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บทคัดย่อ

เพื่อความมั่นคงทางการเงินนอกจากการออมเงินแล้ว อีกผลิตภัณฑ์ทางการเงินหนึ่งที่น่าสนใจคือการลงทุนในหุ้น ซึ่งนอกจากจะเป็นการออมเงินไปในตัวแล้วการเพิ่มขึ้นของมูลค่าของราคาหุ้นที่ลงทุนยังเป็นการเพิ่มพูนจำนวนเงินให้มากขึ้นด้วย อย่างไรก็ตามการลงทุนในหุ้นนั้นจะต้องมีการตัดสินใจจากการพิจารณาแนวโน้มของราคาหุ้นว่าจะเพิ่มขึ้นหรือไม่เพื่อให้ได้ผลตอบแทนในมูลค่าการลงทุน สำหรับบทความนี้ได้นำเสนอการจำลองราคาหุ้นด้วยกระบวนการสโตแคสติกและนำไปวิเคราะห์หุ้นจริงเพื่อสาธิตให้เห็นประโยชน์ของการประยุกต์ใช้คณิตศาสตร์ในการตัดสินใจลงทุนในหุ้น

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Academic Article

Stock price simulation with stochastic processes

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Abstract

For financial security, regardless of saving money, another interesting financial product is investing in stocks. In order to save money, the increase in the value of the stock price also increases the amount of money. However, investing in stocks must be decided by considering the tendency of the stock price that it increases or not in order to receive returns on investment values. For this article, stock price simulations with stochastic processes have been presented and used to analyze real stocks to demonstrate the benefits of applying mathematics in investing in stocks.

Keywords: Stochastic process, Simulation, Stock price.

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Introduction

Investing in the stock market is another option to generate income and is considered to play a part in contributing to the development of the capital market and the overall economy of the country. However, the stock price in the stock market has changed every day, making it impossible to know whether the future stock price will increase or decrease. For this reason, if we forecast a stock price without a good analysis approach or lack of education from past statistics to make investment decisions, the investment may be inaccurate causing damage to the capital (Mollet & Ziegler, 2014; Peloza, 2009; Wójtowicz, 2016).

In general, investors use two ways to analyze for choosing to invest in stocks: Fundamental Analysis and Technical Analysis. The concept of security analysis using Fundamental analysis is a concept that focuses on finding factors that determine the rate of return, risks from investment, and the value of securities and they are used to determine the real value of securities. The technical analysis is the study of stock price behavior or past market behavior using statistical principles and it is used to predict future stock price movement behavior and to help investors find the right investment timing (Petrusheva & Jordanoski, 2016). However, both analyzes rely on mathematical knowledge. The case of Fundamental analysis applies mathematics to consider Price to Earnings Ratio (P / E Ratio), Price to Book Value Ratio (P/BV Ratio) and Dividend Yield whereas in the case of Technical analysis, mathematics would be applied for consideration Moving Averages, Indicators, and so on (Drakopoulou, 2015).

For this article, we will present a stock price simulation using the stochastic process. There are many interesting researches that use this process to analyze the stock price trend which is very effective (Stein, & Stein, 1991; Dmouj, 2006; Dunbar, 2016; Ofomata, Inyama, Umana & Omame, 2017). There is a demonstration of real stock price simulation and present the price graph obtained from the simulation compared to the actual value. The simulated price trend compared to the actual price trend will tell investors the ability to predict which will be another option for investing in that stock.

Stochastic Process

The equation obtained from the creation by the stochastic process would be called a probabilistic or stochastic model which is different from deterministically mathematical models which is a model that sets parameters and variables to be static and most will find the answer easily with absolute accuracy. The stochastic model is a model that requires parameters and variables to be unstable and uncertainty. The data used in the model is uncertain such as the amount of demand for a product in the future, simulation of dynamic systems that change over time, and simulation of random variables that are ordered with time. In probability theory, the simulation of co-random variables that are sequenced by time is called stochastic process, which is defined by the set

$$\{X(t), t \geq 0\}.$$

$X(t)$ is a random variable that has values on a set of real number.

t is time that has value on a set of positive real number.

If the variable t is a continuous time value, it is called a continuous-time stochastic process. And in the case of time being discrete, which is defined by the set

$$\{X(t), t = 0,1,2,...\},$$

It is called a discrete-time stochastic process.

For simulating stock prices with the stochastic process Lognormal random variables and normal random variables are used. Both variables are related to each other. A random variable X is a Lognormal random variable with parameters μ and σ if and only if $Y = \ln X$ is a Normal random variable with average μ and variance σ^2.

Creating a stochastic simulation equation would be started by considering the deterministic process for increasing and decreasing exponentially. The mathematical model of this process would be based on a concept that the rate of change of negative amounts is proportional to its own quantity which makes the relationship equation in the following:

$$\frac{dP}{dt} = \mu P \qquad (2.1)$$

μ Proportional constant

t The value of time.

