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2021

# Application of Randomness in Finance

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# Applications of Randomness in Finance

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## Abstract

We are going to discuss Brownian Motion which is also considered to be a Wiener process and can be thought of as a random walk. We will briefly discuss the fluctuations of financial indices and relate them to Brownian motion and the modeling of stock prices.

## Introduction

A **random walk, also called "drunkard's walk",** is the very first step toward the understanding of applications of randomness in finance [1]. The concept of random walk can be found in many different application of mathematics such as google search engine algorithms, finance, biological movements, and macroscopic. A random walk is a very general type of random process. It involves of taking a series of steps where the direction of these steps are determined probabilistically. For example, suppose you are at integer zero initially on a number line. There is a 50% chance that you will be at +1 after one step or 50% chance that you will be at -1 . After one turn, you can take your second step and for that second step, there is a 25% chance that we will be on +2 on the number line and a 25% chance that we will be on -2 on the number line.
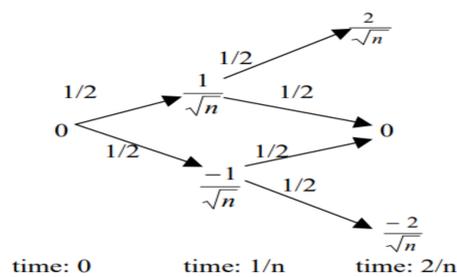
Fig.1: First two steps of the random walk.

The idea of random walk leads us to the idea of **Brownian Motion. Brownian Motion, also called "Wiener Process",** is a continuous time stochastic process [2]. We can define it as a collection of independent identically distributed random walks over a period of time [2] . The properties of Brownian Motion are the following [2]:

- The standard Brownian Motion at time zero, it is zero.
- Brownian Motion at any instant is normally distributed with a mean of zero and a variance of (t).
- The increment of a Brownian Motion at two different times is also normally distributed.
- The expected value of Brownian motion at any time will be zero.

Brownian Motion is a Markov process. The past is irrelevant for where the random walker will be in the future. The past has not influence on the future position of the random walker. Only the current position will have an impact on the position of random walker in the future.

## Methodology

You might be wondering how is the idea of random walks and Brownian Motion related to stock prices. The idea is that stock prices follow a random movements. We do not know exactly whether the stock prices will go down or up with certainty. When we look at the market index, we can see random movements on it. We used the Geometric Brownian Motion formulas for stock price movements to simulate stock prices. We used MatLab as the main software for our research.

1. A simulation of random walks was made.
2. A simulation of Brownian Motion was made.
3. A simulation of the Geometric Brownian Motion was made.
4. A simulation of stock prices path was made.

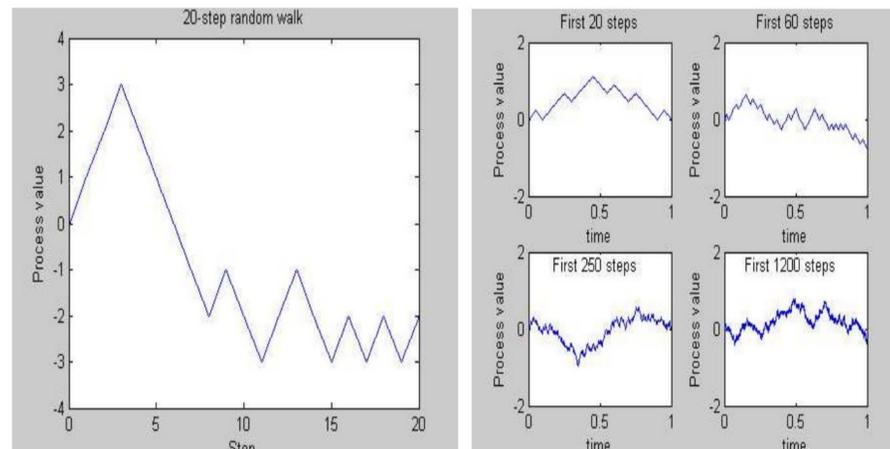The results can be found below.

