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MODELING ASSETS PRICING USING PURE JUMP INVERSE-GAUSSIAN PROCESS

***[1]Ianngi Gabriel Ornguga, [2]Saidu S. Abdulkadir, [2]Emmanuel Torsen and [3]Nelson Pandi Sabo**

[1]Monitoring and Evaluation, JHPIEGO-RISE Project, ST. Monica Health Centre Yakoko, Taraba State, Nigeria
[2]Department of Statistics and Operations Research, Modibbo Adama University Yola, Nigeria,
[3]Department of Economics, College of Social and Management Sciences Adamawa State Polytechnic Yola

*Corresponding authors' email: orngugaianngi@gmail.com

ABSTRACT

In general, stock price changes are rare occurrences, and a Poisson process can be used to describe those price changes. This study focuses on asset price modeling utilizing just jump Inverse-Gaussian processes. The goals are to analyze the price-movement patterns of the stock and gauge its relative volatility using the Inverse-Gaussian jump model. The Inverse-Gaussian jump model was employed to analyze the data. The outcome from Table 2 shows that there are more jumps than zero in the estimation of the inverse Gaussian process. This implies that the stock has been continuously rising. For Nestle Nigeria Limited (628.15), BCC (131.27), NB (110.6), 7UP (79.944), and Guinness (79.944), the average percentage increase in stock price is exceptionally high. The estimated model demonstrates that jump risk can be diversified. It is significantly different for all variables, according to the computed goodness of fit (Chi Square) test. This demonstrates unequivocally that there are daily increases in stock prices. As a result, we draw the conclusion that stock prices have increased recently. The analysis suggests that investors recognize that Nigerian stocks are producing strong returns regardless of stock market trends. To attract more stockholders, more efforts should be made to boost their production.

Keywords: Assets price, Inverse-Gaussian, Jump

INTRODUCTION

A stock market is a solid legal structure that makes it possible to trade shares of companies in a nation (Davou *et al*., 2013). A rising stock market is a sign that the economy of the nation is doing well. Investment growth is correlated with rising share prices, while investment declines are correlated with falling share prices. Investment growth is correlated with rising share prices, while investment declines are correlated with falling share prices. Everyone who invests in the stock market hopes to make money, but because it is a highly volatile financial market, the success or failure of the investor largely depends on the choices he makes, which in turn depend on his understanding of the stock market and strategies or models he uses to predict price movements that may occur as a result of numerous different factors. Numerous research revealed that, depending on how strongly they influence particular markets, macroeconomic factors of the economy have an impact on the stock market. As a result, an investor must constantly monitor the stock market's behavior and the results that are produced as a result of the fluctuation of these variables; an investor must also be aware of the actions he must take and the timing of those actions in order to maximize profit while minimizing risk when risk elimination is not possible (Davou *et al.*, 2013).

The geometric Brownian motion for the price dynamic asset is the model that is most frequently employed in option pricing theory. The model is still disputed as failing to account for unanticipated changes in asset prices. Because there are stocks available on the market, the price increase is crucial. The development of returns over time is defined by the diffusion processes (Chekenya, 2019).

The empirical demonstrations of the estimate techniques for jump diffusion models were presented by Kumar and Vellaisamy (2012) and Barndorff-Nielsen (1997). Significant probabilistic models for assessing financial data include the arbitrage-free dynamics of asset prices and interest rates. The model is employed for the predictable periods, when the method's breakdowns approach a counterintuitive beginning point (Vellaisamy and Kumar 2017).

The jump model is a well-known asset price concept in the marketplace. The initial form is the movement that causes regular price changes, whereas the second form is the shape of a rare occurrence that influences a stock's price to increase. The Nimalendran (1994) jump model, which uses the arbitrage-free dynamics of asset prices and interest rates, is an important probabilistic model for analyzing financial data.

A study on the function of the initial time passage density for diffusion processes was conducted by Atiya and Metwally in 2002. The study found that the field of stochastic processes has attracted significant scientific attention since its inception. Previous research in finance has rekindled interest in stock price rises since these processes can be used to solve a variety of financial issues.

In their investigation of an Inverse-Gaussian process, Vellaisamy and Kumar (2018) were able to determine the procedure's distribution functions. This distribution is a result of a wiener process with float supremum.

Punzo (2018) used submissions to economic data to do research on a novel component of the normal distribution. The study showed that financial data are consistently optimistic and that it is absolutely necessary to take into account the distribution's uniqueness when choosing a model.

