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Exploring Stock Return Discontinuities in the Japanese Banking Industry

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Abstract

This study examines stock return discontinuities in the Japanese banking sector, and we derive the following interest findings. First, our statistical tests evidence that our extended econometric model incorporating a fat-tailed and skewed density and considering return discontinuities is highly effective for estimating the Japanese banking sector stock return volatilities more accurately. Second, the estimated volatilities for the Japanese banking sector stock returns from our extended model incorporating a fat-tailed and skewed density and considering return discontinuities sharply increase during the Lehman crisis and the European debt crisis and at the time of Brexit and the COVID-19 crisis.

Keywords: COVID-19, return discontinuity, risk management, volatility

1. Introduction

Recently, there were strong shocks connected with COVID-19 in international stock markets and entire economy, and they demonstrated the importance of return discontinuities in international equity markets. For instance, due to the COVID-19 shocks, in March 2020, the US S&P 500 index largely fell, and the US volatility index sharply increased, where there were clear stock return discontinuities.

In many industries, the banking sector is the core financial sector and particularly important for entire economy, and volatilities are also crucial for risk management. In addition, the Japanese banking sector still plays highly important role in Asia. We note that there are previous studies on stock return discontinuities (e.g., Ewing and Malik, 2016; Adesina, 2017); however, to our best knowledge, there is little existing research that examined the linkages between stock return discontinuities and volatilities in the Japanese banking sector.

Given these, our research question in this paper is how then return discontinuities are related to the volatility estimations in the Japanese banking sector? Considering these, this study quantitatively examines the return discontinuities in the Japanese banking sector and derives the following interest findings. First, our statistical tests reveal that our extended econometric model incorporating the skew-*t* density and considering return discontinuities is highly effective for estimating the Japanese banking sector stock return volatilities more accurately. Second, the estimated volatilities from our extended econometric model incorporating the skew-*t* density and considering return discontinuities increase in the Japanese banking sector during the Lehman crisis, during the European debt crisis, at the news of Brexit, and at the time of the COVID-19 crisis.

The rest of this article is organized as follows. Section 2 reviews related existing studies, and Section 3 explains the data. Afterwards, Section 4 presents our models, Section 5 describes our results, and Section 6 concludes the paper.

2. Literature review

This section briefly reviews existing research by focusing on the recent studies. First, Ewing and Malik (2016) investigated the volatility spillover effects between oil and stock markets by considering return discontinuities. Adesina (2017) empirically examined the effect of return discontinuities on the volatility persistence of the UK FTSE 100 index returns by focusing on the period including the Brexit vote.

Further, Smith (2017) estimated US equity premium applying a Bayesian model by taking stock return discontinuities into account. Moreover, Tsuji (2018) investigated spillover effects between international oil equities, where the effects of return discontinuities were only partly considered. Yin (2019) studied the US equity premium, also by taking stock return discontinuities into consideration.

Afterwards, Tsuji (2020) empirically examined spillover effects between international banking sector equities, where the effects of return discontinuities were again partly considered. As above, we understand that there is previous research analyzed return discontinuities in equities; however, extant studies that focused on the effects of return discontinuities on volatility estimations for the Japanese banking sector like our present study are limited. Hence, in this paper, by focusing on the important Japanese banking sector, we investigate the effects of return discontinuities on volatility estimations in the framework of generalized autoregressive conditional heteroscedasticity (GARCH) analysis.