## Results

Fig.2: 2-D Random walk.

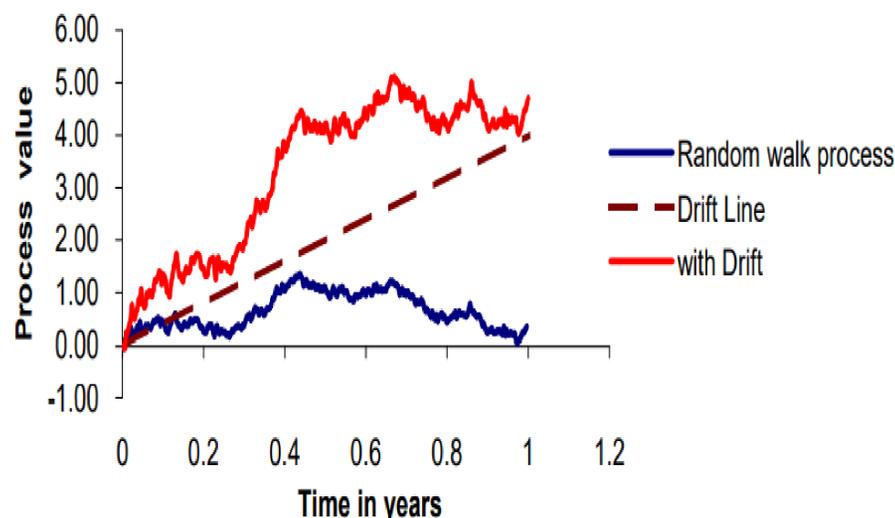Fig.3: Random walk simulation.

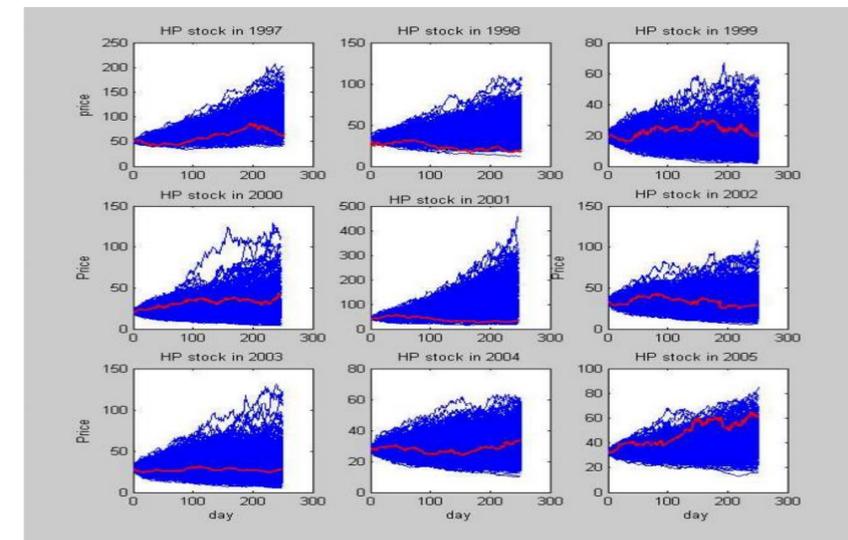Fig.4: Generalized Brownian motion process with positive drift.

Fig.5: One year actual and 1000 simulated paths of HP closing price.

## Conclusion

Random walks, as the name states, follow a random processes. As the number of steps increase, the random walks idea becomes a Brownian Motion. The reason for this is because as n (the number of steps) approaches infinite, random walks is said to converge and behave as a normal distribution. One can model stock prices using Brownian Motion since stock prices are said to follow a random walks approach. Stock prices are unpredictable. However, we know that at certain time, the stock price will either go up or down. We assume that this movements of the stock prices are equality likely to move down or up. The idea of random walks have helped some new problem in mathematics such as old geometric problems [4].

## References

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## Acknowledgment