Ajao and Igbinosa (2014) compared the three-factor and capital asset pricing models used in the Nigerian stock market. Through a comparison of the three-factor model and the capital asset pricing model, their study identified the risk factors in asset pricing in the Nigerian Stock Market. The analysis's findings showed substantial correlations between predicted portfolio returns and excess stock market returns, as well as between firm size and book-to-market equity variables. This suggests that in the Nigerian stock market, the three-component Fama and French model explains the variation in stock returns better than the single factor CAPM.

Testing of Downside Risk Measures was the subject of a study undertaken by Tamara (2017), Using GMM two-step simple and multiple regressions, statistical testing of standard CAPM, Fama French CAPM, and D-CAPM on a set of indices and portfolios was conducted. Results showed that traditional beta tends to underperform downside beta on average in both developing and developed economies. Overall, as several research publications including this master's thesis have demonstrated that beta is not constant over time, confirming a common finding of non-constant volatility, unconditional models should not be the focus of discussion.

Abidin and Jaffar (2013) showed that the GBM can only be used to forecast closing prices for up to two weeks, which is a disadvantage because investors won't have long-term predictions of a stock's price. They suggest changing and adapting the Analytic Hierarchy Process (AHP) paradigm in their article. The case study findings demonstrate that the suggested model is capable of classifying stocks and calculating the proportion of capital investment. As a result, it can help investors make decisions and lower the chance of losing money when investing in the stock market.

MATERIALS AND METHOD

Data

The selection of eleven (11) stocks listed on the Nigerian stock exchange involved the use of a purposive sampling technique. The chosen stock consists of daily results from January 2008 to December 2017, which suggests that there are 2475 observations per person in the stock. Data from a secondary source was used. The daily returns for each firm were evaluated and taken from a wide range of sources, with the Nigerian Stock Exchange's internal documents (www.nse.com.ng/data and www.cbn.gov.ng/statbulletin) serving as the primary source.

Theoretical Framework

Fisher (1999) takes into account the post-Jump likelihoods following the 1987 shock. The findings showed that Jump periods in the past could be connected to an uneven total of updates related to craft imbalances. Kim *et al*. (1994) study of the rising component of the multivariate backdrop. They noticed that the first Market Catalogue's stocks contain a jump element.

Model Specification

The concept presupposes that a continuous-time dynamic model with an instantaneous return is followed by an asset price S(t) Kou (2002).

$$\frac{dS(t)}{S(t)} = \mu_k(t)dt + \sigma_k dBt + P(t)dN(t), \qquad t \geq 0 \tag{1}$$

Where

$S(t)$ Is the price of asset at time t

$\mu_k(t)$ Is the expected rate of return per unit time

σ_k Is the instantaneous standard deviation of the rate of return

B_t Represent the Brownian motion.

$P(t)$ Represent the inverse Gaussian distributionthat has mean μ with variance σ^2 and $N(t)$, is a Poisson process with λ as rate of return.

$$S(t) = S(0)\exp(\mu t + \sigma Bt)\prod_{k=1}^{N(t)}(1 + P(T_k)) \qquad (t \geq 0) \tag{2}$$

Where $\mu = \sigma - \frac{1}{2}\sigma^2$ the T_k denote the times of the successive events of the Poisson process and the product term is interpreted as unity when N(t)=0. Since the solution reduces to geometric Brownian motion in the case where λ=0 and the N(t) are all identically zero, the product term clearly shows the effect of the component $P(t)dN(t)$

Estimation Procedure

The jump diffusion model presupposes that the continuous-time dynamic model with rapid return is followed by the asset price S(t). In this study, we estimate stock prices under inverse Gaussian (IG) processes and compare them to those estimated under the Brownian and jump-diffusion models. EasyFit software version 5.6 was used to produce the estimate for the jump model.

RESULTS AND DISCUSSIONS

Descriptive Statistics

The eleven (11) stocks listed on the Nigerian Stock Exchange were the subject of this study. The information on the stock prices of the eleven companies listed, including 7up Bottling Company, Afrpaints, Berger, Conoil, Flourmill, Guinness, Nigerian Breweries (NB), and Nestle Nig. ltd, PZ, and Vitafoam were taken from the daily list made accessible by the Nigerian stock exchange (Cashcraft Asset Management Limited) from 2008 to 2017, therefore we have 2475 observations for each stock. Using EasyFit version 5.6, the jump model estimate was computed.

