Financial Derivatives
PHY3048
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Apple Stock Analysis

Abstract:

Apple Computer Company is now one of the largest companies in the world, continuing to out-perform its competitors. This stock analysis focus' on the last 10 years in the company's history since the resignation and death of founder and former CEO Steve Jobs. The drift and volatility of the stock were calculated to be 382.128 and 28.422 respectively. The stock continues to increase over the past decade and was one of the few companies to profit from covid-19 pandemic. After careful analysis, it is a strong stock worth investing in with opportunities to make large returns on investments.

Introduction:

Apple Computer Company was founded April 1976 by Steve Jobs and Steve Wozniak after they dropped out of college. From the company's creation, the two founders aimed to redesign the way people saw computers, making them more user friendly. The company had immediate success, with sales increasing by a factor of 150 between the years 1977-1980, when the company went public. Today, Apple dominates the technology industry posting record sales of one of the world's most successful products, the iPhone[1].

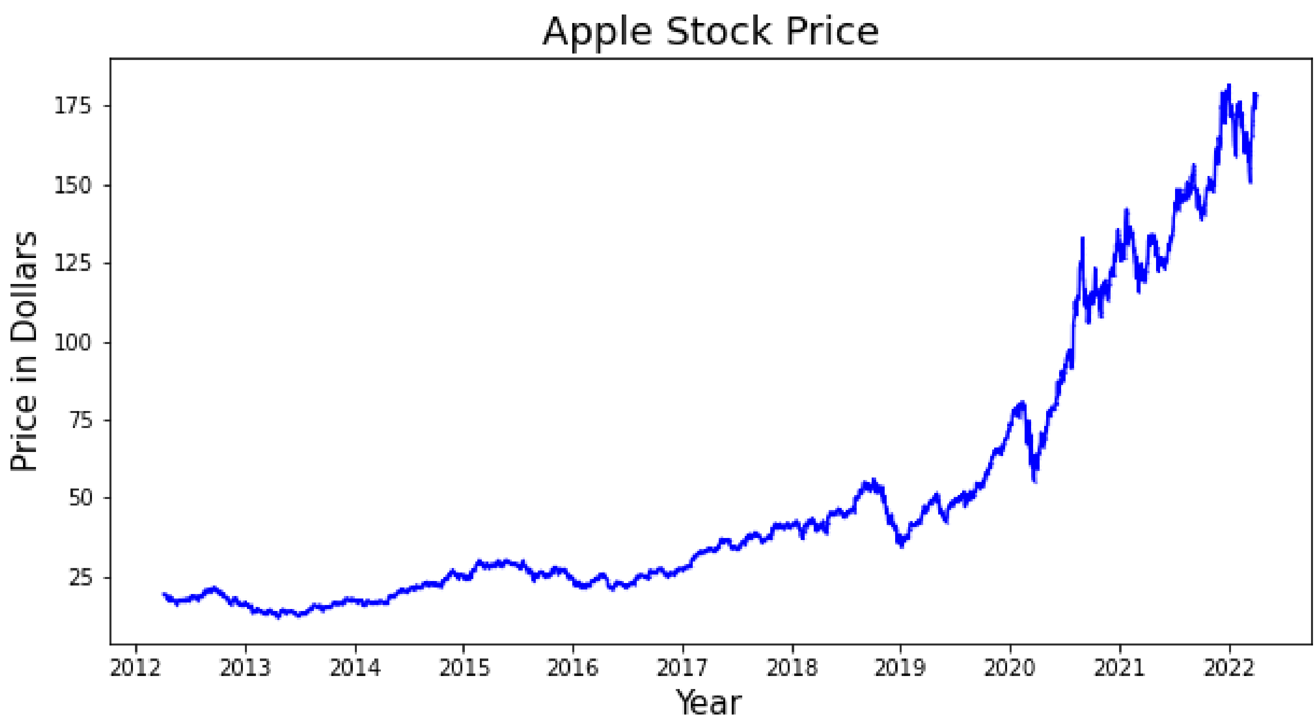

Fig.1. The Apple Stock price from April 2012-April 2022

This report focuses on the last 10 years of Apple's stock performance, starting with the financial year beginning April 2012 to the 2021 financial year, ending in April 2022. The start of the 2012 financial year marks the first one since the resignation of founder and CEO Steve Jobs in August 2011[2]. He later passed away in October 2011. He was replaced as CEO by Tim Cook, who previously held the role of Chief Operations Officer, and remains CEO of the company today[1]. Under his first few years as CEO, Cook decided not to release any new products but only updated versions of previously sold products like the iPad Mini in 2012 and iPad Pro in 2015.

