) to daily stock-index and bond index returns of Vietnam's and US stock markets. We test for contagion or flight-to-quality by using a test for difference in dynamic conditional correlation means. The results show a contagion between the US and Vietnam's stock markets, confirming the widespread influence of the US stock market on a young market like Vietnam. This result suggests a low benefit from diversification for investors holding portfolios containing assets in Vietnam's stock market and US stock market during the crisis. Moreover, the relationship between Vietnam's stock and bond markets represents a flight-to-quality during the US subprime crisis. This finding shows that the investors tend to hold less risky assets, i.e., bonds, instead of stocks during this turbulent period in Vietnam.

Keywords: international financial contagion, flight-to-quality, Vietnam, US subprime crisis, ADCC-GARCH

1 Introduction

Investors always want to diversify their portfolio because of the apparent benefits of diversification. However, the global financial crisis (GFC) in 2008, initiated in the USA, has raised an extreme concern for investors seeking to diversify internationally. The crisis caused a sharp decrease in most of the stock markets across the globe, such as the USA, Europe, Japan, and Vietnam. For that reason, the benefit of diversification has been reduced during the moment investors require it the most. Such an event is normally associated with contagion among stock markets.

Nevertheless, if investors hold assets whose returns increase during a financial crisis, they will suffer less since the negative returns (because of the crisis) are cancelled out partially. Investors, who mostly are risk-averse, turn their interests into safer assets in crisis time. Bonds – government bonds in particular – are such assets. If investors sell stocks and buy bonds, they will create the opposite co-movement between two asset classes and, in turn, drive the

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correlation coefficient between them to fall. This situation is called flight-to-quality – a phenomenon that contributes to the stability and resiliency of the financial system [4].

Vietnam's Stock Market (VSM) was officially established in 2000 with the first securities trading center known as Ho Chi Minh Stock Exchange. The second one was opened in Ha Noi in 2005. The first five years of VSM witnessed a tranquil operation with a small number of listed stocks and listed companies [31]. After that, thanks to the Vietnamese Securities Law, the VSM grew dramatically and reached its peak in 2007 with the total market capitalization accounting for approximately 40% of GDP before declining considerably to the level at about 18% of the GDP in 2008 due to the GFC (Figure 1) [28]. The VSM recovered rapidly afterward and became one of the best performers in Asia in 2016. However, as a young market that has undergone two steps of financial liberalization, the VSM has experienced a huge recession and a spectacular recovery, which implies a volatility cluster in stock returns.

This paper aims to investigate the existence of contagion and flight-to-quality in the Vietnamese securities market under the effect of GFC. Forbes and Rigobon define contagion as the situation when shocks in one (or more) country bring about the significant rise in the correlation of cross-market [16]. It is worth mentioning that a simultaneous decrease in stock markets is not necessary a contagion. Baur and Lucey clarify flight-to-quality as the case when the correlation between stocks and bonds decreases significantly during the financial crisis [4]. Although there are more types of contagion and flight-to-quality, this paper just considers the stock-stock contagion and stock-bond flight-to-quality because it is most related to the research problem. Analyzing the two phenomena – or in other words, the stock and bond correlation coefficient – plays a crucial role in several aspects. First, it provides essential implications for investors in managing risk and allocating assets [11, 13, 26]. Second, information about investor behavior under different market conditions will be given. Finally, it helps the regulators or policy-makers in manipulating the financial system [4].

