Economic Modelling 46 (2015) 204–224

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Value-at-risk estimates of the stock indices in developed and emerging markets including the spillover effects of currency market

Jung-Bin Su *

Department of Finance, China University of Science and Technology, No.245, Sec. 3, Academia Rd., Nangang Dist., Taipei 11581, Taiwan, ROC

ARTICLE INFO

Article history:
Accepted 23 December 2014
Available online xxxx

Keywords:
Value at risk
Exponential GARCH model
Generalized t
Spillover effect
Stock market
Currency market
Developed market
Emerging market

ABSTRACT

This study derives the quantiles of the standardized generalized t (GT) in terms of a nonlinear equation which contains a regularized incomplete beta function. Then the quantiles are evaluated by utilizing Secant numerical approach to solve this nonlinear equation. Subsequently, the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model with GT distribution is utilized to estimate the corresponding volatility, and further estimate the value-at-risk (VaR) of seven stock indices in the developed and emerging markets. Empirical results show that, the stylized facts that appeared in most financial assets are seized effectively by this model and negative return and volatility spillover effects significantly subsist from the currency markets to stock markets. Moreover, the stock indices in emerging market have the higher return and the higher risk. As to VaR performance comparison, the modified historical simulation (MHS) and the EGARCH volatility specification significantly affect the VaR forecast performance for stock indices in the emerging market as compared with the developed market. Moreover, the VaR forecast performance of all models with GT is superior to that with normal return distribution only for stock indices in the developed market and only for 99% level. Turning to the whole market, the VaR forecast performance is almost the same as that for the emerging market. Finally, the MHS-EGARCH model with GT distribution is the optimal model to forecast the VaR among these eight models, irrespective of which of the three markets are used. This finding can provide the financial institutions to select an appropriate model to forecast and further control the market risk they faced.

1. Introduction

Since the Asian Financial Crisis in 1997, the relationship between stock prices and exchange rates has received considerable amount of attention from the economists, international investors and policy makers. Moreover, there are two economic theories to depict the relationships between exchange rate and stock price. They are the "flow-oriented" approach[1] (see, Dornbush and Fisher (1980)) and "stock-oriented" approach[2] (see, Branson (1983); Frankel (1983)). The "flow-oriented" approach assumes that the changes in exchange rate will affect the international competitiveness and trade balance for a country. Thus, the "flow-oriented" approach claims that there is a positive linkage between the exchange rate and stock prices. Conversely, under the "stock-oriented" approach the exchange rate is determined by the demand and supply of financial assets such as equities and bonds. Hence, this theory claims that there is a negative linkage between stock prices

* Tel.: +886 2 27864501x16; fax: +886 2 27864574.
E-mail addresses: jungbinsu@cc.cust.edu.tw, jungbinsu@gmail.com.

[1] The "flow-oriented" approach assumes that the changes in exchange rate will affect the international competitiveness and trade balance for a country. That is, if the local currency of a country depreciates, then the products that are exported from this country will become cheaper than before in the international trade. This will conduct the increasing export volume and domestic income. Hence, the competitiveness of domestic firms will increase and the firms' stock prices will rise up since the firms' stock price is evaluated as the present value of the firms' future cash flows. Thus, the "flow-oriented" approach claims that there is a positive linkage between the exchange rate and stock prices.

[2] Under the "stock-oriented" approach the exchange rate is determined by the demand and supply of financial assets such as equities and bonds. Moreover, this approach can be classified as two types of stock-oriented approaches: the portfolio balance and monetary approaches. Regarding the portfolio balance approach (see, Frankel (1983)), the exchange rates, like all commodities, are determined by market mechanism. A blooming stock market would attract capital flows from foreign investors and hence causes an increase in the demand of a country's currency and vice versa. As a result, rising (resp. declining) stock prices are related to an appreciation (resp. depreciation) in exchange rates. Hence, the portfolio balance approach claims that there is a negative linkage between stock prices and exchange rates.

