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Article

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FINANCIAL ECONOMICS | REVIEW ARTICLE

Market, interest rate, and exchange rate risk effects on financial stock returns during the financial crisis: AGARCH-M approach

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Abstract: Our aim is to investigate the sensitivity of financial sector stock returns to market, interest rate, and exchange rate risk in three financial sectors (financial services, banking, and insurance) in eight countries, including various European, the US, and China economies, over the period 2006–2009 during the financial crisis. The econometric framework is a four-variate GARCH-in-mean model and volatility spillovers. The empirical results show the significant effects (positive and negative, respectively) of the stock market returns, interest rate, and exchange rate volatility of the financial sector during the crisis. Besides, we find, in most cases, significant (positive and negative, respectively) volatility spillovers from market return, interest rate, exchange rate, and interest rate in the financial services and the banking sector both in the European and the US economies during the financial crisis.

Subjects: Communication Studies; Development Studies; Economics, Finance, Business & Industry

Keywords: exchange rate; interest rate; multivariate GARCH; volatility; financial sector stock returns; market linkages in the post-crisis world

1. Introduction

During the last decades, the linkage between the interest rate, the exchange rate, the stock return market, and the financial sector remains a crucial issue for risk management and portfolio management. In recent years, the dynamic relationship between the three risks has had important implications and has drawn the attention of numerous economists, both for theoretical and empirical

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PUBLIC INTEREST STATEMENT

The main purpose of this article is to improve the explanatory power of the financial review; the author's objectives include highlighting the role played by the exchange rates, interest rates, and the financial stock return that affect the volatility of stock market.

This study is considered the first of its kind conducted in the context of the financial crisis. Studying the impact market, interest rate, and exchange rate risk effects on the financial stock returns could provide valuable information to portfolio management for both national and international. This study will help investors achieve and monitor more closely the monetary policy to make decisions on their investments as interest and exchange rates have predictive powers on the bank volatility stock returns.

reasons, because they play an important role in influencing the development of an economy. Besides, the liberalization of financial markets and the technological advances have increased the nexus between the exchange rate, the interest rates, and the stock returns. The relationship between the interest rate, the exchange rate, and the stock returns in the financial sectors has given rise to a prolific research activity over the past few decades.

In this context, Tai (2000), used the multivariate GARCH in mean (MGARCH-M) approach where both conditional of first and second moments of the banks portfolio returns and risk factors are estimated simultaneously showing strong evidence of time-varying interest rate and exchange rate risk premium and weak evidence of time-varying world market risk premium for all three bank portfolios, namely: Money Center bank, Large banks, and Regional bank. In this context, Beirne, Caporale, and Spagnolo (2009) pointed out to the sensitivity of the stock market returns, interest rate, and exchange rate risk in three financial sectors (banking, financial services, and insurance) in 16 countries. In recent research, Andrieș, Ihnatov, and Tiwari (2014) have found very clear results of phase difference of lead-lag relationship between the stock prices, the exchange, and the interest rates. Olugbode, Pointon, and El-Masry (2011) pointed out that the stock returns of UK industries had been more affected by the long-term interest rate risk than by the exchange rate risk or even the short-term interest rate risk.

In the same vein, Koch and Saporoschenko (2001) used an AR (1)-GARCH (1, 1) volatility model to analyze the effect of both the interest rate and exchange rate risk, but only for Japanese financial firms. Conversely, Di Iorio, Faff, and Sander (2006) were interested in both the interest and the exchange rate risk and their effects on the financial sector returns in several euro zone and non-euro zone countries.

The objective of this study is to use the financial stock return, which depends on the exchange rate and other inputs, such as the interest rate and the stock return. The extended econometric framework is a four-variate GARCH-in-mean model helps us explore the causal relationships between the variables: the financial stock return, the exchange rate, the interest rate, and the stock return. The variables are chosen to capture the particular characteristics of eight different countries. First, we focus on three financial sector returns (financial, insurance, and banking sector), while most studies focus on the banking sector returns. The impact of the interest rate fluctuations on the market value of companies has received a great deal of attention in the literature, although much of the empirical research has focused on the banking sector returns because of the particularly interest rate sensitive nature of the banking business (Flannery & James, 1984; Staikouras, 2003, 2006). Nevertheless, the interest rate variations may also exert a significant influence on the financial corporation's (insurance and financial service), mainly through their effect on the financing costs and the value of financial assets and liabilities held by these firms. Second, no previous research has examined the connection between the interest rates and the stock prices at the banking sector by employing a four-variate GARCH-M framework method. However, the analyses on a financial service basis and insurance sector are appropriate because market aggregation may hide significant differences between the financial service and the insurance sector in terms of interest rate sensitivity.

Third, the financial firms in regulated and/or highly indebted financial service and insurance sector are commonly recognized as the most interest rate sensitive Beirne et al. (2009). Two primary reasons help to explain this result. Our study thus contributes to the existing literature. First, by giving, the profits and, consequently, the stock prices of heavily indebted corporations are strongly dependent on interest rate developments, as the cost of their debt is directly related to the level of interest rates. Second, regulated companies such as utilities adjust the prices of their products and services with some lag behind cost increases due to the constraints imposed by regulators. This contributes to the strengthening of the negative impact of the interest rate rises on the stock prices of these firms.

Finally, if most studies use an event study approach, we employ a four-variate GARCH-in-mean model in order to capture the time varying volatility the stock returns, while most studies employed a GARCH univariate model. Previous research implicitly assumes that Fund programs are credible such that market participants expect them to improve the efficiency in the economy in general and of the banking sector in particular. We rather interpret the changes in financial sector returns (financial service, insurance sector, and banking sector) based on the available evidence on the corporate governance characteristics in the European, the US, and China economies, over the period 2006–2009 during the financial crisis.

The empirical results can be summarized as follows. Estimations based on the GARCH-BEKK indicate that the banking sector is very much affected by the volatility of the exchange rates, the interest rates and the stock returns. Finally, based on the GARCH-BEKK, strong evidence of the exchange rate, interest rate, and stock return is found in both financial and insurance sectors.

The algorithm of the article is as follows: Section 2 briefly reviews the related literature, followed by Section 3 which outlines the econometric method, where as Section 5 presents the used data and depicts the empirical findings and Section 6 contains the concluding annotations and offers some policy implications.

2. Review literature

The nexus between the exchange rate, the interest rates, and the stock returns has been a subject of large research over the past few decades. This research can be categorized into three strands.