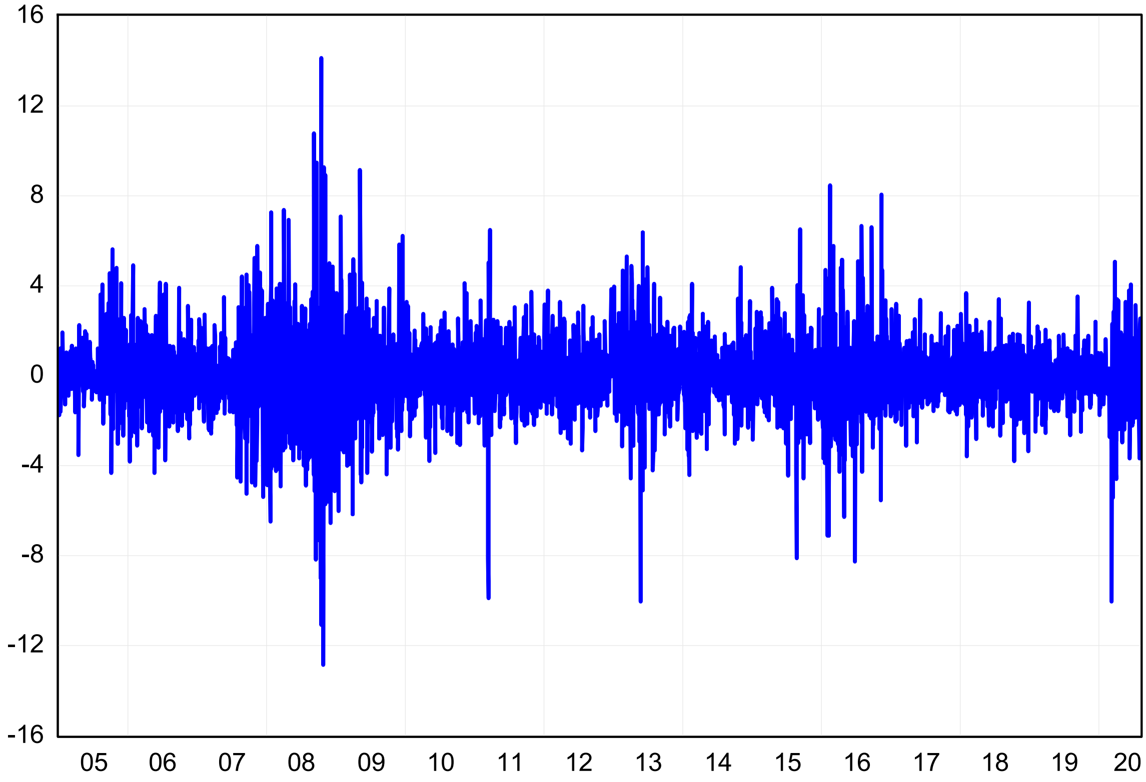

Figure 1. Return evolution of the Japanese banking sector stocks

3. Data

This study investigates the daily returns of the Japanese banking sector stock price index, and the index data are in Japanese yen. Using the Japanese banking sector index prices, we compute and examine the daily log difference percentage returns in this study. Figure 1 shows the dynamic evolution of the Japanese banking sector stock returns, and we identified their return discontinuities by applying the iterated cumulative sums of squares algorithm as in Ewing and Malik (2016) and Tsuji (2020).

The sample period for the Japanese banking stock returns is from January 4, 2005 through to August 10, 2020, and during the period, we found nine points of return discontinuities for the return series. Table 1 shows descriptive statistics for the Japanese banking stock returns. As exhibited, return series show the larger value of kurtosis, 9.170, than that of normal distributions, meaning the Japanese banking stock returns have fat tails. Table 1 also indicates that the normality of the Japanese banking stock returns is strongly rejected by the Jarque–Bera statistic. These return characteristics show the necessity of considering at least fat-tailed distributions when investigating these series.

Table 1. Summary statistics for the daily log banking stock returns in Japan

Statistic	Value	Statistic	Value
Mean	−0.023	JB	6456.08
SD	1.729	*p*-value	0.000
Skewness	0.009	ADF	−60.427
Kurtosis	9.170	*p*-value	0.000

Note. SD: standard deviation; JB: Jarque–Bera statistic; ADF: augmented Dickey–Fuller test statistic.

4. Models

To consider the effects of return discontinuities on volatilities, we use standard and extended Glosten–Jagannathan–Runkle GARCH (GJR-GARCH) models (Glosten et al., 1993), which take return discontinuities and fat-tailed and skewed densities into account. First, the standard GJR-GARCH model without considering return discontinuities is specified as follows:

$$ret_t = \lambda_0 + \sum\nolimits_{i=1}^{p} \lambda_i ret_{t-i} + \tau_t, \tag{1}$$

$$\sigma_t^2 = c + g\sigma_{t-1}^2 + a\tau_{t-1}^2 + bI_{t-1}\tau_{t-1}^2. \tag{2}$$

In Equation (1), ret_t denotes the Japanese banking sector stock return at time t, ret_{t-i} denotes the i-th lag of the Japanese banking sector stock return, and τ_t denotes the error term. For the error term, we examine normal distribution errors, Student-t distribution errors, and skew-t distribution errors. In Equation (2), σ_t (σ_{t-1}) is the Japanese banking sector stock return's volatility at time t ($t-1$), and $I_{t-1} = 1$ if the error term $\tau_{t-1} < 0$ and 0 otherwise.