http://dx.doi.org/10.1016/j.econmod.2014.12.022
0264-9993/

and exchange rates. Based on the above-mentioned two theories, it seems that some relation exists between exchange rate and stock price on return and volatility. Regarding this question, the spillover effects on return and volatility between the two markets are often explored in the past literatures (see, Andreou et al. (2013); Caporale et al. (2014); Zhao (2010)). Thus we propose two hypotheses to check the existence of two effects mentioned above. The first hypothesis, $H_0^1 : \phi_{ij} = 0$ vs $H_1^1 : \phi_{ij} \neq 0$, is used to check whether the return spillover effect significantly exists from the jth market to the ith market, and ϕ_{ij} is the return spillover parameter. The second hypothesis, $H_0^2 : \zeta_1 = 0$ vs $H_1^2 : \zeta_1 \neq 0$, is used to check whether the volatility spillover effect from exchange rate market to stock market, and ζ_1 is the volatility spillover parameter.

Additionally, from the empirical results of past literatures, we find that the linkage between these two markets is sometimes negative (see, Granger et al. (2000); Tastan (2006); and Tsai (2012)) or positive (see, Phylaktis and Ravazzolo (2005)), and occasionally unclear (Yau and Nieh, 2006). For example, Granger et al. (2000) utilized the unit root and co-integration models to determine the Granger relations between stock prices and exchange rates, and found that, there significantly exists a relation between stock and foreign rate markets in most of the countries in Asia. That is, exchange rates may lead stock prices, or stock prices lead exchange rates with *negative* correlation, or even there seems subsist a strong feedback relation between them. Tastan (2006) applied a bivariate generalized autoregressive conditional heteroskedasticity (GARCH) framework to reveal the dynamic relationship between Euro and two stock market indices in the United States (the Dow-Jones Industrial Average Index and S&P500 Index), and found that both the exchange rate and equity returns are correlated in a complicated manner. That is, the conditional correlations vary significantly over time, although the unconditional correlation coefficient between Euro and stock market indices is quite low and *negative*. Tsai (2012) utilized the quantile regression model to estimate the relationship between stock price index and exchange rate, and showed that, for six Asian countries, the negative relation between stock and foreign exchange markets is more obvious when exchange rates are extremely high or low. Phylaktis and Ravazzolo (2005) employed the similar theory of Granger et al. (2000) to study the long-run and short-run dynamics between stock prices and exchange rates, and reported that stock and foreign exchange markets are *positively* related in a group of Pacific Basin countries during the period 1980–1998. Yau and Nieh (2006) used various linear and nonlinear, time-series methodologies to investigate the short-term and long-term interrelationships among the stock prices of Taiwan and Japan and the NTD/Yen exchange rate during the period of January 1991–July 2005, and found that, there appears to be *no long-term relation* between NTD/Yen exchange rate and the stock prices of Taiwan and Japan. Pan et al. (2007) examined the dynamic linkages between exchange rates and stock prices for seven East Asian countries, and showed that there exists a significant causal relation from exchange rates to stock prices for the period January 1988 to October 1998. Zhao (2010) employed the same model as Tastan (2006) to investigate the dynamic relationship (i.e. the cross-volatility effects) between Renminbi real effective exchange rate and stock price, and ascertained that there exists the *bi-direction* volatility spillover effects between the two markets, indicating that the past innovations in stock market have the great effect on future volatility in foreign exchange market, and vice versa. Liu and Wan (2012) explored the co-movement between Shanghai stock market and China Yuan exchange rates, and found that stock price and exchange rate are significantly cross-correlated.