If $\mu > 0$, it is called the increase rate and if $\mu < 0$, it is called the reduction rate. If the value P has been known at time t, then this differential equation has solutions according to the equation (2.1)

$$P(t) = P(0)e^{\mu t}. \qquad (2.2)$$

From equation (2.2), these mathematical models would be used to explain deterministic behavior because there are not random events appear in the model. When the initial configuration P is the constant proportion, we can rewrite the equation (2.1) as

$$\frac{dP}{P} = \mu\, dt. \qquad (2.3)$$

And if we change the variable $X = \ln P$ then we will get the following equation

$$dX = \mu\, dt. \qquad (2.4)$$

From the equation (2.4) considering the relative discontinuity of time results in

$$X(t + \Delta t) - X(t) = \Delta X = \mu \Delta t. \qquad (2.5)$$

The equation (2.5) can be seen as a deterministic equation, but it will become a stochastic equation if randomly members are imported. Let $dZ(t)$ be normal random variables by a normal distribution with mean 0 and the standard deviation 1, then the following stochastic equation is

$$\Delta X = \mu \Delta t + \sigma\, dZ(t)\sqrt{\Delta t}. \qquad (2.6)$$

Let $dW(t) = dZ(t)\Delta t$ so that $dW(t)$ is normal random variable by a normal distribution with mean 0 and standard deviation Δt. Random variables can make the difference in the equations (2.6) and can generate random walks if the value $X(t_i)$ are known for certain values t_i in the followings:

$$X(t_{i+1}) - X(t_i) = \mu\, \Delta t + \sigma\, dW(t_i)$$

$$X(t_{i+1}) = X(t_i) + \mu\,\Delta t + \sigma\,dW(t_i)$$
$$\ln P(t_{i+1}) = \ln P(t_i) + \mu\,\Delta t + \sigma\,dW(t_i)$$
$$P(t_{i+1}) = P(t_i)\,e^{\mu\,\Delta t + \sigma\,dW(t_i)}.$$

Stock Price Simulation with Stochastic Processes

The mathematical model of the stochastic process results in the equation of the stock price model which will be used to simulate the stock price and it is

$$P(t_{i+1}) = P(t_i)\,e^{\mu\Delta t + \sigma\,dW(t_i)}.$$

$P(t_i)$ is the stock price at the time t_i.

$P(t_{i+1})$ is the stock price at the time t_{i+1}.

μ is the average price of the stock.

Δt is a change of time.

σ is the standard deviation of the stock price data.

$dW(t_i)$ is the normal random variable.

Collecting the stock price information will be needed to study and here uses ADVANC shares to demonstrate the stock price simulation using the stochastic process. The closing price of the stock each day for 30 days is collected. Then, the stock price is simulated by using the stochastic process. Microsoft Excel is used to help calculation built-in values and create graphs which conclude as follows:

Step 1 Fill in the closing price of the collected stock $P(t_i)$ and calculate $\ln P(t_i)$.

Step 2 Calculate the value of the changes in the closing price of the stock
$dX(t_i) = \ln P(t_{i+1}) - \ln P(t_i)$.

Step 3 Calculate the mean and standard deviation of $dX(t_i)$.

Step 4 Generate random probability values that have values on the closing range $[0,1]$ to create a normal random value $dW(t_i)$.

Step 5 Simulate stock prices from formulas $P(t_{i+1}) = P(t_i)\,e^{\mu\Delta t + \sigma\,dW(t_i)}$ and create a resulting graph.

The results from the stock price simulated by using the stochastic process of ADVANC shares are shown in table 1.

Table 1. The stock price simulated by using the stochastic process of ADVANC shares

