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Introduction

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STATISTICS

The Impact of Skewness and Kurtosis for VaR Calculation

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Abstract. *This paper investigates the effect of skewness and kurtosis in the calculation of Value-at-Risk for non normal distribution returns. We consider the method Modified Value-at-Risk (MVaR), using the standard and the skewed Student-t distribution and applying the Cornish-Fisher expansion. We also consider the effect of non constant volatility by applying GARCH models. We apply this method for several stocks listed in Indonesian capital market.*

Keywords: Modified Value-at-Risk, skewed Student-t distribution, Cornish-Fisher expansion, GARCH models.

1 Introduction

In this paper we investigate the influence of skewness and kurtosis in the calculation of Value-at-Risk (VaR) for the stock return data under non normal distribution assumption by meaning of Modified Value-at-Risk (MVaR). Under normality assumption, MVaR has been discussed by several researchers, see e.g., (Bodson, Coen & Hubner, 2008; Boudt, Peterson & Croux, 2007). In this paper, we consider MVaR calculation using the Cornish-Fisher expansion under the assumption of Student-t distribution.

Furthermore, to observe the effect of skewness and kurtosis in VaR calculation, we also consider the assumption of skewed Student-t distribution, which is able to describe the asymetricity of stock return data often found in practice. We further consider the effect of non constant volatility by applying GARCH models. Finally, we apply the methods above to analyze the risk of several stocks that are traded in the Indonesian capital market.

The rest of this paper is described as follows. In section 2, we describe the methodology used in calculation. In section 3, we provide empirical example using real data. Last section concludes.

2 Methodology

2.1 MVaR for Student-t Distribution

We use R to represent random variables and r to express the value of the log asset return. Next, note that the standardized Student-t random variable will have the probability density function given as:

$$f(r\,|\,v)=c\left(1+\frac{r^2}{v-2}\right)^{-(v+1)/2} \quad ;\ -\infty<r<\infty \tag{1}$$

where $c=\Gamma\{(v+1)/2\}/\sqrt{\pi(v-2)}\Gamma(v/2)$, and v denotes the degree of freedom.

Let D denote the differential operator, and $D^j f(r)=d^j f(r)/dr^j$. The differential order j of $f(r\,|\,v)$ can be expressed as $D^j f(r\,|\,v)=P_j(r\,|\,v)f(r\,|\,v)$, where

$$P_1(r\,|\,v)=-2\left(\frac{v+1}{2}\right)\frac{r}{(v-2)}\left(1+\frac{r^2}{v-2}\right)^{-1},$$

$$P_2(r\,|\,v)=+4\left(\frac{v+1}{2}\right)^2\frac{r^2}{(v-2)^2}\left(1+\frac{r^2}{v-2}\right)^{-2}-2\left(\frac{v+1}{2}\right)\frac{1}{(v-2)}\left(1+\frac{r^2}{v-2}\right)^{-1}+4\left(\frac{v+1}{2}\right)\frac{r^2}{(v-2)^2}\left(1+\frac{r^2}{v-2}\right)^{-2},$$

$$P_3(r\,|\,v)=-8\left(\frac{v+1}{2}\right)^3\frac{r^3}{(v-2)^3}\left(1+\frac{r^2}{v-2}\right)^{-3}+24\left(\frac{v+1}{2}\right)^2\frac{r^3}{(v-2)^3}\left(1+\frac{r^2}{v-2}\right)^{-3}-12\left(\frac{v+1}{2}\right)\frac{r}{(v-2)^3}\left(1+\frac{r^2}{v-2}\right)^{-2}$$