

Econometrics

Select from five to ten publicly traded companies and investigate statistical differences (if any) in the systematic risk - reward relationship during high and low inflation periods



**Introduction**

The technology industry is one of the largest and fastest growing industries seen, from the emergence of the dot com boom and the internet, this attracted massive amounts of investments with Amazon and eBay in e-commerce and with Google and Yahoo bringing in the search engines were the huge winners in this time, Later, in the mid-00s, Apple unveiled the iPhone, and since then, no product has had the same impact on the market as Apple's.

Moving on, in the modern era, technology is at the forefront for many businesses, so innovation is required. As a result, cybersecurity measures are adopted by these businesses to ensure the safety of their customers, and artificial intelligence (AI) and machine learning are being used to help people in their daily lives. One such example is Alexa, which provides assistance to customers both inside and outside of their homes. An additional product that has achieved significant success is ChatGPT, an AI-powered language model created by OpenAI. It generates text that seems human by using deep learning to respond to user inputs. Using patterns, it has learnt from a vast quantity of data during its training phase, it predicts the next word in a given text. This tool has been used in many industries and is valuable to everyone due to its everyday use.

**Literature review**

The financial literature has paid considerable attention to the systematic risk-reward connection throughout different inflationary eras. The impact of macroeconomic conditions, including inflation, on the risk and return dynamics of publicly listed corporations has been thoroughly examined in previous research. A basic foundation for comprehending this relationship is provided by the Capital Asset Pricing Model (CAPM).

Academics like Sharpe (1964) and Lintner (1965) established the foundation for understanding systematic risk by establishing the idea of beta, which is a measure of a stock's volatility in the market. Research on the effects of shifting inflation rates on beta and anticipated returns has since been conducted. However, when we look at the CAPM model there have been some criticism due to its assumptions and faults, such as the Fama and French (1993) three-factor asset pricing model, as in recent decades this pricing model has not been able to explain the variation in stock return, but this may be down to the company as we cannot predict on how a company will perform as there are many external factors and this is what models should also take into account, such as demand and market conditions.

By analysing statistical variations in the systematic risk-reward profiles of Apple, Meta, Microsoft, Google, and Amazon over high and low inflation eras, this study seeks to add to the quantity of information already in existence. The chosen businesses, which speak for a lot of the technology industry, provide an engaging framework for comprehending how inflationary pressures can affect their bottom lines. This study aims to offer important insights that contribute to a nuanced understanding of the relationship between inflation, systematic risk, and stock returns in modern financial markets by a careful analysis of historical stock prices and inflation data.

**Data Summary**

For this project, I have chosen to explore the technology industry and the companies I have selected are Apple, Meta, Microsoft, Google, and Amazon. The rationale behind choosing these companies is that they are each different in their own for example Amazon is an online retailer, but their main focus is e-commerce and then Apple which is a global technology company renowned for designing and manufacturing popular consumer electronics, including the iPhone and Mac, while also providing a range of services, such as the App Store and iCloud, shaping the digital landscape. As a result, these businesses offer a clear representation of the overall market trend in the industry due to their substantial market share.

I collected the financial stock price data of these 5 technology companies that are on the NASDAQ on a daily frequency from Yahoo Finance, who source their data from ICE Data Services - a global leader in market data. My dataset includes a total of 1208 observations, ranging from 26thth November 2018 to 31st August 2023. I used a 5-year range as this is typically the length of an economic business cycle in the US. After importing the raw data, I converted the figures to returns using the following formula:

where, Rt = returns for a tech company on day (t)

Pt = Stock price for tech company on day (t)

Pt-1 = Stock price for tech company on the previous day (t-1)

The next step involved cleaning up my data by transferring all the pertinent information, including the adj close value for each of my companies, into an excel sheet. I started by taking daily logs of each company's figure to improve the accuracy of the value and see how it changed exponentially. I also saw changes in my inflation figures, which I labelled as Window, and the market premium (MKT-RF), risk-free rate (RF), Then to help me calculate excess returns for each company (R-RF), Then using the Kenneth R. French data library, I imported the Fama/French 3 factors data on a daily timeframe. Because it incorporates two more factors—size risk and value risk—this asset pricing model expands upon the CAPM.

where, ERt = Excess returns for tech company on day (t)

Rt = Arithmetic returns for tech company on day (t)

RFt = Risk free rate on day (t) sourced from Kenneth R. French data library

**Stationarity Test**:

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| --- | --- | --- | --- | --- | --- |
| Table 1: Augmented Dickey-Fuller Test | | | | | |
|  | AAPL | META | MSFT | GOOG | AMZN |
| Test Statistic | 1.29 | 0.229 | 1.09 | 0.876 | 0.101 |
| P-Vaue | 0.951 | 0.71 | 0.926 | 0.896 | 0.673 |

Since this table is the most accurate because the statistics come from the ADF test, which indicates no drift and no trend, we can see that the P-values for all 5 companies are greater than 0.1, which indicates that there is no stationarity and no drift.