Stock price	$\ln P(t_i)$	$dX(t_i)$	Random Probability	$dW(t_i)$	Simulated stock price
186	5.225746674	0	0.997772231	2.843969076	186
187	5.231108617	0.005361943	0.335884293	-0.423721976	191.9098167
185.5	5.223054882	-0.008053735	0.627976939	0.326499957	191.3258857
187	5.231108617	0.008053735	0.152331586	-1.0264847	192.2529007
183.5	5.212214667	-0.018893949	0.581363758	0.205383534	190.4581439
184.5	5.217649463	0.005434796	0.699507565	0.522984744	191.1376159
185.5	5.223054882	0.005405419	0.219415267	-0.774169548	192.4605519
186	5.225746674	0.002691792	0.934051758	1.506665246	191.1698827
187	5.231108617	0.005361943	0.069643308	-1.478452822	194.4924451
186.5	5.228431239	-0.002677378	0.978446024	2.022662535	191.7641568
186.5	5.228431239	0	0.672419979	0.446605336	196.1574269
189	5.241747015	0.013315776	0.548618855	0.122172645	197.356695
191	5.252273428	0.010526413	0.979425549	2.042026508	197.887727
196.5	5.280662431	0.028389003	0.058865317	-1.564370289	202.4624659
194	5.267858159	-0.012804272	0.84848213	1.029945181	199.4422903
195	5.272999559	0.0051414	0.191739329	-0.871504668	201.8950381
196	5.278114659	0.005115101	0.536574013	0.091806255	200.3361552
194.5	5.270432163	-0.007682496	0.327525102	-0.44675744	200.8111369
194	5.267858159	-0.002574004	0.895882587	1.258434045	200.1516826
192	5.257495372	-0.010362787	0.623084813	0.31359274	203.1000543
192	5.257495372	0	0.798331473	0.83567626	204.0564484
194.5	5.270432163	0.012936791	0.066350772	-1.503533426	206.1448227
193.5	5.265277512	-0.005154651	0.301075176	-0.521310695	203.1995349
192.5	5.260096154	-0.005181359	0.164079871	-0.977827309	202.3736836
192	5.257495372	-0.002600782	0.514551453	0.036483175	200.5869458
193	5.262690189	0.005194817	0.925581774	1.443653556	200.9457076
195	5.272999559	0.01030937	0.725391315	0.598933291	204.3028981
196.5	5.280662431	0.007662873	0.22529424	-0.754434303	205.8811466
198	5.288267031	0.007604599	0.193267291	-0.865919002	204.542877
193	5.262690189	-0.025576842	0.935050782	1.514502517	202.9754589
194	5.267858159	0.00516797	0.30951574	-0.497223459	206.5202058

Bring the results to create a comparison chart between the actual stock price and the stock price obtained from the simulation. We can see how the stock price trend derives from the simulation which predicts the real price behavior. The ADVANC stock that simulates the price and gets the results from table 1 can be created the graph as shown in figure 1:

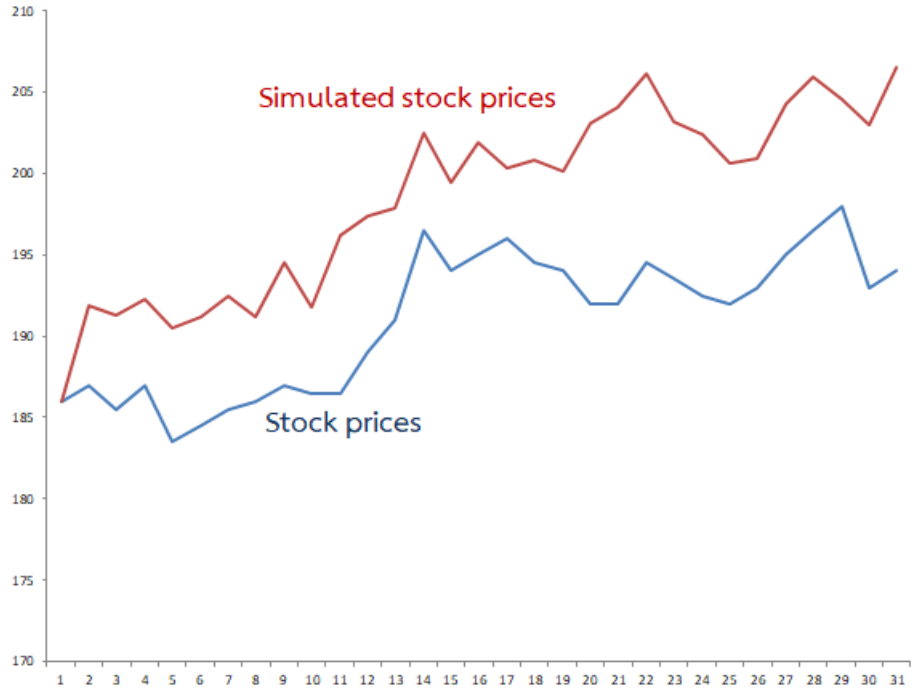

Figure 1. The ADVANC stock that simulates the price and gets the results from table 1

From the graph, it can be seen that the stock price obtained from the simulation can capture the behavior of the real stock price well making it possible to predict the trend of price changes which will help trading decisions more accurate and more confident for investors.

Summary

This article is a study of stock price simulation. The actual closing price of the stock is used to create a mathematical model using the stochastic process which is a process that uses variables in a random variable. Microsoft Excel program is used to help calculations the price of the stock market. These data create a comparison chart between the actual stock price and the stock price obtained from the simulation in order to see how well the stock price derived from the simulation captures real stock price behavior which in the case of ADVANC shares. For this reason, the process has been studied capturing the real stock price behavior of the stock price from the simulation making the price behavior of stocks that are likely to occur in the future. Trend considering could be applied to indicate the time that can be traded for making decisions in investment. Stock price simulation using the stochastic process is the basic technical analysis.

Researchers interested in the technical analysis should pay attention to the basis for the development of complex analysis.

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