2.1. Relationship between interest rates and stock returns of financial sector

A large number of studies have focused on the interest rates of the financial stock returns (see Elyasiani, Mansur, & Pagano, 2007; Flannery, Hameed, & Harjes, 1997; Lajeri & Dermine, 1999 and others). However, some more recent studies, such as those of (Akhtaruzzaman, Shamsuddin, & Easton, 2014) indicated that the Australian banks show a negative exposure to changes in the as both domestic bank interest rates, and US interest rate volatility is found to be an important predictor of Australian bank stock return volatility, and findings are obtained for the aggregate portfolio of financial stock. In addition, they show that the time-varying conditional correlation between the Australian and US financial stock returns increases during financial crises and varies directly with net capital flows between Australia and the USA. Moreover, in this context, Martínez, Lapena, and Sotos (2014) state that Spanish industries exhibit, in general, significant interest rate sensitivity, although the degree of the interest rate exposure differs considerably across industries depending on the time horizon under consideration.

Czaja, Scholz, and Wilkens (2009) and Korkeamäki (2011) pointed out that the impact of the interest rate fluctuations on equity returns has declined over time primarily due to the increased availability of improved tools for managing interest rate risk. In addition, the exposure of the Australian financial sector has increased over the last decade. For example, the exposure of the country's global consolidated operations to the USA has increased substantially since 2003. Another interesting finding in the literature is the volatility of the interest rate which significantly affected the stock returns of these companies (Papadamou & Siriopoulos, 2014). So far, the empirical literature on the link between the interest rate and the stock return has been developed primarily in the time domain by using a board range of time series methods, including GARCH-M methodology Elyasiani and Mansur (1998) found that the interest rate-level volatility directly affects the first and second moments of the bank stock return distribution, respectively. They also stated that the negative correlation between the banking stock volatility and risk premium, indicates a possible agency theory problem using VAR techniques (Laopodis, 2010), OLS regression (Reilly, Wright, & Johnson, 2007).

2.2. Relationship between exchange rate and stock return of financial sector

Modeling the exchange rate exposure has been an important growing area of research in the last decade. The second strand of studies has examined the impact of the exchange rate and stock return on either financial or non-financial sector (see Chkilia, Aloui, & Nguyen, 2012) these authors used univariate and multivariate GARCH-type models to investigate the properties of conditional volatilities of the stock returns and exchange rates, as well as their empirical relationship. They found that bilateral relationships between the stock and foreign exchange markets had been highly significant for both France and Germany.

Although the theoretical literature suggests causal relations between the stock prices and the exchange rates, empirical evidence is rather weak. Pan, Fok, and Liu's (2007) results indicated significant causal relation from the exchange rates to the stock prices in Hong Kong, Japan, Malaysia, and Thailand before the 1997 Asian financial crisis. They also found a causal relation from the equity market to foreign exchange market for Hong, Korea, and Singapore. Furthermore, while no country shows a significant causality from the stock prices to exchange rates during the Asian crisis, a causal relation from the exchange rates to the stock prices is found for all the countries except for Malaysia. In their study on Istanbul Stock Exchange (ISE), Acikalin and Seyfettin Unal (2008) used a co-integration test and vector error correlation model showing that the exchange rate has a direct long-run equilibrium relationship with the stock market index. Findings from the study reveal two ways of causalities between the two variables; which implies that prediction of ISE is possible using the past information on the moves of the exchange rate.

2.3. Relationship between exchange rate, interest rate, and stock return of financial sector

The third strand of studies has examined the impact of the exchange rate, interest rate, and the stock returns on the financial sector. In addition, Ryan and Worthington (2004) identified a three-way linkage between the market, interest rate, and foreign exchange rate risk in the Australian banking. Their results suggest that market risk is an important determinant of bank stock returns, along with short- and medium-term interest rate levels and their volatility. However, long-term interest rates and the foreign exchange rate do not appear to be significant factors in the Australian bank return generating process over the considered. Period

Most empirical studies concerning the pricing of bank stock returns focus mainly on the pricing of the interest rate and very few published papers explicitly investigate the joint interaction of exchange rates and interest rates on bank stock pricing however Choi, Elyasiani, and Kopecky (1992) show that they examined the role of the market the interest rate, and the exchange rate risks in pricing the US commercial bank stock returns by estimating and testing a three-factor model under both unconditional and conditional frameworks, on the other hand. Beirne et al. (2009) indicated that in most cases there is a significantly positive effect of the stock market returns on the mean returns in each sector. In contrast, the interest and exchange rates have a significant (negative and mixed, respectively) effect in a fewer number of cases. They showed that the three types of risk are found to play a role mainly in the financial service sector, but with no clear sign pattern.

Finally, in most cases, volatility spillovers occur from the market return to sector returns in the insurance and banking sector in the European economies, though there are also some instances of interest rate and exchange rate spillovers, both in Europe and the USA. However, Ahmad, Ahmad, and Rehman (2010) employed a multiple regression model to test the significance the change in the interest and exchange rate on the tock returns. They showed that both the change of the interest rate and that of the exchange rate have a significant impact on the stock returns over of the sample period. Kasman, Vardar, and Tunç (2011) used an OLS and GARCH estimation models to test the effects of the interest and foreign exchange rate changes on the Turkish bank's stock returns. They found that the interest and exchange rate changes have a negative and significant impact on the conditional banks stock returns. In addition, the bank stock return sensitivities are found to be stronger for the market return than for the interest and exchange rate, implying that the market

returns play an important role in determining the dynamics of the conditional returns of the banks stocks.

In the same view, Aloui and Jarboui (2013) using the OLS and GARCH estimation models, they found that the exchange and the market index have an impact and an important role in determining the dynamics of the conditional bank stock returns. However, the interest rates do not appear to be significant factors in the Tunisian bank returns. Moreover, the long-return interest and exchange rate volatility is the major determinant of the conditional bank's stock return volatility.

The present study is different from the previous studies in the different ways. First, it uses a four-variate VAR-GARCH (1, 1)-in mean model to study the four-way linkages between the financial sector index, the stock market index, the interest rate, and the exchange rate for a panel of eight countries. However, to the best of our knowledge, none of the empirical studies has focused on the four-way linkages between the financial sector index, the stock market index, the interest rate, and the exchange rate, especially the combination of financial sector by using four-variate VAR-GARCH (1, 1)-in mean model framework. The model helps us examine, at the same time, the impact of the stock market index, the interest rate, and the exchange rate on the financial sector index. Second, we use a four-variate VAR-GARCH (1, 1)-in mean model because this helps not only with the time-varying conditional variances but also with the time-varying conditional covariance. In addition, the earlier GARCH models failed to ensure positive definiteness of the conditional covariance matrix.