**Methodology**

In this investigation, I will be using the Capital Asset Pricing Model (CAPM) to describe the relationship between the excess returns for US technology stocks and systematic risk and discuss the reward relationship during high and low inflation periods. As it is stated in an article that the CAPM still has ‘something to offer’ and that the number of favourable outcomes that had been produced from the model was plotted in a positive slope The formula for the CAPM model I will use is:

where, ERt = Excess return for tech company on day (t)

α = Risk-free rate

β1 = Stock price for tech company on day (t)

(Rmt – Rft) = Market risk premium

et = Error term for tech company on day (t)

I have chosen the window which is the period of high inflation from April 2021 to August 2023 this data was sourced from the US bureau labour of statistics as this was the period when the economies were still struck dealing with COVID-19 and dealing with national lockdowns, therefore many businesses had to shut down and the stock market was severely impacted. However as my topic is on technology companies the argument could be is that people would be stuck at home meaning it would give them more time on their devices and with social media being huge it was a lot of people were stuck with so it may have brought more users to these companies, but in terms of spending as this was a time of uncertainty many consumers may have refrained from spending so this would have severely impacted all the companies especially Amazon and the stock market.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2: Regression results | | | | | | | | | | | |
|  | AAPL | Stat sign | META | Stat sign | MSFT | Stat sign | GOOG | Stat sign | AMZN | Stat sign |
| Intercept | -0.0503 |  | 0.0421 |  | 0.0127 |  | 0.0228 |  | -0.0068 |  |
| MKT | 0.6795 | \*\*\* | 0.5135 | \*\*\* | 0.5796 | \*\*\* | 0.5113 | \*\*\* | 0.7665 | \*\*\* |
| Window | 0.0739 |  | -0.0533 |  | -0.0019 |  | -0.0193 |  | 0.0045 |  |
| MKT:Window | 0.1688 | \*\*\* | 0.0405 |  | -0.0801 | . | -0.0356 |  | 0.3239 | \*\*\* |
|  |  |  |  |  |  |  |  |  |  |  |
| R2 | 0.6582 | | 0.3982 | | 0.6954 | | 0.5918 | | 0.4649 | | |

Assumptions made so that the model can work effectively:

1. **Market Efficiency:**

* Assume that past stock returns are a reliable indicator of future performance and that stock prices represent all available information.

1. **Stationarity:**

* Assume that during the chosen time periods, statistical relationships and risk profiles are mostly unchanged.

1. **Inflation Impact:**

* Assume that the systematic risk and return of the chosen companies are significantly impacted by inflation.

1. **Homogeneous Risk Response:**
   * Assume that businesses in the same group or industry react to inflation similarly in terms of systemic risk.
2. **Normal Distribution:**

* For statistical analysis, assume that beta values and stock returns are somewhat normally distributed.

1. **Linear Relationship:**

* For the purpose of beta estimate, assume that stock returns and market returns follow a linear relationship.

**Results and Analysis**

**Regression tests**

Regression analysis is a statistical test that assesses the degree of correlation between an independent and dependent variable (s). The results of all five regression tests—conducted for each tech company—displayed in Table 2 below.

From the table we can see the how different periods of inflation play a role on risk, therefore, the factors we are mainly focusing are on the figures for MKT and MKT:WINDOW as we are looking at the risk for investments in periods of low inflation and high inflation, therefore, from first observations of the table we can see that the results we have attained are very similar across the each of the 5 companies. To work out the result during periods of high inflation, you add together MKT + MKT: WINDOW.

AAPL

We can see in periods of low inflation it is not risky as the figure 0.6795 is less than 1 and it is statistically significant, and during times of high inflation we can still see that the figure is 0.84843 and being statistically significant, which although it is less than 1 making it not risky it is still higher than the figure during periods of low inflation making is riskier. Therefore, if the market goes up by 1% the stock price will be more riskier during periods of high inflation.

META

For META we can see during in periods of low inflation it is not risky as the figure 0.5135 is less than 1 and it is statistically significant. Also the figure for high inflation shows that there is little change as it only increase by 0.0405, this is backed up by the figure for high inflation not being statistically significant.

MSFT & GOOG

Both these companies have similar results to META as they are both alike in terms of the product they give out, therefore we can see for MSFT during periods of low inflation it is not risky as the figure 0.5796 is less than 1 and it is statistically significant. Also, the figure for high inflation shows that there is little change as it only changes very slightly, this is backed up by the figure for high inflation not being statistically significant.