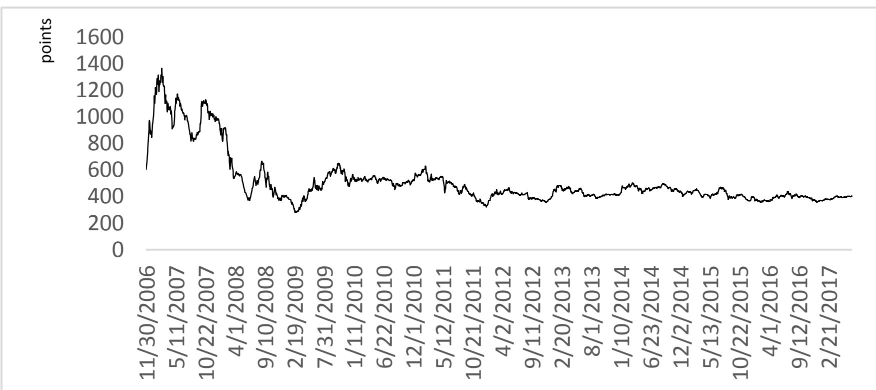

Figure 1. Vietnam's stock index

Source: Ho Chi Minh Stock Exchange

The stock–bond correlation was first analyzed by Keim and Stambaugh [24]. King and Wadhwani investigate the relationship between the US and UK stock markets and find the contagion effect after the US market crash in 1987 [26]. Calvo and Reinhart analyze the Mexican Peso Crisis in 1997 and find that effect for many emerging markets [8]. Many other papers have proved that the volatility of markets is transmitted through countries – one of the manifestations of contagion [13, 19]. In contrast, Forbes and Rigobon show that during a financial crisis, the correlation coefficient between stock markets will be biased upward and conclude that there is no contagion but interdependence [14]. Brière et al. confirm that the existence of contagion is just due to globalization and find the combined effect of globalization with flight-to-quality [7].

Connolly et al. find that because of flight-to-quality, when the volatility of the stock market increases, the correlation between stocks and bonds decreases for the US market [10]. Kim et al. have the same conclusion in some major European markets [25]. Macroeconomic factors also affect flight-to-quality. Ilmanen et al., Guler and Ozlale, and Andersson et al. discover that flight-to-quality is affected by the uncertainty of inflation [22, 18, 3]. In addition to inflation, Li states that the correlation between stock and bond returns is likely to rise because of the volatility in the real interest rate [27]. D'Addona and Kind find the opposite conclusion for G-7 countries, which shows that the correlation tends to fall because of inflation volatility [12]. The microstructure aspect also puts an influence on flight-to-quality for the Korean market [29].

Boyd et al. and Andersen et al. analyze the correlation between stocks and bonds returns under different conditions of the economy [6, 2]. They find that during expansions, the discount rate has the highest impact on the correlation that makes it increase. Meanwhile, during recessions, the most important factor is cash flow. As a result, stock and bond returns could fall. Jensen et al. propose an opposite finding for small-cap stocks of the US market, which shows that a decrease of monthly correlation tends to happen during expansions [23]. Other researchers investigate the stock and bond return correlations during the crisis [1, 20].

This paper contributes to the literature in the following aspects. Although flight-to-quality and contagion are very familiar over the world, this topic is surprisingly new for Vietnam. Being the first research in this field, this paper will provide a new point of view of the Vietnamese securities market for investors. The rest of the paper is structured as follows: in Section 2, the research methodology will be presented. Section 3 describes the data. Empirical results will be provided in Section 4. Finally, Section 5 makes some conclusions about the research problem.

2 Methodology

2.1 Dynamic conditional correlation model

The contagion and flight-to-quality are tested by analyzing time-varying correlations between stock and bond returns. We use the DCC-GARCH model developed by Engle and Sheppard, and Engle [15, 14]. Besides, to capture the asymmetric effect of the shock, we apply the model introduced by Glosten et al. to examine the time-varying correlation coefficients in this study [17]. Generally, the DCC-GARCH(1,1) specification is enough to capture the characteristics of heteroscedasticity of stock and financial variables [5]. This model is estimated by applying log-likelihood estimation procedures.

The estimation of dynamic correlation coefficients between the returns of two markets consists of three steps. Firstly, we filter the returns to obtain residual returns [15]. We employ the model specification proposed by Chiang et al. as follows [9]:

$$r_t = \gamma_o + \gamma_1 r_{t-1} + \gamma_2 r_{t-1}^{US} + \varepsilon_t \tag{1}$$

An AR(1) process is used to explain the autocorrelation of stock and bond returns. r^{US} is the U.S. stock index returns, used as the global factor.