The company finally released an all-new product at the beginning of the 2015 financial year with its Apple Watch, a product that initially flopped on release, causing the dip in stock price in 2015, but now is the best-selling smart watch on the planet. This release was coupled with the launch of the Apple Music streaming service in June 2015. The long-awaited release finally saw the collaboration of Apple and the company Beats, a headphone and music streaming service Apple had previously bought in 2014 for $3.2 billion[3]. It is Apple's largest acquisition to date and the move was to try and compete with streaming sensation Spotify, which was causing iTunes to be left behind. The move saw 11 million people using it's new service in the first year and now has over 78 million.

Due to the unwavering popularity of their iPhone products Apple became the first company ever to be worth $1 Trillion Dollars in August 2018. However, the stock price dipped soon after due to concerns about the presales of the latest iPhone models[4]. The company broke yet another record when it was briefly worth $3 Trillion Dollars when the stock price reached an all-time high of $182.94 in January 2022[5]. Despite the financial decline due to the coronavirus pandemic with Apple having to close their stores for lockdown, their stock price continued to increase. While many other companies experienced record losses, many even closing down for good, Apple initially experienced a dip in the stock price at the beginning of the pandemic before a stark increase[6]. Since people around the globe were forced to work from home, many customers decided to upgrade their appliances for this global change in lifestyle causing record sales[7] and profits nearly doubled[8] making 2021 one of the companies most profitable years, as seen in Fig.2.

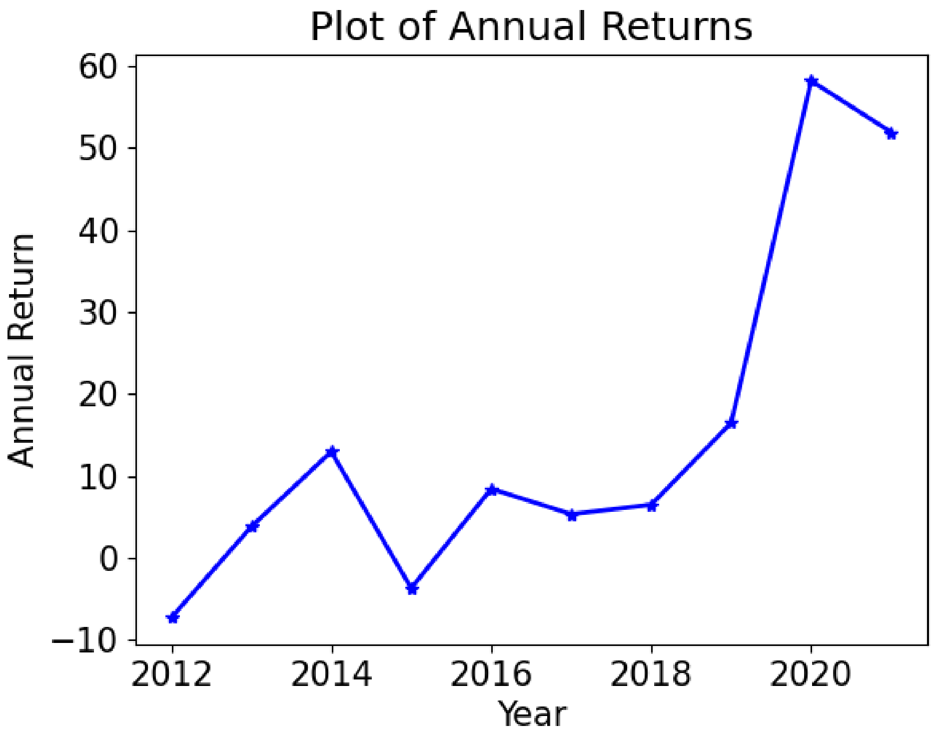

Fig.2. Annual Returns of the Apple Stock Price

Analysis:

Part 1: Analysis of Share Price Data

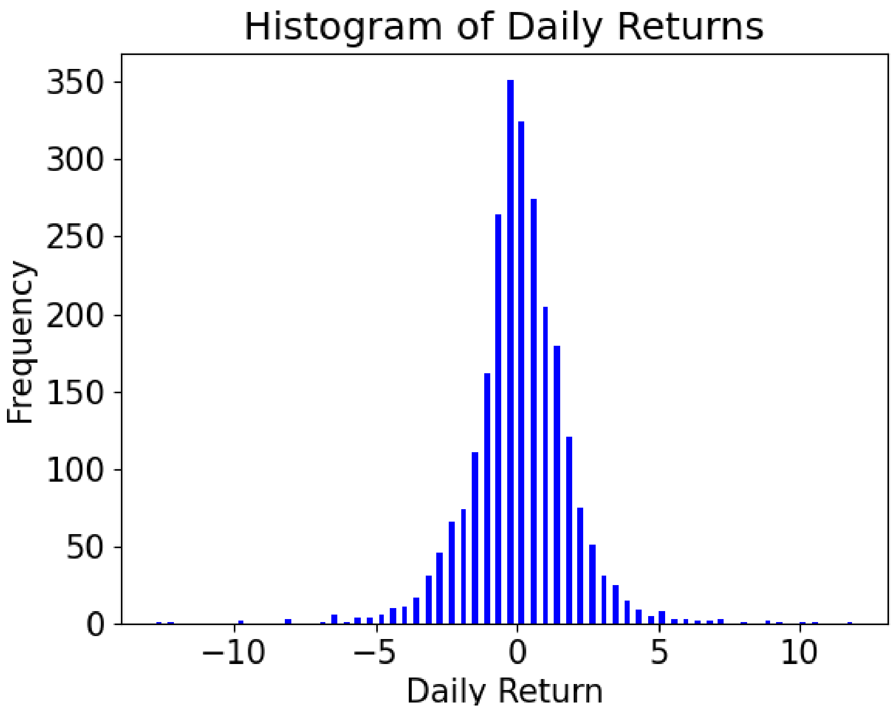

Fig.3. Histogram showing the frequency of the daily returns of the stock

Above, Fig.3., shows a histogram of the daily returns of the stock price, the histogram is slightly skewed to the left indicating that there are more days with a positive daily return than negative. This is expected for a company like Apple, whose stock price has continued to steadily increase over the years. On average, the daily returns are around zero showing the strength of Apple's stock as there are not many drastic daily changes in price.

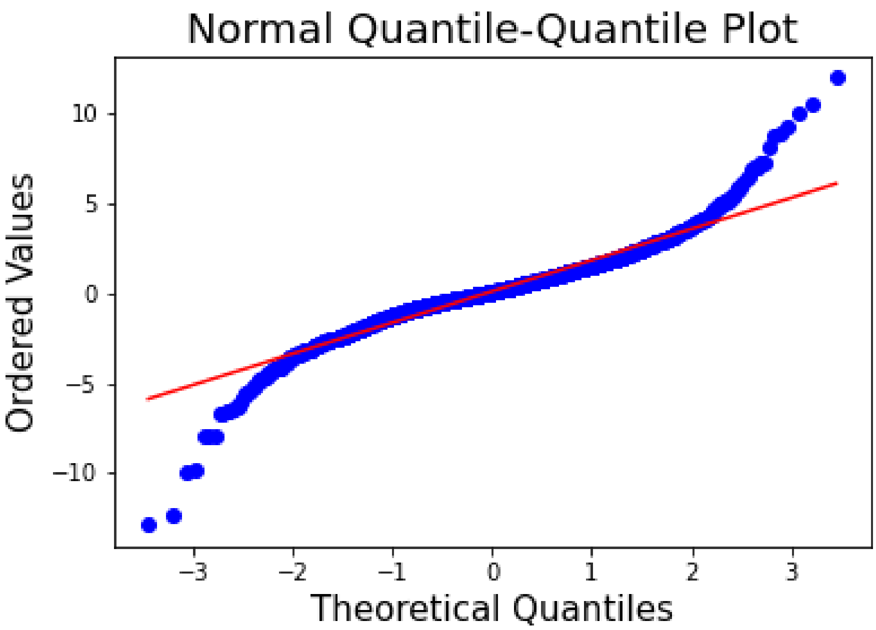

Fig.4.Normal Quantile Plot of the stock data

Fig.4. shows the quantile-quantile plot of the daily returns with the red line representing a perfectly normal distribution and the blue data representing the data points from the daily returns. In an ideal scenario, the data would follow this normal distribution and Fig.4. shows the majority of the data does follow a normal distribution with only the tails of the data skewing away from the red line.