For GOOG during periods of low inflation the result we get for the coefficient is not risky as the figure 0.5113 is less than 1 and it is statistically significant. Also, the figure for high inflation shows that there is little change as it only changes very slightly, this is backed up by the figure for high inflation not being statistically significant.

AMZN

Here we have a similar situation in comparison to AAPL, in periods of low inflation it is not risky as the figure 0.7665 is less than 1 and it is statistically significant, but we can see that the result of the coefficient in periods of high inflation is 1.095 and being statistically significant, which in overall context and following the rules of the CAPM model because it is greater than the figure in periods of low inflation it is riskier and it is over 1 so it will be risky. So, we can say that Amazon risk profile changes with inflation. meaning if the market goes up by 1% stock prices will be riskier during inflation.

From this regression, we can see similarity in the types of companies in the technology industry, because my WINDOW variable was set to measure risk in periods of high inflation, and with this period being in COVID-19, we can assume that because AAPL and AMZN rely on their retail aspect and because there was low consumer confidence this meant that demand for the companies was low so we could assume that this made it more riskier for investing in the stock prices as these companies are sensitive during periods of high inflation.

For META, GOOG and MSFT, because these companies’ main products solely rely on consumer usage and because it is easily accessible to use Facebook and Google and Microsoft applications, it is inevitable that there won’t be much difference in risk in periods of high inflation, and for the context of COVID-19 we could have seen more people use the products and may have assumed it was less risky. But there was no change in the coefficient, meaning these companies had a low risk profile.

Furthermore, the R2 coefficient evaluates how well the variables have performed in explaining the excess returns as of late. A low R2 suggests that many factors that might account for the excess returns' actual performance rather than their expected performance are absent from the model.

**F-Test Results**

I then performed a F-test to confirm my regression test results on the risk profiles for each company, the rules are F-statistic is great 4 and P-Value is close to 0

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| Table 3: F-test results | | | | | |
|  | AAPL | META | MSFT | GOOG | AMZN |
| F-Statistic | 7.2515 | 0.2394 | 1.8912 | 0.3244 | 12.385 |
| P-Value | 0.0007406 \*\*\* | 0.7872 | 0.1513 | 0.7231 | 4.741e-06 \*\*\* |

Therefore, we can see from the tests it confirms the high risk profile for the risk market for companies AAPL and AMZN as for AAPL the F-statistic 7.2515 is greater than 4 and the P-value is statistically significant and close to zero, likewise for AMZN the the F-statistic 12.385 is greater than 4 and the P-value is statistically significant and close to zero, from this we can say that both companies have a high risk profiles but AMZN has the higher one during periods of high inflation.

Whilst for META, MSFT, GOOG we can see that these all have low risk profiles ad all F-statistic for all is below 4 and P-value is not close to zero and has no statistical significance, with META being the company with the lowest risk.

**Residuals (Errors)**

In regression analysis, heteroscedasticity) refers to the unequal scatter of residuals or error terms. From the graphs we may assume, for META the variance is consistent as homoscedasticity is present while the other four companies have heteroscedasticity present, therefore portraying an inconsistent variance as variance for errors are high in certain areas.

A group of colorful graphs

Description automatically generated with medium confidence

Then from the histogram plots we can see that these are normally distributed so I am happy with this.

A graph of a graph of a number of numbers

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Autocorrelation is used to measure the degree of similarity between a time series and a lagged version of itself over successive time. From the acf test I can see that with my errors that they is no auto correlation and that there are no patterns in errors.

Using the table below I can confirm that there is no auto correlation as the result of DW follow the rules as they are all close to 2.

|  |  |  |
| --- | --- | --- |
| Table 4: Durbin-Watson Test Results | | |
| Company |  | DW |
| AAPL |  | 1.87 |
| META |  | 1.92 |
| MSFT |  | 1.92 |
| GOOG |  | 1.94 |
| AMZN |  | 2 |

Also, I can state that there will be no multicollinearity as we are working with the CAPM model, and the variable were given so there will not be any similar variables.

**Conclusion**

The aim of my project was to measure the risk of stock prices of 5 companies in high inflation periods and low inflation periods, the different periods of inflation did not have a drastic impact on stock prices as 3 out of the 5 companies were still less risky during high inflation, and because there were many external factors such as COVID-19 and with technology being innovated constantly, the main factor depended on the type of technology company it was, as we saw with Amazon and Apple who depend mainly on their retail and consumer spending therefore during times of high inflation, consumer confidence and demand would have been at its lowest meaning it is difficult to say if it is actually risky during high inflation or if external factors play a part, but I was able to get a wide range of technology companies and was able to see that online presence is important because for the likes of META, Google and Microsoft, they are able to still run as there main product is applications used in everyday life. So if I was to do this again, I would choose a period of high inflation where all 5 companies were not restricted.

**References**

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