Secondly, the parameters in the variance models are estimated using the residual returns (ε_t) from the first step.

$$\varepsilon_t = D_t v_t \sim N(0, H_t) \tag{2}$$

$$v_t \sim N(0, R_t) \tag{3}$$

and

$$H_t = D_t R_t D_t \tag{4}$$

where ε_t is the $k \times 1$ column vector of residual returns of r_t; D_t is the $k \times k$ diagonal matrix of the time-varying standard deviations of residual returns; v_t is the column vector of standardized residual returns; H_t is the $k \times k$ matrix of time-varying covariance; R_t is the $k \times k$ matrix of time-varying conditional correlations.

The elements in D_t are obtained from the univariate GARCH(1,1) models with $\sqrt{h_{i,t}}$ on the i^{th} diagonal.

$$h_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1} + d_i \varepsilon_{i,t-1}^2 I_{\varepsilon<0}(\varepsilon_{i,t-1}) \tag{5}$$

for $i = 1, \ldots, k$, where I is an indicator function for $\varepsilon < 0$. With this assumption, we suppose that negative shocks tend to increase the variance more than positive ones.

Thirdly, the correlation coefficients are then estimated. The correlation between the stock index returns i and j at time t is defined as

$$\rho_{ij,t} = \frac{E_{t-1}(\varepsilon_{i,t}\varepsilon_{j,t})}{\sqrt{E_{t-1}(\varepsilon_{i,t}^2)E_{t-1}(\varepsilon_{j,t}^2)}} \tag{6}$$

Substituting $\varepsilon_{i,t} = \sqrt{h_{i,t}}v_{i,t}$ and $\varepsilon_{j,t} = \sqrt{h_{j,t}}v_{j,t}$ to Equation (6), we have

$$\rho_{ij,t} = \frac{E_{t-1}(\sqrt{h_{i,t}}v_{i,t}\sqrt{h_{j,t}}v_{j,t})}{\sqrt{E_{t-1}(h_{i,t}v_{i,t}^2)E_{t-1}(h_{j,t}v_{j,t}^2)}} = \frac{E_{t-1}(v_{i,t}v_{j,t})}{\sqrt{E_{t-1}(v_{i,t}^2)E_{t-1}(v_{j,t}^2)}} = E_{t-1}(v_{i,t}v_{j,t}) \tag{7}$$

with

$$E_{t-1}(v_{i,t}^2) = E_{t-1}(h_{i,t}^{-1}\varepsilon_{i,t}^2) = h_{i,t}^{-1}E_{t-1}(\varepsilon_{i,t}^2) = 1$$

and

$$E_{t-1}(v_{j,t}^2) = E_{t-1}(h_{j,t}^{-1}\varepsilon_{j,t}^2) = h_{j,t}^{-1}E_{t-1}(\varepsilon_{j,t}^2) = 1$$

The conditional correlation is hence the covariance of standardized disturbances. Let Q_t be the time-varying covariance matrix of v_t(Q_t=E_{t-1} (v_t v_t'), then we have

$$R_t = (diagQ_t)^{-1/2}Q_t(diagQ_t)^{-1/2} \tag{8}$$

Q_t in this equation is an $n \times n$ positive symmetric matrix. It is defined by

$$Q_t = (1 - \theta_1 - \theta_2)\bar{Q} + \theta_1 v_{t-1}v_{t-1}' + \theta_2 Q_{t-1} \tag{9}$$

where $\bar{Q}$ is the unconditional covariance of the standardized residuals, resulting from the univariate GARCH(1,1) equation; θ_1 and θ_2 are positive parameters which satisfy $\theta_1 + \theta_2 < 1$.