2.4. Relationship between European, China, and US markets

In the literature dealing with the trade and financial linkages for the properties of business cycles, a number of studies consider how such linkages affect the nature of the cyclical interactions between the emerging and European economies. Some of these studies focus on the changes in the time-series patterns of the interdependence across both groups of countries. Some other studies attempt to measure the magnitude of the spillovers between both groups.

The European Union (EU) occupies the third place, just behind Japan and the USA, in the foreign trade with China. The EU has seen its low-trade surplus years. The financial crisis has caused a banking crash in the US, with cascading bank failures. Far from being spared, the European banks have, in turn, recorded losses. The evidence, as almost zero growth rates in 2008, shows that the crisis hit Europe. Indeed, the euro-zone has an experience of loss of competitiveness against the dollar zone. Contagion is also evident in the financial markets, considering the massive liquidity injection by the European Central Bank and the severe "credit crunch", which demonstrate that the contagion is massive.

Undermined in part by the economic setbacks experienced by China, the stock markets derailed in August. The agitated volatility was a destabilizing factor that increased the fear of the investors. There were an August 24, will be remembered as the worst day for the US exchanges in four years. There was a spectacular liquidation that led experts to wonder if the old bull cycle of six years finally ended. This "Black Monday" on which the world's equities experienced a severe correction, beginning with those of Shanghai instead accusing the largest losses.

This chaos led investors to wonder whether the instability of financial markets would influence the decision of the US Federal Reserve to raise its key interest rate or not in September. Moreover, the Canadian stocks plunged deeply into the negative in August, the month which was marked by fears of recession and deteriorating global economic conditions. The S&P/TSX was down −3.47% in August and −4.04% YTD, while the major stock markets of Asia, Europe and North America were falling sharply all. All the sectors ended in the red, but the energy, the financial services, the consumer discretionary, the industrial, and health products lost more than the others. The financial services sector also registered heavy losses in August; pessimism was also extended to bank stocks (which weigh heavily enough in this sector). At the time of writing, experts believed that the bank shares had lost about 5.4% of their capitalization so far in the third quarter and exchanged below their cur-

rent/historical earnings ratios. The risks for banks are, first, that the depressed sector of the energy does make them undergo substantial loan losses and, second, the deterioration of Canadian economy discourages individuals to borrow if they fear for employment and the labor market in general. On the other hand, Tonnelier showed that the stock market shocks, until relatively disconnected from the Chinese real economy could end up affecting the latter, further exacerbating a little slower growth which weakened its, Asian, American and European but also, first and foremost Germany trading partners.

In China, the European Union and the USA, those who focus on the hard rivalry and influence between the two powers tend to forget how China was influenced by the United States during the last generation. Ideas, technologies and products intended to come across the Pacific—links to Europe were much less milking. Beijing Analysts—described the US–China relationship as a love–hate relationship: just as Americans want to take credit for the introduction of capitalist markets in China, they also fear why the Chinese put their newly found wealth. As the Chinese prefer US products and consider the US more "advanced" than any other part of the world, they also feel the role of the USA in East Asia and approach "hegemonic" of the world policies. Europe has, until recently lagged far behind the development of the China's awareness of the outside world.

3. Data and model specification

In this paper, we examine the three-way linkages between the stock returns in financial sectors to market, the interest rate, and the exchange rate risk for eight countries, namely Germany, the USA, Greece, the UK, France, Spain, Italy, and China. As mentioned earlier, most existing literature deals with the stock returns to market, the interest rate, and the exchange rate risk in the financial sector (Financial service, Banking and insurance). The data are collected for the period from January 2006 till April 2009. Therefore, the interrelationship between the three variables is worth investigating by considering them a four-variate VAR-GARCH (1, 1)-in mean model in a modeling framework.

We adopt a model from a family of the multivariate GARCH model which was first proposed by Bollerslev et al. This model provides a general framework for multivariate volatility modeling but requires a large number of parameters to be estimated. More specifically, we apply a four-variate VAR-GARCH-in-mean framework with the BEKK representation proposed by Engle and Kroner (1995) to model and test for market spillovers in means and variance of the stock returns as well as market spillovers from second to first moment (GARCH-in-mean effects). This approach builds upon and expands the existing studies, such as those of Beirne et al. (2009). The use of a GARCH-in-mean specification enables us to estimate cross-market spillovers from second to first moments. This is an important contribution of the present study, which differentiates it from that of Beirne et al. (2009) and other related papers. An appealing property of the GARCH-BEKK is that the model ensures a positive definite and conditional covariance matrix. In order to reduce the number of parameters estimated in the GARCH-BEKK model, restrictions, such as symmetricity and diagonality are often imposed.

We represent the joint process governing the stock returns in the financial sectors to the market, interest rate, and exchange rate risk by a four-variate VAR-GARCH (1, 1)-in mean process. In its general specification, the model has the following form:

$$x_t = \alpha + \beta x_{t-1} + \gamma H_t^{1/2} + \mu_t \tag{1}$$

x_t = (fin-returns$_t$, stock-returns$_t$, interest$_t$, ex-rate$_t$ and the residual vector $\mu_t(e_{1,t}, e_{2,t}, e_{3,t}, e_{4,t})$ is four-variate and normally distributed $\mu_t|I_{t-1}$ $(0, H_t)$ with its corresponding conditional variance covariance matrix given by:

$$H_t = \begin{matrix} h_{11t} & h_{12t} & h_{13t}h_{14t} \\ h_{21t} & h_{22t} & h_{23t}h_{24t} \\ h_{31t} & h_{32t} & h_{33t}h_{34t} \\ h_{41t} & h_{42t} & h_{43t}h_{44t} \end{matrix} \tag{2}$$

The parameter specification of the mean return Equation (1) is defined by the constant $\alpha = (\alpha_1, \alpha_2, \alpha_3, \alpha_4)$, the autoregressive term $\beta = (\beta_{11}, \beta_{12}, \beta_{13}, \beta_{14}|0,\beta_{22}, 0,0|0,0,\beta_{33},0|0,0,\beta_{44})$ and the GARCH-in-mean term $\gamma = (1/1, 1/2, 1/3,1/4|0,0,0,0|0,0,0,0|0,0,0,0)$ which appears in the first equation only. The parameter matrices of the variance Equation (2) are given by C_0, which is restricted to be upper triangular, and two matrices A_{11} and B_{11}. It should be noted that in our model there are nine zero restrictions in the latter two matrices, but we are interested in testing only for the causality-in-variance (spillover) running from the stock returns in the financial sectors to market, the interest rate, and the exchange rate risk.

