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Empirical analysis of long memory, leverage, and distribution effects for stock market risk estimates

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ABSTRACT

In this study, eight generalized autoregressive conditional heteroskedasticity (GARCH) types of variance specifications and two return distribution settings, the normal and skewed generalized Student's *t* (SGT) of Theodossiou (1998), totaling nine GARCH-based models, are utilized to forecast the volatility of six stock indices, and then both the out-of-sample-period value-at-risk (VaR) and the expected shortfall (ES) are estimated following the rolling window approach. Moreover, the in-sample VaR is estimated for both the global financial crisis (GFC) period and the non-GFC period. Subsequently, through several accuracy measures, nine models are evaluated in order to explore the influence of long memory, leverage, and distribution effects on the performance of VaR and ES forecasts. As shown by the empirical results of the nine models, the long memory, leverage, and distribution effects subsist in the stock markets. Moreover, regarding the out-of-sample VaR forecasts, long memory is the most important effect, followed by the leverage effect for the low level, whereas the distribution effect is crucial for the high level. As for the three VaR approaches, weighted historical simulation achieves the best VaR forecasting performance, followed by filtered historical simulation, whereas the parametric approach has the worst VaR forecasting performance for all the levels. Furthermore, VaR models underestimate the true risk, whereas ES models overestimate the true risk, indicating that the ES risk

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measure is more conservative than the VaR risk measure. Additionally, based on back-testing, the VaR provides a better risk forecast than the ES since the ES highly overestimates the true risk. Notably, long memory is important for the ES estimate, whereas both the long memory and the leverage effect are crucial for the VaR estimate. Finally, via in-sample VaR forecasts in regard to the low level, it is found that long memory is important for the non-GFC period, whereas the distribution effect is crucial for the GFC period. On the other hand, with regard to the high level, the distribution effect is crucial for both the non-GFC and the GFC period. These results seem to be consistent with those found in the out-of-sample VaR forecasts. In accordance with these results, several important policy implications are proposed in this study.

1. Introduction

A financial crisis is defined as some financial assets suddenly losing large part of their nominal value, for example the banking panics in the nineteenth and early twentieth centuries, stock market crashes and the bursting of other financial bubbles, currency crises, and sovereign defaults. In general, governments have attempted to eliminate or mitigate financial crises by regulating the financial sector, for instance making institutions' financial situations publicly known by requiring regular reporting under standardized accounting procedures and ensuring that institutions have sufficient assets to meet their contractual obligations, through reserve requirements, capital requirements, and other limits on leverage. Notably, some financial crises have been blamed on insufficient regulation and have led to changes in regulation in order to avoid a repeat occurrence. However, excessive regulation has also been cited as a possible cause of financial crises. In particular, the Basel II Accord has been criticized for requiring banks to increase their capital when risks rise, which might cause them to decrease their lending precisely when capital is scarce, potentially aggravating a financial crisis. Hence, it is important to control or forecast financial risk precisely. In recent years, value-at-risk (VaR) has been the most well-known risk measure owing to its conceptual simplicity, ease of computation, and ready applicability, resulting in it becoming the generally accepted risk measure for financial risk management. Moreover, it is consistent with the way in which many insurance and other financial institutions currently measure and manage their risk. This makes it more likely that it will be embedded in the business by the general management. However, VaR is not a coherent risk measure since it simply does not satisfy one of the axioms of coherence, the axiom of sub-additivity,[1] whereas another risk measure, expected shortfall[2] (ES), does satisfy this property. Therefore, this type of risk measure is also used in this study. In addition, in order to forecast financial risk precisely, it is important to choose the appropriate model to fit the real financial data well. As shown in the previous literature (see Choudhry, 1997; Fama, 1965; Mandelbrot, 1963; Su & Hung, 2011; Theodossiou, 1998), some features exist in volatility specification, such as volatility pooling, the leverage effect, and long memory, and subsist in the unconditional distributions, like fat tails, leptokurtosis, and a moderate amount of skewness (hereafter, distribution effect), for most financial asset returns series. Moreover, the study data cover the global financial crisis (GFC), thus the study period is divided into two sub-periods, the GFC and the non-GFC period, to explore how the above-mentioned features affect the in-sample risk estimate

[1] This property expresses the fact that a portfolio made of sub-portfolios will risk an amount which is at most the sum of the separate amounts risked by its sub-portfolios. For a sub-additive measure, portfolio diversification always leads to risk reduction, whereas VaR type of risk measure violates this axiom, diversification may produce an increase in their value even when partial risks are triggered by mutually exclusive events.

[2] Expected shortfall (ES) is the expected value of the loss in those cases where it exceeds the predefined confidence level or the VaR (see Yamai & Yoshiba, 2002). Thus the expected shortfall is equal to the average loss a company will suffer in case of situations where losses exceed the predefined confidence level.