The conditional correlation coefficient, also the element of matrix R_t, then, is

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}} \tag{10}$$

$$\rho_{ij} = \frac{(1-\theta_1-\theta_2)\bar{q}_{ij}+\theta_1 v_{i,t-1}v_{j,t-1}+\theta_2 q_{ij,t-1}}{\sqrt{(1-\theta_1-\theta_2)\bar{q}_{ii}+\theta_1 v_{i,t-1}^2+\theta_2 q_{ii,t-1}}\sqrt{(1-\theta_1-\theta_2)\bar{q}_{jj}+\theta_1 v_{j,t-1}^2+\theta_2 q_{jj,t-1}}} \tag{11}$$

As proposed by Engle, the DCC model can be estimated by using a two-stage approach to maximize the log-likelihood [14]. Let θ and ϕ be the parameters in matrices *D* and *R*, respectively, and the log-likelihood function to determine the parameters in the equations (1 and 5) can be written as follows:

$$L(\theta,\phi) = -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + log|H_t| + \varepsilon_t' H_t^{-1}\varepsilon_t) \tag{12}$$

$$= -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + log|D_t R_t D_t| + \varepsilon_t' D_t^{-1}R_t^{-1}D_t^{-1}\varepsilon_t)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + 2log|D_t| + log|R_t| + v_t' R_t^{-1}v_t)$$

where $v_t \sim$ N$(0, R_t)$ is the residuals standardized from their conditional standard deviations. Rewriting (12) gives

$$L(\theta, \phi) = -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + 2log|D_t| + \varepsilon_t' D_t^{-2}\varepsilon_t) +$$

$$-\frac{1}{2}\sum_{t=1}^{T}(log|R_t| + v_t' R_t^{-1} v_t - v_t' v_t) \quad (13)$$

$$= L_1(\theta) + L_2(\phi)$$

where

$$L_1(\theta) = -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + 2log|D_t| + \varepsilon_t' D_t^{-2}\varepsilon_t) \quad (14)$$

$$L_2(\phi) = -\frac{1}{2}\sum_{t=1}^{T}(log|R_t| + v_t' R_t^{-1} v_t - v_t' v_t) \quad (15)$$

$L_1(\theta)$ is the log-likelihood function of variances, and $L_2(\phi)$ is that of correlations. In the first stage, the parameters of variances in L_1 are determined by maximizing $L_1(\theta)$. In the second stage, given the estimated parameters in the first stage, the likelihood function $L_2(\phi)$ is maximized to estimate the correlation parameters in $L_2(\phi)$.

2.2 Flight-to-quality or contagion tests

Contagion occurs when there is a significant increase in correlations during the turmoil period compared with those during the tranquil period. Otherwise, if there is a significant decrease in correlations during the turmoil period, then flight-to-quality occurs. However, the estimates of the correlation coefficient can be biased by market volatility heteroscedasticity [16]. In fact, market volatility tends to increase after a shock or a crisis, which makes the correlation coefficients increase even though the underlying cross-market relationship is the same as during more stable periods. In this paper, the correlation coefficients of the stock returns are estimated using the DCC GARCH models and hence vary with market variances through time. Thus, the conventional contagion effect test that ignores the adjustment for heteroscedasticity can be improved.

We apply the Zivot–Andrew test to determine the structural breakpoints in the U.S. stock market to define tranquil and turbulent periods. To test for the existence of contagion or flight-to-quality phenomenon, we use a one-sided *t*-test for the difference between average conditional correlation coefficients of stable and turmoil periods. The hypothesis for contagion is as follows:

$$H_0: \rho_2 = \rho_1$$

$$H_1: \rho_1 < \rho_2$$

The hypothesis for flight-to-quality is

$$H_0: \rho_2 = \rho_1$$

$$H_1: \rho_1 > \rho_2$$

where ρ_1 and ρ_2 are the average conditional correlation coefficients of stable and turmoil periods, respectively. Rejecting the null hypothesis supports the contagion/flight-to-quality. This *t*-test of the equality of means is preceded by the preliminary test of the equality of variances.