In the multivariate GARCH (1, 1)-the BEKK representation proposed by Engle and Kroner (1995), which guarantees, by construction that the variance–covariance matrices in the system are positive the definite H_t takes the following form:

$$H_t = C_0'C_0 + \begin{vmatrix} A_{t1} & A_{t2} & A_{t3} & A_{t4} \\ 0 & A_{22} & 0 & 0 \\ 0 & 0 & A_{33} & 0 \\ 0 & 0 & 0 & A_{44} \end{vmatrix}, \begin{vmatrix} e^2_{1,t-1} & e_{1,t-1}e_{2,t-1} & e_{1,t-1}e_{3,t-1} & e_{1,t-1}e_{4,t-1} \\ e_{2,t-1}e_{1,t-1} & e^2_{2,t-1} & e_{2,t-1}e_{3,t-1} & e_{3,t-1}e_{4,t-1} \\ e_{3,t-1}e_{1,t-1} & e_{3,t-1}e_{2,t-1} & e^2_{3,t-1} & e_{3,t-1}e_{4,t-1} \\ e_{4,t-1}e_{1,t-1} & e_{4,t-1}e_{2,t-1} & e_{4,t-1}e_{3,t-1} & e^2_{4,t-1} \end{vmatrix}$$
$$\begin{vmatrix} A & A_{t2} & A_{t3} & A_{t4} \\ 0 & A_{22} & 0 & 0 \\ 0 & 0 & A_{33} & 0 \\ 0 & 0 & 0 & A_{44} \end{vmatrix} \begin{vmatrix} B_{11} & B_{t2} & B_{t3} & B_{t4} \\ 0 & B_{22} & 0 & 0 \\ 0 & 0 & B_{33} & 0 \\ 0 & 0 & 0 & B_{44} \end{vmatrix}, H_{t-1} \begin{vmatrix} B_{11} & B_{t2} & B_{t3} & B_{t4} \\ 0 & B_{22} & 0 & 0 \\ 0 & 0 & B_{33} & 0 \\ 0 & 0 & 0 & B_{44} \end{vmatrix} \quad (3)$$

Equation (2) models the dynamic process of H_t as a linear function of its own past values H_{t-1} and past values of the squared innovations $e^2_{1,t-1}, e^2_{2,t-1}, e^2_{3,t-1}, e^2_{4,t-1}$), allowing for own-market and cross-series influences in the conditional variance. The important feature of this specification is that it guarantees, by construction, that the covariance matrices in the system are positive.

Given a sample of T observations, a vector of unknown parameters θ and a 4×1 and a vector of variables x^2_t, the conditional density function for the model (1–3) is:

$$F(x_t|I_{t-1};\theta) = (2\pi)^{-1}H_t^{-1/2} \exp(-[\mu_t'(H_t^{-1})\mu_t]/2 \quad (4)$$

The Log likelihood function (L) is:

$$L = \sum_{t=1} T \log(x_t|I_{t-1};\theta) \quad (5)$$

4. Hypotheses tested

A number of hypotheses are tested on the estimated parameters and a likelihood ratio test statistic (LR) is computed by the unrestricted and restricted models, where $LR = -2(L_r - L_u) \sim x^2(K)$. The main tested restrictions are: (1) the effect of the stock market returns, the interest rates, and the exchange rates on mean returns in each financial sector; (2) the effect of changes in the second moment of the stock market returns, the interest rates, and the exchange rates on mean returns in each financial sector. Finally, (3) volatility spillovers from the stock market returns, the interest rate, and the exchange rate returns to volatility of returns in each financial sector.

Tests of no GARCH-in-mean effect during the financial crisis:

H1: No market return volatility effect in mean $1/_{12} = 0$

H2: No interest rate short-term volatility effect in mean $1/_{13} = 0$

H3: No interest rate long-term volatility effect in mean $1/_{14} = 0$

H4: No exchange rate effect $1/_{15} = 0$

H1 to H4 test the sensibility of the level of the relevant financial sector index return to volatility in market returns, interest rates, and exchange rates.

Test no causality in mean effect during the financial crisis:

H5: No market return effect $\beta_{12} = 0$

H6: No interest rate short-term effect $\beta_{13} = 0$

H7: No interest rate long-term effect $\beta_{14} = 0$

H8: No exchange rate effect $\beta_{15} = 0$

H5 to H8 test the sensibility of the level of the relevant financial sector index returns to volatility in market returns, interest rates, and exchange rates.

5. Empirical results and discussion

5.1. Results of the banking sector during the financial crisis

Table 1 shows that most of the key variables of the banking service sector model are significant at 1 and 5% with a positive effect for Germany, the USA, and Italy and a negative effect for the UK from the exchange rate causality to the banking sector β_{12}. We can also see a statistical significance at 1 and 5% with a positive and a negative effect from short-term interest rate, long-term interest rate, and stock returns (β_{13}, β_{14}, and β_{15}) to the banking sector. In the same view, we can say that the spillovers of the stock market, exchange rate volatility, short-term interest rate, and long-term interest rate are measured respectively by $1/_{12}$, $1/_{13}$, $1/_{14}$, and $1/_{15}$. The findings reveal that these are statistically significant with a positive and a negative effect from the exchange rate of the volatility short-term interest rate, long-term interest rate and stock returns to the banking sector ($1/_{12}$, $1/_{13}$, $1/_{14}$, and $1/_{15}$).

Evidence of the volatility spillovers from market returns, short-term interest rate, long-term interest rate, and the exchange rate volatility are statistically significant with a positive and negative effect on the banking sector (measured by the parameters (A_{12}, A_{13}, A_{14}, and A_{15}).

For the spillovers from the market returns, the long-term interest rate, the short-term interest rate, and the exchange rate conditional volatilities, the findings indicate that they are significant at 1 and 10% with positive and negative effect from the exchange rate volatility (B_{12}) on the banking sector. We can also find a statistically significant and positive (Greece, France, UK, Italy and China) effect from the short-term interest rate on the banking sector (B_{13}). Moreover, the long-term interest rate and the stock market returns have a positive and a negative impact on the banking sector (B_{14} and B_{15}).

During the current crisis, we notice that the Spanish banking sector has become sensitive to the volatility of the exchange rate, to the interest rate, and to the stock returns. This is quite normal since this period is considered as the beginning of an economic crisis in Spain as its public deficit exploded in 2009, reaching 11.2 of its GDP according to Eurostat. Actually, the Spanish crisis was generated by a housing bubble that weakened the financial and banking sector. Moreover, in 2009, the rating agency Standard & Poor's downgraded the Spain's rating from AAA to AA.