Table 1: Summary statistics of daily returns of 11 stocks from 2008-2017

Stocks	Mean (%)	Std. Dev. (%)	Skewness	Excess Kurtosis	Std. Error	Range
7up	0.7994	0.4960	0.96031	-0.4679	0.99703	170
AFRPAINTS	0.0296	0.0038	0.20072	-1.3233	0.00766	1.14
BCC	1.3127	0.6439	-0.13842	-1.1108	1.2944	235.99

BERGER	0.0844	0.0230	0.21222	1.7304	0.04625	16.52
CONOIL	0.4401	0.2487	1.8739	3.7753	0.49984	154.53
FLOURMILL	0.5244	0.2571	-0.01378	-1.4643	0.51685	98.24
GUINNESS	1.6099	0.6194	0.30738	-1.0425	1.2451	237.41
NB	1.106	0.4515	-0.13411	-1.3536	0.90748	164.39
NESTLE	6.2815	3.3229	0.22124	-1.1326	6.6793	1451.5
PZ	0.2730	0.0760	0.25414	0.08274	0.15267	48
VITAFOAM	0.049	0.0217	1.7495	3.6154	0.04362	13.36

Percentages are used to report the summary statistics. Looking at Table 1, it is apparent that the stock's daily return has a mean of 0.7994%, a variance of 0.4960%, a skewness of 0.96031, a kurtosis of -0.4679, a range return of 170, and a standard error of 0.99703. The majority of indices are positive, with the exception of three that have a negative skew: BCC (-.13842), Flourmill (-.01378), and NB (-.13411). It appears that all indicators have positive skewness during the study period. Additionally, Conoil (1.8739), Vitafoam (1.7495), and 7UP all have significant positive skewness values (0.96031). BCC has the highest negative skewness, with a negative skewness of (-0.13842). The two largest stocks above the value of the Kurtosis are Conoil (3.7753) and Vitafoam (3.6154), whereas two distributions Berger (1.7304) and PZ are less peaked (0.08274).

Empirical Results

Table 2: Appraisals of the diversified inverse Gaussian process on daily returns of stock

	Inverse Gaussian jump process			**Wiener process**		**Goodness of fit**
Stocks	**μ**	**σ**	**λ**	**μ**	**σ**	**Chi Square**
7UP	79.944	49.601	207.67	0.80	0.50	1267.3**
AFRPAINTS	2.9611	0.38088	178.98	0.03	0.004	1408.8*
BCC	131.27	64.394	545.46	1.31	0.64	1655.5*
BERGER	8.4449	2.3011	113.74	0.08	0.02	208.01*
CONOIL	44.013	24.867	137.88	0.44	0.25	326.31**
FLOURMILL	52.442	25.713	218.13	0.53	0.26	1616.4**
GUINNESS	79.944	49.601	207.67	1.61	0.62	481.07*
NB	110.6	45.146	663.78	1.11	0.45	1204.1*
NESTLE	628.15	332.29	2244.6	6.28	3.32	1500.3*
PZ	27.296	7.5951	352.56	0.27	0.08	125.99*
VITAFOAM	4.9259	2.1701	25.382	0.05	0.02	342.38**

The estimate of daily returns is given by μ, and standard deviation of return is given by σ; the amount of jump is given by λ. The estimated parameters μ and σ are reported in percentage terms. The final column gives the goodness of fit (Chi Square) test which shows that jump risk is diversifiable. The estimated parameters from the stochastic process (4) are displayed together with the corresponding goodness of fit (Chi Square) test. From Table 2, we observed the number of jump in price of an assets that are different from zero, they are; Nestle (628.15), BCC (131.27), NB (110.6), 7UP (79.944) and Guinness (79.944) are very large numbers compare with those from other studies.

Estimate of the jump size show an expected positive value. The goodness of fit (Chi Square) test for the listed stocks are all significant which clearly indicate the existence of jumps in price of stocks per day. From the aforementioned it can be deduced that the model shows agood fit to the data. The goodness of fit (Chi Square) test shows significant different for all variable, therefore we conclude that there is presence of jump in the market portfolio.

CONCLUSION

The appraisals of inverse Gaussian process take a number of jumps that are greater than zero. This suggests the continuous jump in the stock. The average jump in price of stock, for Nestle Nig. Ltd (628.15), BCC (131.27), NB (110.6), 7UP (79.944) and Guinness (79.944), are very large numbers. The estimated model shows that it is possible to diversify jump risk. The computed goodness of fit (Chi Square) test shows that it is momentous different for all variables. Therefore, we conclude that presence of jump in price of stock in the market.

POLICY RECOMMENDATIONS

Based on conclusion the following recommendations were made;

i. We recommend that there should be large capitalization and a lot of listed companies in Nigeria capital market in other to attract more stockholders.
ii. Regardless the behaviours of Nigerian stock markets, we realized that Nigeria stocks are driving up a better return. Notwithstanding, Nigerian stock markets should improve their performance to attract more investors.

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