Drift is a quantitative way of measuring the trend of a company's stock price, with a positive value indicating a generally increasing stock and negative indicating the opposite. Volatility is a measure of how spread out the daily returns are, i.e. how volatile the stock is. The drift and volatility of the entire data set were calculated using Eq1. and Eq2. and found to be:

$$Drift = \ln(return)_{average} \times N^0\ of\ Trading\ Days \quad (1)$$
$$Volatility = \sigma_{return} \times (N^0\ of\ Trading\ Days)^{1/2} \quad (2)$$

σ_{return} = Standard Deviation of the returns

Drift = 382.128
Volatility = 28.422

These values were then used to calculate the predicted price of the Apple stock with a 95% confidence level over a quarter, 6 months and 1 year and are detailed in Table 1.

Table 1: Predicted Apple Stock Prices

Time:	Minimum stock price: ($)	Maximum stock price: ($)
3 months	297.51	398.95
6 months	446.30	589.95
1 year	756.17	959.04

The predicted stock price values were calculated using Eq3.:

$$S_{max/min} = S_0 + \mu S_0 dt \pm \sigma S_0 dt^{1/2} X \quad (3)$$

S_0 = Closing Share price used in the analysis
μ = Drift
dt = Time over which to predict the stock price
σ = Volatility
X = No of Standard Deviations

When considering a $1 Million investment in the stock at the beginning of this analysis, the return after 10 years would have been +$6,968,866.67 demonstrating a growth of 6.97% on your principle. The maximum return on the principle could have been +$7,128,287.50 if all shares were sold on January 3rd 2022 and the maximum loss could have been -$377,125,27 if all shares were sold on April 19th 2013. In contrast, if the principle was invested in a savings account for the past 10 years with a continuously compound interest rate of 0.814% average over the 10 years, the return would have been +$84,804.73. Therefore, when considering how to invest the $1 Million principle, I would recommend investing in the Apple Stock rather than in a savings account. Apple continue to be very successful with a technology empire incomparable to other companies in the industry. Their stock price is mostly influenced by the sales of their products, which continue to become more popular as they dominate the market, with 5 different iterations of the iPhone taking the Top 5 spots for globally best-selling phones of 2021[9].

Part 2: Option Calculations

Options are a contract that give the buyer the right, but not the obligation, to buy or sell an asset for a specified amount in the future. They are unlike stocks as options do not represent any ownership of the company. Call options give you the right to buy the asset, while put options give you the right to sell an asset. European options differ from others as they can only be utilised on the expiry date, not before. 2-step binomial trees have been constructed to evaluate the options pricing of this stock for a 2-month European Long Call Option and Long Put Option. The following parameters were used to construct these binomial trees:

Volatility, σ = 28.422
Upward Trend, u = 1.086
Downward Trend, d = 0.921
Probability of an Upward move, p_u = 0.484
Probability of a Downward move, p_d = 0.516
Average LIBOR Interest Rate, r = 0.814%
Time between each branch, t = 1 month
Closing Share price used in analysis = $178.44
Call Strike Price, E_{call} = $185.00
Put Strike Price, E_{put} = $170.00

The upward and downward trends were calculated using Eq.4., Eq.5. and the share prices for the other nodes calculated. Using these values, the pay-offs at the D,E,F nodes were calculated, Eq.6. for a call option and Eq.7. for a put option, and can be seen as the values in red on the binomial trees.

$$u = e^{\sigma \Delta t^{\frac{1}{2}}} \quad (4)$$

$$d = e^{-\sigma \Delta t^{\frac{1}{2}}} \quad (5)$$

$$Pay - Off = MAX(S_T - E_{call}, 0) \quad (6)$$

$$Pay - Off = MAX(E_{put} - S_T, 0) \quad (7)$$

These values were used to determine the probability the price would increase using Eq.8., the probability of a downward move was then calculated as, 1-p_u.

$$p_u = \frac{e^{rT} - d}{u - d} \quad (8)$$

Then, the option prices at nodes A,B,C were calculated, Eq.9., and can be seen on the binomial trees as the values in red.

$$f = e^{-rT}(p_u f_u + p_d f_d) \quad (9)$$

f = option price
f_u = share price of the upward node
f_d = share price of the downward node

Using all these values, the following binomial tree was constructed for a European Long Call Option, Fig.5., and for a European Long Put Option, Fig.6., with the black values displaying share price at that node and the values in red displaying the node pay-offs and option prices.