Therefore, we can say that the banking sector in all the analyzed countries continued to be affected by the volatility of the exchange rate, the interest rate, and the stock return market, but at different degrees, which shows that these countries were affected by the debt crisis of the Euro zone. In this way, Choi et al. (1992) and Chamberlin et al. examined the joint impact of the interest rate and the exchange rate on the banking stock returns. These authors show the importance of these latter for the bank stocks. Conversely, the study of Choi et al. (1992) seems contradictory to ours because, according to these authors, the exchange rate impact is different from that of the interest

Table 1. Banking sector stock return effects: estimated four-variate GARCH (1, 1) model during the financial crisis

During the financial crisis	Variables															
	Exchange rate				Interest rate short-term				Interest rate long-term				Market return			
Country	β_{12}	$1/_{12}$	A_{12}	B_{12}	β_{13}	$1/_{13}$	A_{13}	B_{13}	β_{14}	$1/_{14}$	A_{14}	B_{14}	β_{15}	$1/_{15}$	A_{15}	B_{15}
Germany	0.020*** (0.035)	0.042* (0.000)	0.021 (0.954)	−0.145 (0.952)	0.000 (0.119)	0.055* (0.000)	3.793 (0.336)	−14.39 (0.226)	0.000 (0.865)	0.054* (0.000)	−0.048* (0.000)	−13.7*** (0.098)	−0.000 (0.712)	0.054* (0.000)	−4.917* (0.000)	0.845 (0.852)
US	0.000* (0.000)	2.113* (0.000)	0.029*** (0.054)	−0.005*** (0.088)	0.122* (0.000)	0.456*** (0.022)	0.0017*** (0.061)	−0.000 (0.877)	0.270* (0.000)	0.858* (0.000)	−0.016 (0.622)	−0.136*** (0.093)	0.231 (0.66)	1.769 (0.034)	−0.034 (0.232)	-(0.0126*** (0.0522)
Greek	0.065 (0.752)	0.271 (0.494)	−0.254 (0.780)	−0.281 (0.895)	−0.379* (0.000)	1.436* (0.000)	0.976* (0.000)	−1.345* (0.000)	−0.227 (0.248)	0.237 (0.463)	−0.522* (0.000)	−0.248 (0.658)	0.118 (0.666)	0.298 (0.371)	0.144 (0.034)	−0.515 (0.585)
France	0.096 (0.535)	0.477* (0.000)	−0.818* (0.000)	0.250 (0.351)	−0.122* (0.000)	1.484* (0.000)	0.217*** (0.096)	−1.760* (0.000)	0.497* (0.000)	0.856* (0.000)	0.066 (0.677)	−0.302 (0.102)	0.497* (0.000)	1.056* (0.000)	0.234* (0.000)	0.144*** (0.021)
UK	−0.002*** (0.050)	0.491*** (0.073)	−7.488 (0.848)	−124.7 (0.529)	0.008 (0.838)	0.922* (0.000)	0.020*** (0.019)	66.42* (0.000)	0.1526 (0.387)	0.7100*** (0.022)	0.054 (0.194)	68.13* (0.000)	0.239*** (0.036)	0.475*** (0.076)	0.050* (0.000)	66.50* (0.000)
Italy	1.296*** (0.039)	1.001* (0.000)	−0.002 (0.860)	−0.124* (0.000)	−0.078 (0.109)	1.270* (0.000)	0.880** (0.005)	1.523* (0.000)	−0.377* (0.000)	0.871* (0.000)	0.284*** (0.010)	−0.477* (0.000)	−0.532*** (0.009)	0.877* (0.000)	−0.151*** (0.007)	−0.320* (0.000)
China	−0.015 (0.326)	0.066 (0.939)	0.000 (0.100)	0.015* (0.000)	−0.000 0.323)	0.060 (0.944)	0.000 (0.314)	0.017* (0.000)	n/a	n/a	n/a	n/a	0.975* 0.000)	0.291 (0.128)	0.000** (0.003)	0.017* (0.000)
Spain	−0.000 (0.142)	0.295 (0.420)	−0.022 0 (0.815)	−0.142*** (0.089)	0.086*** (0.008)	−0.192*** (0.006)	−0.205 (0.735)	−0.731 (0.403)	0.025 (0.871)	−0.217 (0.129)	0.216 (0.456)	0.036 (0.933)	1.310* (0.000)	−0.038 (0.478)	−5.232 (0.475)	−8.766 (0.440)

*Significance at the 1% level.

**Significance at the 5% level.

***Significance at the 10% level.

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Table 2. Financial sector stock return effects: estimated four-variate GARCH (1, 1) model during the crisis financial

During the financial crisis	Variables															
	Exchange rate				Interest rate short-term				Interest rate long-term				Market return			
Country	β_{12}	$1/_{12}$	A_{12}	B_{12}	β_{13}	$1/_{13}$	A_{13}	B_{13}	β_{14}	$1/_{14}$	A_{14}	B_{14}	β_{15}	$1/_{15}$	A_{15}	B_{15}
Germany	−2.272*** (0.025)	1.591*** (0.012)	0.086* (0.000)	0.045 (0.135)	0.115* (0.001)	0.551*** (0.039)	−0.099 (0.796)	0.101 (0.874)	0.566* (0.000)	0.603** (0.002)	−0.096 (0.588)	0.359*** (0.094)	1.64* (0.000)	0.649* (0.000)	0.014 (0.771)	0.094 (0.811)
US	0.000* (0.000)	1.767* (0.000)	−0.049 (0.852)	0.049 (0.889)	0.070* (0.000)	0.808* (0.000)	0.001 (0.999)	−0.006 (0.999)	0.195* (0.000)	0.859* (0.000)	0.006 (0.999)	−0.006 (0.999)	0.753*** (0.038)	0.649 (0.239)	0.001 (0.999)	−0.006 (0.999)
Greek	0.691** (0.002)	0.055 (0.890)	0.018 (0.974)	−13.409 (0.258)	−0.210*** (0.055)	1.458** (0.002)	0.075 (0.774)	−0.439 (0.276)	0.298 (0.181)	0.995*** (0.008)	0.224 (0.232)	0.591 (0.182)	−0.680*** (0.024)	1.129** (0.002)	0.114 (0.300)	−0.235 (0.126)
France	−0.127 (0.204)	0.378* (0.000)	17.16 (0.631)	609.4 (0.264)	−0.076* (0.000)	0.958* (0.000)	−0.066 (0.857)	1.472 (0.676)	0.346* (0.000)	0.596* (0.000)	−0.832*** (0.003)	−4.027 (0.185)	0.316* (0.000)	0.702* (0.000)	−0.838 (0.166)	−5.683 (0.395)
UK	−0.001 (0.208)	0.589*** (0.009)	−143.4* (0.000)	246.4 0.108)	0.015 (0.640)	0.801* (0.000)	0.227 (0.000)	−1.72* (0.000)	0.114 (0.411)	0.649*** (0.008)	0.220* (0.000)	1.805* (0.000)	0.132 (0.149)	0.564*** (0.011)	0.237* (0.000)	−1.70* (0.000)
Italy	0.026 (0.918)	0.930* (0.000)	−0.016 (0.847)	−0.220*** (0.060)	−0.056** (0.002)	1.045* (0.000)	26.98 (0.4491)	932.1* (0.001)	−0.377* (0.000)	0.871* (0.000)	−0.362*** (0.040)	−1.244 (0.480)	0.047 (0.581)	0.953* (0.000)	0.016 (0.725)	0.332 (0.405)
China	−0.010 (0.235)	0.360 (0.462)	0.024*** (0.023)	−0.119* (0.000)	−0.000 0.235)	0.360 (0.462)	−1.005* (0.000)	0.436 (0.312)	n/a	n/a	n/a	n/a	−0.056 (0.596)	0.952* (0.000)	0.173* (0.000)	−0.196* (0.000)
Spain	0.033 (0.288)	0.170*** (0.013)	0.088 (0.313)	0.566*** (0.074)	−0.163 (0.257)	0.027 (0.827)	0.886*** (0.033)	0.639 (0.778)	1.353* (0.000)	0.357* (0.000)	0.176 (0.510)	−0.613 (0.681)	−0.001** (0.004)	1.585*** (0.097)	−15.14*** (0.068)	−7.199 (0.858)