3 Data and descriptive statistics

The data in this research consist of daily log-returns of the stock and bond index of the US and Vietnam. For the US, the Dow Jones U.S. Total Market Index (full-cap) was used because it represents the top 95% of the US stock market based on market capitalization. This data were downloaded from the Global Financial Database. The Vietnamese stock index was sourced from the MSCI Price Index, and the bond index from JP Morgan Emerging Market Bond Index (Datastream). The sample spans from November 30, 2006 (It is the earliest daily data we can find for the MSCI Price Index) to June 30, 2017, with 2762 observations. All data are quoted in USD.

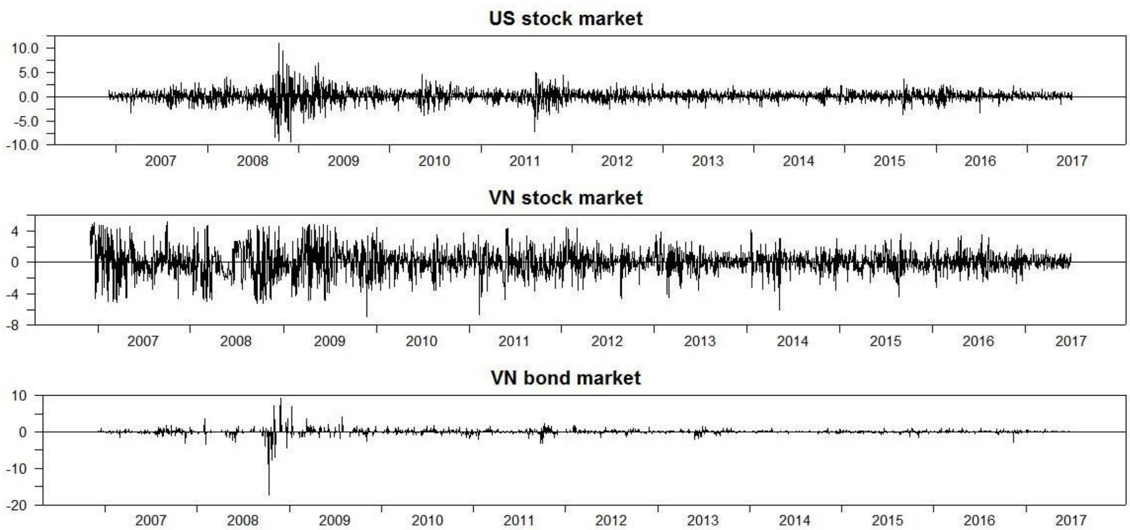

Figure 2. Daily returns of US stock market, Vietnam's stock and bond market

Source: Global Financial Database

Table 1. Descriptive statistics of daily log returns of stock and bond index

Series	REUSSI	REVNSI	REVNBI
Mean	0.021	–0.013	0.026
Std.	1.280	1.656	0.664
Min	–9.590	–6.992	–17.422
Max	10.800	5.216	9.229
Skewness	–0.376	–0.083	–6.094
Kurtosis	9.895	1.295	220.020

Source: Results from analysis

Figure 2 shows the evolution of the daily returns of the considered markets. We can observe that the returns of Vietnam's stock market seem to have the highest volatility, while Vietnam's bond market has the lowest volatility. The descriptive statistics of the data are shown in Table 1. According to the statistics, the REVNBI (daily returns of Vietnam's bond index) has the highest return and lowest standard deviation, while the REVNSI (daily returns of Vietnam's stock index) has the lowest return but highest standard deviation. This confirms once again what we observe in Figure 2.

Table 2 presents the unconditional correlation between each pair of the series. During the whole sample period, the REVNSI and REUSSI move in the opposite direction on average. However, the correlation coefficient between REVNSI and REUSSI is not statistically significant. Surprisingly, the REVNBI is positively correlated with REUSSI and REVNSI at a significance level of 1%.

Table 2. The unconditional correlation coefficient

	REUSSI	REVNSI	REVNBI
REUSSI	1	–0.002	0.160***
REVNSI		1	0.057***
REVNBI			1

Note: *** represents a statistical significance at 1%.