Next, we specify the extended GJR-GARCH model, which considers return discontinuities as follows:

$$ret_t = \lambda_0 + \sum\nolimits_{i=1}^{p} \lambda_i ret_{t-i} + \tau_t,$$

$$\sigma_t^2 = c + g\sigma_{t-1}^2 + a\tau_{t-1}^2 + bI_{t-1}\tau_{t-1}^2 + \sum\nolimits_{i=1}^{m} dum_i D_{i,t}. \tag{3}$$

The mean equation of this model is the same as Equation (1), and in this model, the only difference between Equations (2) and (3) is the presence of the last term, where $D_{i,t}$ are dummy variables for the return discontinuities. Regarding the last term, $D_{i,t} = 1$ from the i-th return discontinuity point onwards and 0 elsewhere, and m is the number of the return discontinuities we identified. In Equation (3), the other notations are the same as in Equation (2). Further, in Equations (2) and (3), the parameter a captures the ARCH effect, the parameter g indicates the GARCH effect, and the parameter b captures the asymmetric return shock effects on volatilities.

Table 2. Estimation results of the GJR models with or without return discontinuities

	Panel A. With normal distribution errors	Panel B. With skew-*t* errors	Panel C. With skew-*t* errors and considering return discontinuities
c	0.046**	0.048**	0.083**
p-value	0.000	0.000	0.000
a	0.043**	0.046**	0.028**
p-value	0.000	0.000	0.010
g	0.898**	0.891**	0.748**
p-value	0.000	0.000	0.000
b	0.093**	0.107**	0.155**
p-value	0.000	0.000	0.000
dum_1			0.505**
p-value			0.000
dum_2			−0.370**
p-value			0.000
dum_3			0.973**
p-value			0.000
dum_4			2.630*
p-value			0.035
dum_5			−3.165*
p-value			0.017
dum_6			−0.353**
p-value			0.002
dum_7			0.272**
p-value			0.007
dum_8			−0.402**

p-value			0.001
dum_9			0.439*
p-value			0.013
DOF		5.535**	6.312**
p-value		0.000	0.000
LS		0.046*	0.062**
p-value		0.015	0.001
LL	−7361.238	−7251.205	−7204.147

Note. ** and * denote 1% and 5% significance levels, respectively.

DOF: degrees of freedom parameter of skew-*t* errors

LS: log value of skewness parameter

LL: log-likelihood value.

5. Results

5.1 LR Tests

Before estimating our quantitative models, using the likelihood ratio (LR) tests, we first inspect the GJR models by considering normal, Student-*t*, and skew-*t* distribution errors and stock return discontinuities. As a result, for the Japanese banking sector stock returns, our LR tests find as follows.

First, the GJR model with Student-*t* errors is statistically significantly superior to that with normal distribution errors. Second, the GJR model with skew-*t* errors is statistically significantly superior to that with Student-*t* errors. Third, the GJR model with skew-*t* errors and considering return discontinuities is statistically significantly superior to that with skew-*t* errors ignoring return discontinuities.

That is, according to our LR tests, we understand that in the three models, the best model to derive the Japanese banking sector stock return volatilities is the GJR model with skew-*t* errors, which takes return discontinuities into account.