*Significance at the 1% level.

**Significance at the 5% level.

***Significance at the 10% level.

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Table 3. Insurance sector stock return effects: estimated four-variate GARCH (1, 1) model during the financial crisis

During the financial crisis	Variables															
	Exchange rate				Interest rate short-term				Interest rate long-term				Market return			
Country	β_{12}	$1/_{12}$	A_{12}	B_{12}	β_{13}	$1/_{13}$	A_{13}	B_{13}	β_{14}	$1/_{14}$	A_{14}	B_{14}	β_{15}	$1/_{15}$	A_{15}	B_{15}
Germany	−1.477* (0.000)	1.22*** (0.011)	0.051 (0.188)	−0.025 (0.748)	0.077*** (0.006)	0.554*** (0.008)	2.076*** (0.016)	3.132* (0.000)	0.420* (0.000)	0.609* (0.000)	−0.636*** (0.063)	0.471 (0.296)	1.222* (0.000)	0.644* (0.000)	0.099 (0.147)	0.090 (0.152)
US	0.000* (0.000)	0.890* (0.000)	0.049 (0.797)	0.049 (0.594)	0.010 (0.113)***	0.750* (0.000)	0.033 (0.998)	0.044 (0.994)	0.052* (0.000)	0.645* (0.000)	0.033 (0.998)	0.044 (0.994)	0.469** (0.002)	0.194 (0.387)	0.033 (0.998)	0.044 (0.994)
Greek	0.022 (0.368)	0.946* (0.000)	0.195 (0.535)	−27.059* (0.000)	−0.088 (0.080)	0.970* (0.000)	−11.42*** (0.009)	−36.34*** (0.043)	0.079 (0.258)	0.979* (0.000)	3.506* (0.000)	−7.410*** (0.052)	−7.300*** (0.030	−2.064* (0.000)	1.248* (0.000)	−3.792*** (0.018)
France	−0.074 (0.662)	0.966* (0.000)	−3.969 (0.903)	−369 (0.437)	−0.015 (0.509)	1.074* (0.000)	−0.074 (0.871)	−2.247 (0.493)	−0.160 (0.144)	0.834* (0.000)	0.754*** (0.006)	1.413 (0.559)	−0.043 (0.605)	0.900* (0.000)	0.197 (0.786)	5.018 (0.410)
UK	−0.000 (0.485)	0.750* (0.001)	0.178* (0.000)	−0.277* (0.000)	0.049 (0.136)	0.832* (0.000)	−7.952* (0.000)	5.740*** (0.007)	0.238*** (0.094)	0.535* (0.030)	−1.983* (0.000)	1.384*** (0.055)	0.086 (0.366)	0.716** (0.002)	0.501* (0.000)	−0.415* (0.000)
Italy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
China	−0.002 (0.881)	−1.614 (0.114)	0.047* (0.000)	−0.111* (0.000)	−0.000 (0.878)	−1.617 (0.113)	−2.007* (0.000)	0.376 (0.272)	n/a	n/a	n/a	n/a	0.109*** (0.003)	−1.514* (0.000)	0.189* (0.000)	−0.176* (0.000)
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

*Significance at the 1% level.

**Significance at the 5% level.

***Significance at the 10% level.

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Table 4. LR tests of restrictions for financial sector during the financial crisis

Variables — Banking sector during the financial crisis

Country	H1: $1/_{12} = 0$	H2: $1/_{13} = 0$	H3: $1/_{14} = 0$	H4: $1/_{15} = 0$	H5: $\beta_{12} = 0$	H6: $\beta_{13} = 0$	H7: $\beta_{14} = 0$	H8: $\beta_{15} = 0$
Germany	78.136* (0.000)	2614.677* (0.000)	14.8933* (0.000)	667.162* (0.000)	87.620* (0.000)	101.487* (0.000)	103.300** (0.002)	28.020* (0.000)
US	35.782* (0.000)	126.860* (0.000)	32.450* (0.000)	13.223* (0.000)	8.3403** (0.003)	4.895*** (0.0269)	0.0211* (0.884)	123.203* (0.000)
Greek	5.893*** (0.015)	104.792* (0.000)	121.235* (0.000)	131.472* (0.001)	16.479* (0.000)	28.864* (0.000)	47.824) (0.000*	76.966* (0.000)
France	165.033 (0.000)	224.077* (0.000)	227.843* (0.000)	218.701* (0.000)	82.527* (0.000)	91.168* (0.000)	91.047) (0.000*	85.463* (0.000)
UK	27.1477* (0.000)	6.1260*** (0.013)	260.593* (0.000)	225.232* (0.000)	86.940* (0.000)	71.450* (0.000)	71.829* (0.000)	80.710* (0.000)
Italy	0.0047* (0.944)	17.895* (0.000)	82.421* (0.000)	31.413* (0.000)	24.592* (0.000)	28.481* (0.000)	70.832* (0.000)	95.674* (0.000)
China	8.894** (0.002)	1.334 (0.2479)	n/a	1.471 (0.158)	35.943* (0.000)	51.341* (0.000)	n/a	71.636* (0.000)
Spain	90.903* (0.000)	94.259* (0.000)	93.450 (0.430)	111.015* (0.000)	10.512* (0.000)	27.618* (0.000)	29.323* (0.000)	13.509* (0.000)