Source: Results from analysis

4 Empirical findings

4.1 Dynamic conditional correlations

We now use the asymmetric dynamic conditional correlation (ADCC) multivariate GARCH models presented in the previous section to estimate the conditional correlations between

Vietnam's stock market and the US stock market and those between Vietnam's stock and bond markets in one single system.

Table 3 reports the estimates of the returns and conditional variances equations. The AR(1) terms in the mean equation are significant for all the variables. The coefficients of the US returns in the mean equations are highly significant, which confirms the impact of the American stock market on Vietnam's security markets. The coefficients of lagged variances and shock-square terms are all significant at 1%, which means that the volatilities of these markets are time-varying. Hence, it completely supports the GARCH(1,1) models. Besides, the coefficients of the indicator variable *I* in the variance equations are all significant at 1%, confirming that negative shocks have a higher effect on the variance of the positive shocks. The estimated parameters θ_1 and θ_2 of the DCC processes are all significant at 1%. The condition $\theta_1 + \theta_2 < 1$ is satisfied. All of this confirms that the ADCC-GARCH(1,1) used is appropriate.

Table 3. Estimation of ADCC–GARCH model

$r_t = \gamma_o + \gamma_1 r_{t-1} + \gamma_2 r_{t-1}^{US} + \varepsilon_t$

$h_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1} + d_i \varepsilon_{i,t-1}^2 I_{\varepsilon<0}(\varepsilon_{i,t-1})$

$Q_t = (1 - \theta_1 - \theta_2)\bar{Q} + \theta_1 v_{t-1} v_{t-1}' + \theta_2 Q_{t-1}$

Parameter	γ_o	γ_1	γ_2	Ω	α	β	I
US stock	0.024***	–0.056***		0.023***	–0.019**	0.904***	0.185***
	(1.629)	(–2.813)		(7.243)	(–2.498)	(88.491)	(0.018)
VN stock	–0.034***	0.170***	0.235***	0.077***	0.118***	0.833***	0.034***
	(–1.448)	(9.008)	(11.171)	(7.802)	(10.419)	(80.091)	(0.018)
VN bond	0.028***	0.103***	0.071***	0.003***	0.132***	0.856***	0.169***
	(5.695)	(4.210)	(10.112)	(6.084)	(9.019)	(88.285)	(0.003)

Note: The numbers in parentheses are *t*-statistics. *** represents a statistical significance at 1% (*p* value) of the parameters.

Source: Results from analysis

We use the Zivot-Andrew test to find the structural breaks of the US stock market. The results shown in Table 4 indicate that there are four structural breaks for the US stock market during the whole period. Based on this finding, we set to 09/22/2008 as the date of the crisis. It is reasonable because it corresponds to the Lehman Brothers' collapse[1], which has a big impact on the US stock market. Hence, we define the periods of the US crisis as follows: the tranquil period stretches from 11/30/2006 to 09/22/2008 (the first break) and the turbulent period for detecting contagion and flight-to-quality covers from 09/23/2008 to 3/10/2009 (the second break)

[1] Lehman Brothers is the fourth largest U.S. Investment Bank, which filed for bankruptcy on 15 September 2008.

as shown in Figure 3. The definition of the US crisis period is similar to that by Samarakoon [30].

Table 4. Structural break of US stock market

Break point	9/22/2008	3/10/2009	7/25/2011	8/18/2015
Statistics	–5.348**	–5.33321**	–7.474***	–6.332***

Note: Italic numbers in parentheses are t-statistics. *** and ** represent a statistical significance at 1% and 5% (*p* value)