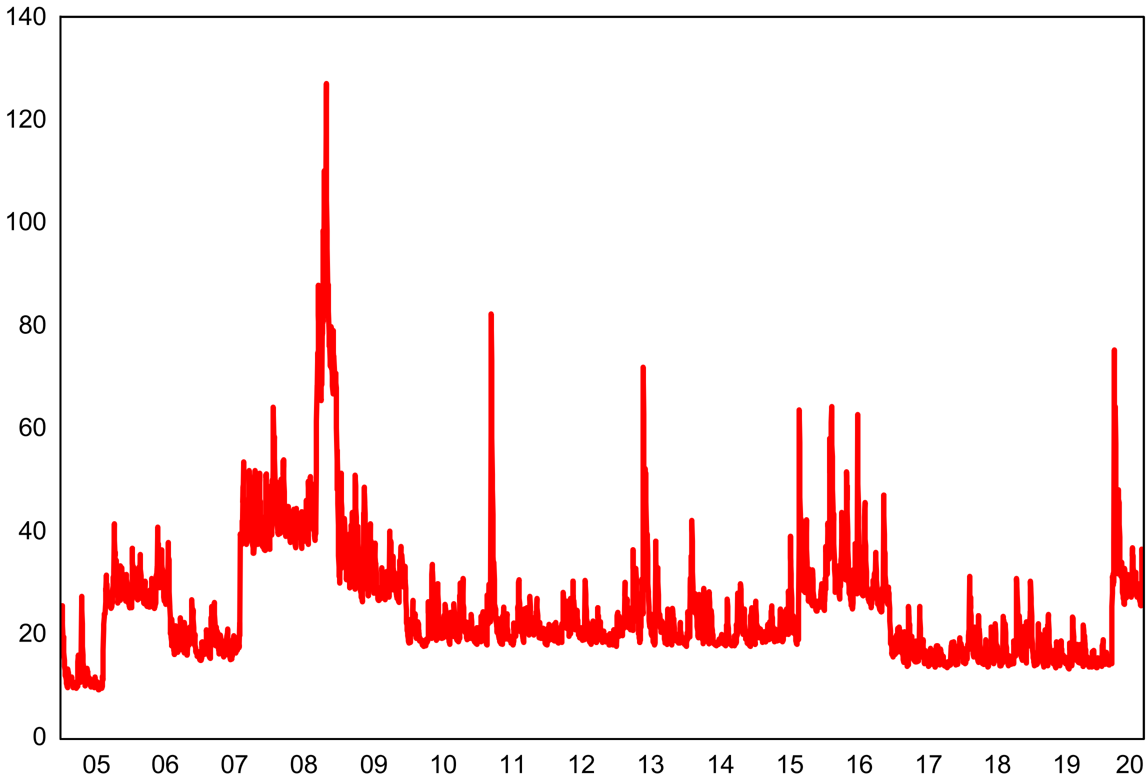

Figure 2. Annualized Japanese banking stock return volatilities estimated by considering return discontinuities

5.2 Model Estimations

Table 2 shows the estimation results for the three GJR models, i.e., the GJR model with normal distribution errors (Panel A), that with skew-*t* errors (Panel B), and that with skew-*t* errors and considering return discontinuities (Panel C). As Panel A shows, in the GJR model with normal distribution errors, the estimated parameters of ARCH (a), GARCH (g), and volatility asymmetry (b) effects are all statistically significant.

Next, as Panel B indicates, in the GJR model with skew-*t* errors, the estimates of a, g, and b parameters are again all statistically significant. Further, Panel B exhibits that the estimated degrees of freedom (DOF) parameter for the skew-*t* density is statistically significant, with a value of 5.535, and the estimated log value of skewness parameter (LS) is also statistically significant. These results show the effectiveness of incorporating the heavy-tailed and skewed skew-*t* density into our extended GJR models in capturing the fat tails and skewness of the Japanese banking sector stock returns.

In Panel C, once again, all the estimates of a, g, and b parameters are statistically significant, and the estimated DOF parameter for the skew-*t* density is again statistically significant, with a value of 6.312, and the estimated log value of skewness parameter (LS) is again statistically significant. These results again prove the effectiveness of incorporating the skew-*t* density into our GJR models for capturing the fat tails and skewness of the Japanese banking sector stock returns.

Moreover, Panel C further exhibits that all the dummy variable parameter estimates for return discontinuities, dum_1 to dum_9, are statistically significant. We consider that this demonstrates the effectiveness of considering return discontinuities for modeling the Japanese banking stock return volatilities.

5.3 Volatility Estimates

We next examine the volatility estimates considering return discontinuities. Figure 2 presents the volatility estimates from our extended GJR with skew-*t* errors and considering return discontinuities. Figure 2 clearly shows the following evidence for the Japanese banking sector. First, the estimated volatilities particularly jump during the Lehman crisis. Second, the estimated volatilities increase during the European debt crisis. Third, the estimated volatilities also rise at the news of Brexit. Fourth, the estimated volatilities jump at the time of the COVID-19 crisis.

As above, Figure 2 clearly demonstrates that considering return discontinuities enables us to capture the volatility increases more accurately at the time of risky events that upset the Japanese banking industry. The estimated volatilities shown in Figure 2 are from our best GJR-GARCH model, that is, the GJR-GARCH model with skew-*t* errors and considering return discontinuities. Hence, we consider that the volatilities presented in Figure 2 can more precisely capture the risks in the Japanese banking sector. Therefore, we emphasize that in practice, we should use such volatilities for the risk management in the banking industry in Japan.

6. Conclusions

This study quantitatively explored return discontinuities in the Japanese banking sector, and we derived the following interest findings. First, our LR tests clarified that our extended GJR model incorporating the skew-*t* density and considering return discontinuities is highly effective for estimating the Japanese banking sector stock return volatilities more precisely. Second, the estimated volatilities from our extended GJR model incorporating the skew-*t* density and considering return discontinuities sharply increase in the Japanese banking sector during the Lehman crisis, during the European debt crisis, at the news of Brexit, and at the time of the COVID-19 crisis.

We note that for other assets than equities, return discontinuities examined in this study are also important (e.g., Ahmad and Aworinde, 2016; Li et al., 2020). In addition, although not reported, we also investigated by employing similarly extended exponential GARCH (EGARCH) models, and all the results from such extended EGARCH models were much the same. Hence, we emphasize that all our results demonstrated in this paper are highly robust and significant. We therefore trust that the new evidence and imprecations provided in this paper will contribute to not only academic research but also practical financial risk management in all related industries.

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