Variables — Financial service during the financial crisis

Country	H1: $1/_{12} = 0$	H2: $1/_{13} = 0$	H3: $1/_{14} = 0$	H4: $1/_{15} = 0$	H5: $\beta_{12} = 0$	H6: $\beta_{13} = 0$	H7: $\beta_{14} = 0$	H8: $\beta_{15} = 0$
Germany	4.090*** (0.0431)	32.4207* (0.000)	36.4790* (0.000)	142.18* (0.000)	199.351* (0.000)	90.123* (0.000)	4.091* (0.000)	67.265* (0.000)
US	22.665* (0.000)	17.819* (0.000)	83.183* (0.000)	11.152* (0.000)	97.329* (0.000)	105.49* (0.000)	79.334* (0.000)	87.010* (0.000)
Greek	467.31* (0.000)	99.771* (0.000)	429.40* (0.000)	111.20* (0.000)	16.299* (0.000)	10.938* (0.000)	46.928* (0.000)	54.259* (0.000)
France	120.663* (0.000)	90.452* (0.000)	13.826* (0.000)	157.18* (0.035)	58.067* (0.000)	72.377* (0.000)	88.977* (0.000)	85.546* (0.000)
UK	500.648* (0.000)	131.24* (0.000)	19.370* (0.000)	110.34* (0.000)	88.112* (0.000)	100.86* (0.000)	96.039* (0.000)	96.494* (0.000)
Italy	91.014* (0.000)	60.117* (0.000)	94.302* (0.000)	4.370*** (0.036)	31.697* (0.000)	12.129* (0.000)	77.208* (0.000)	80.541* (0.000)
China	28.053* (0.000)	38.882* (0.000)	n/a	29.911* (0.000)	91.277* (0.000)	93.298* (0.000)	n/a	92.710* (0.000)
Spain	7.078*** (0.007)	0.0026 (0.958)	19.098* (0.000)	16.012* (0.000)	35.746* (0.000)	10.869* (0.000)	68.533* (0.000)	81.646* (0.000)

Variables — Insurance sector during the financial crisis

Country	H1: $1/_{12} = 0$	H2: $1/_{13} = 0$	H3: $1/_{14} = 0$	H4: $1/_{15} = 0$	H5: $\beta_{12} = 0$	H6: $\beta_{13} = 0$	H7: $\beta_{14} = 0$	H8: $\beta_{15} = 0$
Germany	2.293 (0.1298)	69.018* (0.000)	103.30* (0.000)	101.288* (0.000)	4.091*** (0.043)	175.812* (0.000)	83.767* (0.000)	79.228* (0.000)
US	96.547* (0.000)	70.050* (0.000)	67.49* (0.000)	96.946* (0.000)	79.334* (0.000)	104.961* (0.000)	98.024* (0.000)	112.02* (0.000)
Greek	63.097* (0.000)	81.593* (0.000)	59.37* (0.000)	86.5010* (0.000)	65.052* (0.000)	88.957* (0.000)	73.489* (0.000)	71.160* (0.000)
France	31.779* (0.000)	37.812* (0.000)	38.59* (0.000)	37.782* (0.000)	88.977* (0.000)	71.940* (0.000)	71.059* (0.000)	74.754* (0.000)
UK	42.585* (0.000)	17.933* (0.000)	93.18* (0.000)	26.313* (0.000)	96.039* (0.000)	101.755* (0.000)	82.627* (0.000)	75.727* (0.000)
Italy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
China	84.404* 0.000)	83.568* (0.000)		8.630* (0.003)	73.513* (0.000)	73.022* (0.000)		70.832* (0.000)
Spain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

*Significance at the 1% level.

**Significance at the 5% level.

***Significance at the 10% level.

rate, besides it changes over time, whereas our result shows that this impact remained unchanged during the financial crisis.

Recent search in our study seems to be consistent with that of Beirne et al. (2009) who found that the banking sector in all the major economies is exposed to the stock market returns, to the interest and the exchange rates. In addition, we should notice that the relationship between the exchange rates, the short term interest rates and the banking sector in Spain is negative. This result seems to be consistent with that of Ballester, Ferrer, and Gonález (2010) who found that the volatility of the interest rates has a negative and significant impact on the stock returns of the Spanish banking sector. Similarly, Aloui and Jarboui (2013), show that the exchange rate and the stock returns have an impact on the Tunisian banking sector.

5.2. Result of financial sector stock return effect: during the financial crisis

The result obtained for all countries (see Table 2) can be summarized as follows. In the vast majority of cases there is a statistically significant effect at 1 and 5% levels, respectively with a positive and negative effect of the exchange rate causality, short-term and long-term interest rates and the stock market returns on the banking sector β_{12}, β_{13}, β_{14} and β_{15}. As for the spillovers, we can say that there is a statistically significant and positive effect of the exchange rate volatility, the short-term and long-term interest rates, and the stock market ($1/_{12}$, $1/_{13}$, $1/_{14}$, and $1/_{15}$) on the financial sector, with the exception of some countries where it is insignificant.

Regarding the volatility spillover, we can see a statistically significant effect at 1% and 5% levels, respectively. It is a positive and negative effect of the exchange rate volatility, rate short-term, long-term interest rates, and the stock market on the financial sector (A_{12}, A_{13}, A_{14}, and A_{15}). On the other hand, the exchange rate conditional volatilities and the short-term interest rates are found to be significant with a positive and negative effect on the financial sector B_{12}, B_{13}, and (B_{15}). By contrast, the long-term interest rates and the stock market returns have a significantly positive effect on the conditional volatilities only in a few cases, (notably Germany and the UK) (measured by the parameters (B_{14}).

The results are also consistent with the studies of Beirne et al. (2009) who found that, in most cases, the volatility of the exchange rates, the interest rates, and the stock market performance have either a positive or a negative impact on the financial sector. From Table 2, we can see that unlike the banking sector, the financial sector is very much affected by the volatility of the exchange rates, the interest rates and the stock return. Furthermore, we notice that the volatility of the exchange rates, the interest rates, and the equity returns have a very important impact on the financial sector of the USA and the UK compared to the other countries. This is due to the collapse of the financial sector of the USA and that of the UK which was the main cause of the financial crisis.