Source: Results from analysis

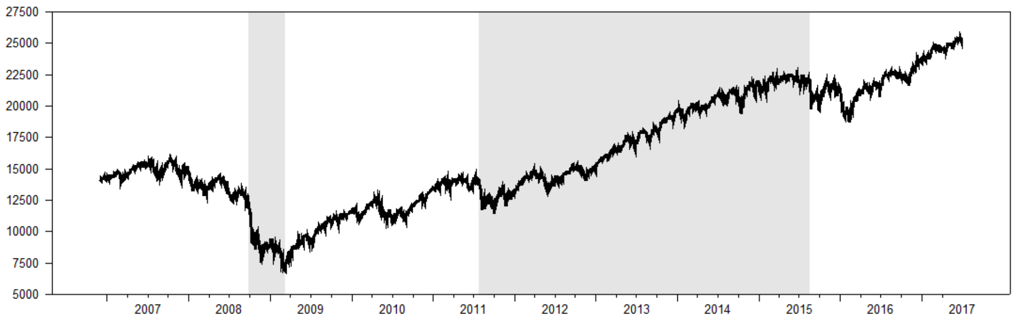

Figure 3. Evolution of US stock index

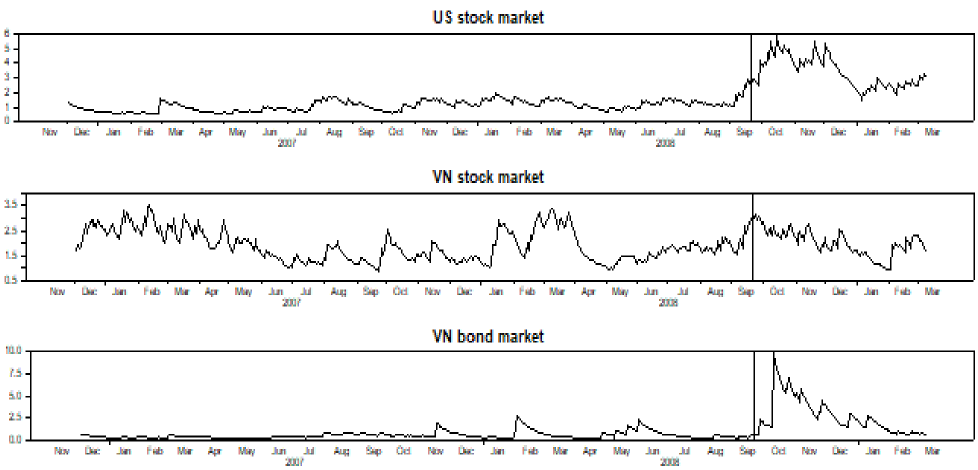

Figure 4. The volatility of US stock market, Vietnam's stock and bond market

Source: Results from analysis

Figure 4 presents the volatility of the US stock market and Vietnam's stock and bond markets. We can observe that the volatility in these markets increases rapidly right after the break date, especially Vietnam's bond market. The computed dynamic conditional correlations during the US crisis are presented in Figure 5 and Figure 6. The vertical continuous lines represent the break date 09/22/2008. In the tranquil period, the DCCs between the US stock market and Vietnam's stock market are low. Then, they tend to increase after the crisis begins. We can observe the opposite trend for the correlations between Vietnam's stock and bond markets. They tend to descrease during crisis period. Hence, we may say that contagion and flight-to-quality phenomenon exist in Vietnam during the US subprime crisis. However, we must do a statistical test to confirm this observation, which is presented in the next section.

4.2 Contagion and flight-to-quality tests

In this section, we test for the existence of contagion or flight-to-quality in Vietnam's securities markets. We calculate the average correlations in the pre-crisis and crisis periods and then use the *t*-test as presented in Section 2 to verify whether the average correlation in the crisis period is statistically higher or lower than that in the pre-crisis period. The results are reported in Table 5. We can see that the correlation between the US and Vietnam's stock markets, and those between Vietnam's stock and bond markets are quite small. However, there is an significant increase in the average dynamic correlation between the US and Vietnam's stock markets after the crisis. The results confirm the contagion effect of the US stock market on Vietnam's stock market. Besides, we also find out flight-to-quality within Vietnam's financial markets. The correlation between Vietnam's stock and bond markets decreases significantly during the US crisis.