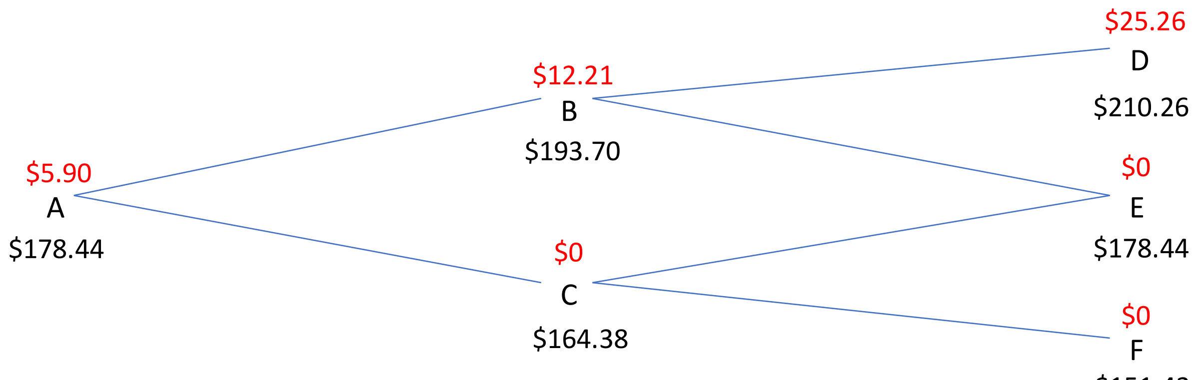

Fig.5. European Long Call Binomial Tree

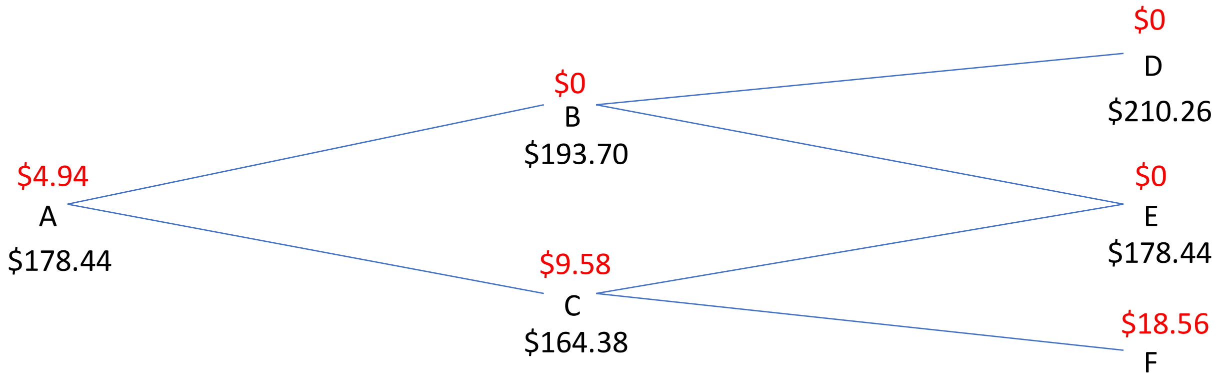

Fig.6. European Long Put Binomial Tree

It is possible for a client to invest in both the Apple stock and its options however, covered warrants are similar to options but are protected as you cannot lose more than your original investment. This type of financial product has a longer maturity than options and are a safer long-term investment.