From the literature reviews mentioned above, it actually exists in some type of relation between stock and foreign exchange markets. Moreover, according to the framework of the parametric techniques (Jorion, 2000), the values of VaR estimate depend on the conditional mean return and conditional volatility for a stock index. Regarding a specified country, the return and volatility of a stock index respectively are affected by those of a corresponding exchange rate based on the empirical results found in the above literature review or the above-mentioned two theories, the "flow-oriented" and "stock-oriented" approaches. It is reasonable that the VaR of a stock index will be affected by the changes in the corresponding exchange rate for a country. Furthermore, past literatures almost only pay attention to explore the relation between these two markets in price trend, thus this study further applies this concept, the correlation between these two markets, to estimate the value-at-risk (VaR)[3] for the stock indices in developed and emerging markets[4] including the spillover effects of currency market. Additionally, several stylized facts subsist in the return distributions of financial market such as fat-tails and leptokurtosis (see Fama (1965); Jondeau and Rockinger (2003); Mandelbrot (1963); Theodossiou (1998) and so on) and their volatility like volatility clustering, asymmetry and mean reversion, and co-movements of volatilities across assets and financial markets (see Engle and Patton (2001); Jondeau and Rockinger (2003); Poon and Granger (2003)). Consequently, this study employs the asymmetric type of GARCH, the exponential GARCH (EGARCH) of Nelson (1991) with generalized t (GT) of McDonald and Newey (1988) including the volatility of foreign exchange markets as the exogenous variables (EGARCH-x-GT model[5]), to seize the stylized facts such as volatility clustering and asymmetry, and fat-tails and leptokurtosis in the unconditional distributions.

Hence, this paper mainly utilizes the EGARCH-x model with normal and GT distributions, to estimate the corresponding volatility, and further estimate the VaR in terms of different stock indices. Additionally, the GT distribution is a special probability density function and its quantiles are not provided by ordinary econometric software, hence, via the Secant numerical approach[6], we acquire the quantile-operator of the standardized GT distribution by solving a nonlinear equation which contains a regularized incomplete beta function[7]. As to VaR approaches, this work applies the modified historical simulation proposed by Hull and White (1998) (hereafter, MHS) besides the parametric approach widely employed in the past literatures about VaR, thereafter four types of models, namely GARCH-based, EGARCH-based, MHS-GARCH-based and MHS-EGARCH-based models, with two return distribution settings (normal and GT), totaling eight models, are employed to estimate the VaR of seven stock indices, and explore which of the VaR approaches, volatility specifications and return distribution settings can perform the better VaR performance under the constraints of the other two factors within the developed and emerging markets. The study data includes daily prices of the following seven stock indices and their corresponding exchange rates: the United Kingdom's Ftse and Usuk, Switzerland's Swiss and Szus, Japan's N225 and Jpus, South Korea's Kospi and Kous, Singapore's Straits and Sius, Taiwan's Tsec and Taus, and India's Bse and Inus. Turning to the measure of accuracy, both unconditional and conditional coverage tests proposed by Kupiec (1995) and Christoffersen (1998), as well as the dynamic quantile test of Engle and Manganelli (2004), are used to assess the forecasting performance of alternative VaR models mentioned above.

Our results show that, the stylized facts such as fat-tails and leptokurtosis in the return distributions, volatility clustering and

[3] For the definition of VaR, please refer to Jorion (2000). Moreover, the literatures of VaR estimation are quite abundant (see, Angelidis et al. (2004); Rossignolo et al. (2012); So and Yu (2006); Su and Hung (2011), etc.) and we do not make a thorough review here. But the major features of VaR, please refer to Artzner et al. (1999).

[4] An emerging market is a country that has some features of a developed market but is not yet a developed market. It may be a nation with social or business activity in the process of rapid growth and industrialization, and it will be developed markets in the future. Conversely, a developed market is a country that is most developed in terms of its economy and capital markets. This type of country owns high income, but this also includes openness to foreign ownership, ease of capital movement, and efficiency of market institutions.

[5] The empirical model of this study (an asymmetric GARCH model with GT distribution including the volatility of foreign exchange markets as the exogenous variables, EGARCH-x-GT model) is based on the "flow-oriented" approach (see, Dornbush and Fisher (1980)) and "stock-oriented" approach (see, Branson (1983); Frankel (1983)) that depict the relationship between exchange rate and stock price.

[6] See Faires and Burden (2003) for more details.

[7] The detailed derivative procedure is shown in Appendix A.3.