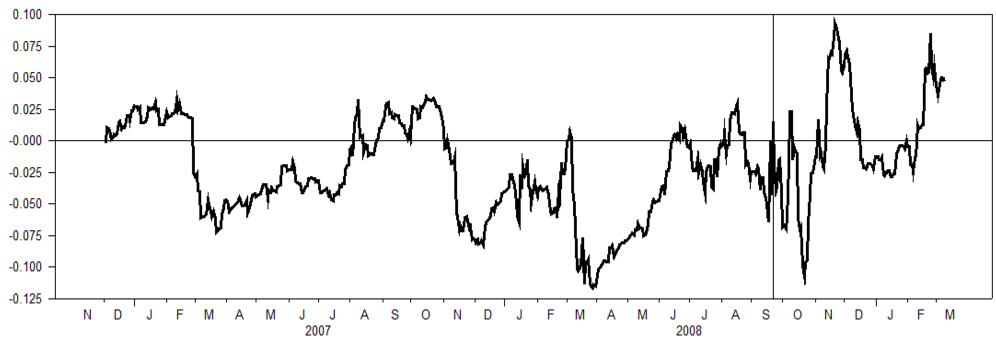

Figure 5. The dynamic correlation estimation between US stock market and Vietnam's stock market

Source: Results from analysis

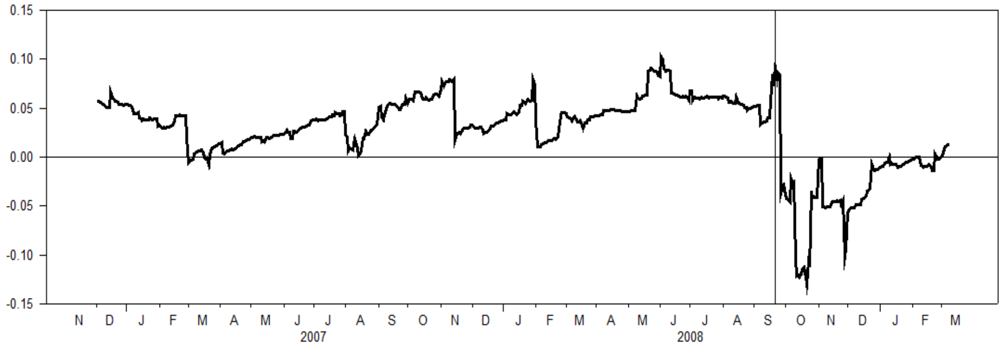

Figure 6. The dynamic correlation estimation between Vietnam's stock and bond markets

Source: Results from analysis

Table 5. Results of contagion and flight-to-quality tests

	Stable period *11/30/2006 – 9/22/2008*			**Turmoil period** *9/23/2008 – 3/10/2009*				
	Mean	**Std Dev**	***N***	**Mean**	**Std Dev**	***N***	***t*–statistic**	**Results**
US–VN stock markets	–0.0266	0.037	471	0.0016	0.044	121	–6.515	C***
VN stock and bond markets	0.0414	0.021	471	–0.0292	0.039	121	–19.233	FTQ***

Note: Italic numbers in parentheses are t-statistics. *** represents a statistical significance at 1% (*p* value); C: Contagion; FTQ: Flight-to-quality.

Source: Results from analysis

5 Conclusions

In this paper, we analyze the existence of contagion and flight-to-quality in Vietnam's financial markets under the effect of the Global Financial Crisis. The methodology contains the estimation of dynamic conditional correlations, the Zivot-Andrew test to find the structure breakpoints and *t*-test for the significance of the increase/decrease in the dynamic conditional correlations during the tranquil and turmoil period. We find that the average of dynamic conditional correlations between the US and Vietnam's stock markets rises significantly after the Global Financial Crisis, which suggests a contagion effect of the US crisis on Vietnam. The occurrence of contagion from the US market to Vietnam during the crisis is bad news for investors because it reduces the benefits of diversification, which, in turn, makes the investors suffer more than usual. Besides, we also find that the Vietnamese bond and stock markets show a flight-to-quality as the average dynamic conditional correlation decreases and even becomes negative during the turmoil period, showing a common behavior of most investors in the financial markets: The investors tend to move from risky assets to safer ones to protect themselves from risk during the turbulent period.

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