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VaR performance during the subprime and sovereign debt crises: An application to emerging markets

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ABSTRACT

Highly volatile scenarios, such as those provoked by the recent subprime and sovereign debt crises, have questioned the accuracy of current risk forecasting methods. This paper adds fuel to this debate by comparing the performance of alternative specifications for modeling the returns filtered by an ARMA-GARCH: Parametric distributions (Student's t and skewed-t), the extreme value theory (EVT), semi-nonparametric methods based on the Gram–Charlier (GC) expansion and the normal (benchmark). We implement backtesting techniques for the pre-crisis and crisis periods for stock index returns and a hedge fund of emerging markets. Our results show that the Student's t fails to forecast VaR during the crisis, while the EVT and GC accurately capture market risk, the latter representing important savings in terms of efficient regulatory capital provisions.

1. Introduction

Recent literature has extensively focused on studying the causes and consequences of the subprime and sovereign debt crisis (Kolb, 2010; Shiller, 2008). The origin of the crisis was the sharp decline of the U.S. housing prices in 2006, triggered by the enormous amount of subprime mortgages contracted in a decade characterized by low interest rates and irrational expectations about the sustainability of real estate market prices. The crisis was amplified by different mechanisms such as the highly leveraged banks,

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the deregulation of the financial system, the growth of securitization, the misbehavior of rating agencies and the so-called 'credit crunch', and it caused the bankruptcy of many investment banks (Bear Stearns and Lehman Brothers) and the bailout of insurance companies (AIG). This situation caused panic in the financial markets, dramatically increased systemic risk and turned into a global financial crisis and a major recession (Mishkin, 2011).

In an attempt to restore the trust in the financial system and impulse the recovery, governments implemented expansive fiscal policies and programs to bail out banks and buy toxic assets. These policies sharply increased public deficits and risk premia in different economies, triggering the European sovereign public debt crisis that rapidly spread to the world economy. Therefore, the subprime and sovereign debt crises had their origin in the United States and the European Union economies but had an impact on emerging markets (EMs hereafter). In this paper we focus on studying the impact of both crises on the EM volatility and risk and testing the performance of alternative methodologies to measure it (Huang and Tseng, 2009).

From a risk management perspective, the crisis increased volatility in the financial markets and demanded new methodologies capable of accurately estimating the regulatory capital of financial institutions. Risk measures are commonly obtained by quantile-based methods (Dowd and Blake, 2006), and among these the most widely used is the Value-at-Risk (hereafter, VaR). Different approaches have been used to compute VaR (Jorion, 2006; Kuester et al., 2006) but there is no consensus on the most appropriate methodology. Former VaR models have been criticized because the normality assumption involves risk underestimation, and thus skewed and heavy-tailed distributions have been proposed (Bali and Theodossiou, 2008; Harmantzis et al., 2006).

The current paper expands on this issue by comparing the performance of VaR forecasts obtained by the normal distribution (benchmark) to four natural candidates that account for the heavy tails of stock returns: the Student's t, a skewed variant of the Student's t distribution (Hansen, 1994), the extreme value theory (EVT) approach (Embrechts et al., 1997; and McNeil et al., 2005) and the semi-nonparametric approach based on the Gram–Charlier (GC) density, which is an expansion around the normal density allowing for skewness and excess kurtosis (Edgeworth, 1907).

The VaR forecasting performance of the models is analyzed for the high volatility scenario of the recent subprime and sovereign debt crises. Furthermore, we compare how VaR measures are affected by the occurrence of extreme events in the areas where the crises started but also on different EM. For this purpose, we analyze six leading world stock indices (MSCI Europe, MSCI USA, MSCI EM, MSCI EM Latin America, MSCI EM Europe and MSCI EM Asia) as well as a hedge fund on EM (Dow Jones Credit Suisse EM). For these indices, historical daily losses are compared to the maximum loss forecasted for each method considering a one-day-ahead horizon. VaR forecasts are computed by assuming an ARMA–GARCH model for the conditional mean-variance and estimating the quantile of the assumed distribution at the 99% confidence level. According to this backtesting procedure (Zumbach, 2006), it is expected that for 1% of the cases (days of the sample) the historical losses will fall outside the estimated VaR. This idea allows a straightforward implementation of VaR backtesting or forecasting performance tests (Christoffersen, 2003). As we focus on measuring the impact of the recent crises on the VaR methodology performance, the backtesting period is divided into two subperiods: (i) pre-crisis and (ii) crisis, the latter including the subprime and the sovereign debt crises periods.

The results show that both normal–GARCH and Student's t–GARCH are inadequate for high confidence levels and high volatility periods, although the skewed Student's t– (skewed-t hereafter) GARCH outperforms the Student's t–GARCH. The GC–GARCH and EVT–GARCH, however, produce accurate VaR forecasts in these contexts. Therefore the optimal VaR model depends not only on the assumed confidence level but also on the market conditions observed. The main contribution of the paper is then the comparison of a wide variety of VaR forecasting methods with the scarcely used GC–GARCH during the recent crisis and, particularly, for EM stock indices. We also include a hedge fund on EM and analyze the savings incurred by fund managers in terms of the accuracy of regulatory capital provisions when using our proposed GC–GARCH model.

The rest of the paper is organized as follows: Section 2 presents the models and VaR methodology, Section 3 analyzes the data and the empirical results on VaR forecasting, and Section 4 summarizes the main results of the paper.