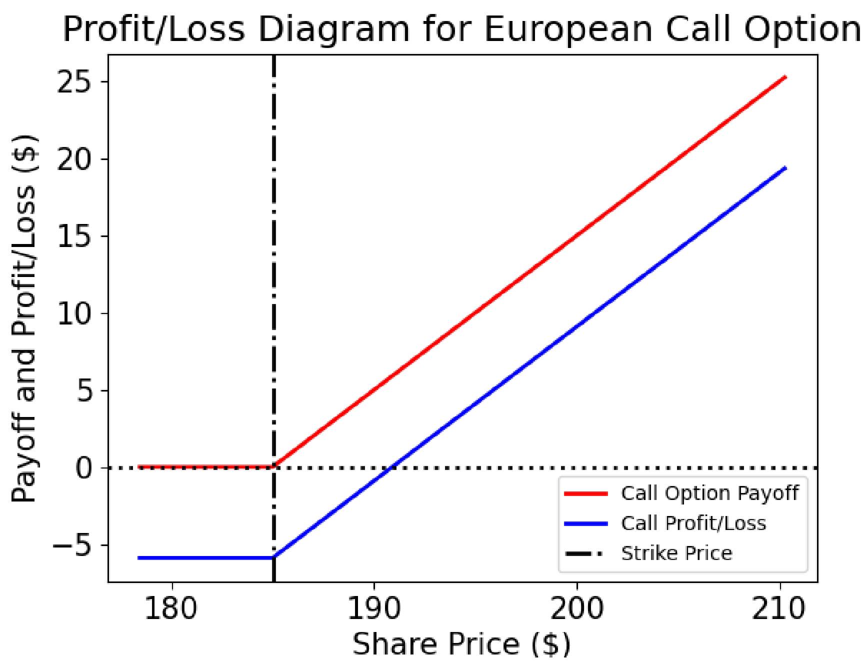

Fig.7. Profit/Loss Diagram for European Long Call Option

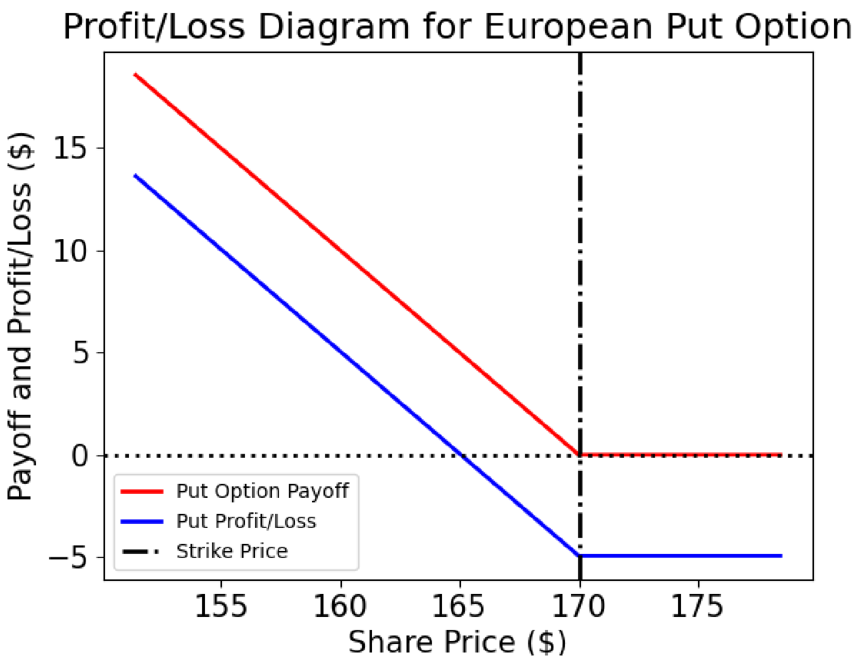

Fig.8. Profit/Loss Diagram for European Long Put Option

The profit/loss diagrams, Fig.7. and Fig.8., display the how much money can be made, or lost, with the options that have been calculated. By analysing the options for the Apple stock, I would advise investing in the stock over the option as a higher return can be made. However, this is with the benefit of hindsight and investing in different financial products always come with a risk involved.

<u>Summary:</u>

Since the company's inception 46 years ago, Apple has continued to out-perform its competitors and dominate the technology field, especially in the phone market. Apple has become a beacon of innovative technology that shows no signs slowing down with anticipation building for the long-awaited release of an Apple VR Headset. Due to these factors, the past 10 years of Apple's stock performance and major events throughout the company history, I would advise investing in the stock. Preferably, wait until the stock price drops before initially investing so you can get a higher return on your investment. Historically the stock tends to increase in value whenever a new product has been released so investing before this release would ensure a good return on any principle.

<u>References:</u>

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