5.3. Result of the insurance sector stock return effects during the financial crisis

Table 3 implies that, in the majority of cases, there is a positive and negative effect of the exchange rate volatility, the short-term interest rate, and the stock market returns on the banking sector β_{12}, β_{13}, and β_{15}, with the exception of a significant and positive effect of the long-term interest rates (β_{14}) on the insurance sector. Furthermore, according to Table 4, we can say that there is a statistically significant positive and negative effect of exchange rate volatility, the short-term and long-term interest rates, and stock the market returns on the insurance sector ($1/_{12}$, $1/_{13}$, $1/_{14}$, and $1/_{15}$). Regarding the long-term interest rate ($1/_{14}$), we can say that there is significant and positive effect in all the cases. We can also observe a significant volatility spillover with a positive effect in a few cases from the exchange rate volatility and stock market on the insurance sector (A_{12} and A_{15}).

Inversely, we can find that short-term and long-term interest rates have a significant positive and negative effect (A_{13} and A_{14}) on the insurance sector. Moreover, the exchange rate conditional volatilities and the stock market returns, appear to have a significantly negative effect mainly on the insurance sector B_{12} in a few cases (Greece, the UK, and China) and B_{15} (Greece, the UK, and China).

We can also find a significant positive and negative effect from short-term and long-term interest rates on the insurance sector in some countries B_{13} (Germany, Greece, and the UK) and B_{14} (Greece and UK).

According to this chart, we can see that the insurance sector in the USA is slightly affected by the volatility of the exchange rate, the interest rate, and the fallout from the stock price volatility compared to the other financial and banking sectors. This shows that the financial crisis can be a banking one. In addition, the volatility of the exchange rates, the short- and long-term interest rates seem to be very low. On the other hand, the spillover of the volatility of the stock market prices has a significantly positive effect on the insurance sector in the USA compared to the countries which have a (positive, mixed) impact. This result seems to be consistent with the studies of Beirne et al. (2009) who indicated that the long-term interest rates and the exchange rates have an effect on the financial, banking and insurance sector. Besides, during the crisis, the insurance sector of the UK, China, and Greece was the most affected by the volatility of the exchange rates, the interest rates, and the spillover of the volatility of the stock market prices. For the UK, the volatility of the exchange rates, the interest rates, and the spillover of the stock market prices have a positive and negative impact on the insurance sector. This result seems consistent with the studies of Papadamou and Siriopoulos, 2014 who stated that the interest rates significantly affect the insurance companies. In addition, the German insurance sector is very sensitive to the volatility of the interest rates either in the long- or short-term with a statistically significant and positive relationship. This result seems consistent with the studies of Czaja, Scholz, & Wilkens, 2010 who showed that the insurance sector in Germany is significantly sensitive to the interest rates. In general, most studies found that the volatility of the exchange rates, the interest rates and the volatility of the stock market prices have either a positive or negative impact on the banking, financial, and insurance sector. This effect is very high in these services.

5.4. Results of LR test restrictions for financial (banking, financial, and insurance) sector stock returns during the financial crisis

However, the index returns of the financial sector (i.e. banking, financial, and insurance) are sensitive to the changes in the average market returns, to the interest and the exchange rates, besides they have a positive relationship. Unlike Di Iorio et al. (2006) found that no specific financial sector is less sensitive to neither the short- and long-term interest rates the weak effect of both the exchange rates and the stock market return performance on the financial sector.

Furthermore, these results are consistent with the studies of Beirne et al. (2009) who pointed out that the financial sectors are more sensitive to the short- and long-term interest rates, to the exchange rates and to the stock market returns. The average non-effect of the causality test is represented by (β_{12}, β_{13}, β_{14}, and β_{15}). This shows that the exchange and the short- or long-term interest rates, as well as the stock market returns are significant in all the analyzed countries at 1% level, excepting the USA where the short-term interest rate is significant at 10% (H6), whereas the long-term interest rate is not significant. Hence, hypothesis H7 is rejected). We can therefore conclude that there is a high sensitivity between the index returns in the banking, finance and insurance sector, the market returns, the interest and exchange rates, besides there is a positive relationship.

6. Conclusion

A part from the literature on the causality links between the exchange, the interest rate, and the stock return of financial (banking, financial services, and insurance) sector for a panel of countries during the crisis period, there is no study that examined this interrelationship using the VAR-GARCH-in-mean. The objective of the present work is to fill this research gap by examining the above interaction for eight countries over the period 2006–2009. We have also tested the presence of causality-in-mean and volatility spillovers. Our analysis suggests that (1) there is a causal-in-mean relationship between the exchange rate, the interest rates, and the stock return in most countries; (2) there is a relationship between exchange and the interest rate, and the stock returns in volatility spillovers of most countries.

Overall, the effects of the stock market returns are those that one would expect. As for the interest and exchange rates, the picture which emerges is not equally clear. Nonetheless, long-term interest rate seems to affect the financial sector (financial service and insurance sector). There are also long-term interest rate effects which seem to be most prevalent in the financial service sectors and the insurance sectors, with a much more limited effect on the banking sector. However, the short-term interest rate effects seem to be most prevalent on the banking and the insurance sector, with a much more limited effect on the financial service sector. This also holds for the exchange rate effects, although, in this case, the observed pattern is more easily interpretable in terms of the foreign net position of the concerned financial institutions.

The main implications arising from our study can be presented as follows. First, the empirical results, for the estimation techniques, show that the impact of the stock market returns are those that one would expect. As for the interest and exchange rates, the picture which emerges is not equally clear. Nonetheless, the long-term interest rate seems to have an effect in the financial sector. This also holds for the exchange rate effects, although in this case the observed pattern is more easily interpretable in terms of the foreign net position of the concerned financial institutions. Second, we find that the volatility of the exchange rate, the interest rate and the stock returns have sometimes a positive and sometimes a negative impact on the financial sector (financial service, insurance, and banking). Moreover, we can state that the volatility of the exchange and the interest rates and the stock returns have an effect on the financial (service financial and banking) sector of the US and the European countries. However, the financial sector in China is only affected by the volatility of the market return spillovers on the financial and banking sector during the financial crisis. Then, we show that the volatility of exchange rates, the interest rates, and the stock returns are significant in few cases and have a negative and positive impact on the insurance sector. Moreover, we find that the insurance sector in less important than the service financial and banking sector. In this context, this paper has some policy implications. Concerning, the nature of the impact market, the interest, and the exchange rate risk effects on the financial stock returns could provide valuable information for portfolio management purposes both domestically and internationally. The results suggest that investors should follow the monetary policies more closely to take decisions on their investments since the interest and exchange rates have predictive powers on the bank stock returns and volatility.

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