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# Application of the Fama-French Three Factor Model for a Five Stocks Portfolio in the US. Stock Market

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**Abstract**

In this paper, the Fama-French three-factor model was applied to explore how to construct an optimized portfolio and achieve maximum returns, by using historical stock data for various industries, in the period from 2002 to 2022. The findings of this paper can be useful for first-time investors in various financial markets.

**Keywords:** Fama-French model, portfolio, optimized.

## Introduction

The present article uses the famous Fama-French three model factor [4] that was developed by Eugene Fama and Kenneth French in 1992 in order to conduct a times series regression on a five-stock portfolio. For the selection of the stocks, it was considered an initial investor approach, that is, going for the safe spot, investing on well-known and sustainable companies and from a variety of different industries. Many researches have already been done about the Fama- French model, they had explored its feasibility and shortcomings or presented tests on stock markets in different parts of the world. [1] Alves's article compares the Fama-French model to the Capital Asset Pricing Model (CAPM) for many international stocks and gets to the conclusion that FFM is more accurate. [3] In Datta & Chakraborty's study, the findings established the applicability of Fama and French three factor model on the Indian financial service sector firms. [5] Yang's work provided

another recent study explored and showed that the Fama- French model could be applied to also a five Us. stocks portfolio.

This article's structure goes as it follows: First the stocks were selected and the data was collected from Yahoo Finance, the companies selected belong to the consumer electronics industry, retail industry, food service industry, consumer, pharmaceutical and medical industry, and the beverage industry. The data was collected from the period of 2002 to 2022, then divided in two subperiods, from 2002 to 2012 and from 2013 to 2022. Then for the model the historical data of the three factors were obtained from the online data library of Kenneth R. French. Lastly, the equally weighted portfolio return was obtained by applying the Fama French model.

## Methods

### *Companies selected*

For the analysis of this article. five companies were selected to be a part of the studied portfolio, this with the mind of a starter investor with a solid investment strategy of investing on well stablished and sustainable companies, and they are:

### *Apple Inc. (AAPL)*

For the last thirty years, Apple has been filled with executive talent and innovation, characteristics that maintained them in the first places, Apple's stocks are a part of the biggest portfolios. Apple is a large cap stock with a high book to market value over past years. Apple belongs to the Consumer electronics Software services Online services industry.

### *Company description*

Apple Inc creates, manufactures and sells smartphones, tablets, personal computers and portable devices. The company also offers software and related services, accessories, and third-party digital content and applications. The company has a presence throughout the Americas, Europe, Middle East, Africa and Asia Pacific. Apple is headquartered in Cupertino, California, USA.

### *Sales*

Apple's total net sales for fiscal 2022 were $394.33 billion, up from an all-time high of $274.52 billion for fiscal 2020. Apple's annual revenue has quadrupled in the last decade.

### *Profitability*

Apple's profitability ratios have been on an up-warding tendency over the years:

- Gross profit margin:
  - 2022: 43.31%
  - 2021: 41.78%
  - 2020: 38.23%
  - 2019: 37.82%
  - 2018: 38.34%
  - 2017: 38.47%
- Operating profit margin:
  - 2022: 30.29%
  - 2021: 29.78%
  - 2020: 24.15%
  - 2019: 24.57%
  - 2018: 26.69%
  - 2017: 26.76%
- Net profit margin:
  - 2022: 25.31%
  - 2021: 25.88%
  - 2020: 20.91%
  - 2019: 21.24%
  - 2018: 22.41%
  - 2017: 21.09%
- Return on equity (ROE):
  - 2022: 196.96%
  - 2021: 150.07%
  - 2020: 87.87%
  - 2019: 61.06%
  - 2018: 55.56%
  - 2017: 36.07%
- Return on assets (ROA):
  - 2022: 28.29%
  - 2021: 26.97%
  - 2020: 17.73%
  - 2019: 16.32%
  - 2018: 16.28%
  - 2017: 12.88%

***Walmart Inc. (WMT)***

Walmart is still worth buying for long-term investors looking for some stability to weather the inevitable market ups and downs. This stock pays his 1.5% dividend yield, which is comparable to the S&P 500, and has a great dividend record to back it up. The company has been increasing its dividend for 20 years and still maintains a healthy 68% payout ratio. That

means there is no danger of the dividend being cut any time soon. Walmart is a large cap stock with a high book to market value over past years. Walmart belongs to the retail industry.

***Company description***

Walmart Inc is a retailer that operates grocery stores, supermarkets, hypermarkets, department stores, discount stores and convenience stores. The company's stores offer everyday low prices on grocery and consumer goods, health and wellness, technology, office and entertainment, hardline, apparel and home products. It also operates Warehouse Clubs (including Sam's Clubs). Walmart sells products under various private and licensed brands, including Equate, Bonobos Fielder, Mainstays, George, Onn, Parent's Choice, Time and Tru, Wonder Nation and no Boundaries. The Company provides fuel, gift cards, financial services, money orders, prepaid cards, wire transfers, remittances, check cashing and other related products including bill payments. We sell our products through various e-commerce portals in the United States, Canada, Africa, Central America, China, Chile, Mexico and India.

***Sales***

For the fiscal year ended January 31, 2022, Walmart's worldwide net sales were $567.76 billion, an increase of approximately 2% from the prior year.

***Profitability***

Walmart's profitability ratios have been on a slight up-warding tendency over the years:

- Gross profit margin:
  - 2022: 24.44%
  - 2021: 24.30%
  - 2020: 24.10%
  - 2019: 24.50%
  - 2018: 24.68%
  - 2017: 24.94%
- Operating profit margin:
  - 2022: 4.57%
  - 2021: 4.06%
  - 2020: 3.96%
  - 2019: 4.30%
  - 2018: 4.12%
  - 2017: 4.73%
- Net profit margin:

  - 2022: 2.41%
  - 2021: 2.43%
  - 2020: 2.86%
  - 2019: 1.31%
  - 2018: 1.99%
  - 2017: 2.83%
- Return on equity (ROE):
  - 2022: 16.42%
  - 2021: 16.69%
  - 2020: 19.93%
  - 2019: 9.20%
  - 2018: 12.66%
  - 2017: 17.54%
- Return on assets (ROA):
  - 2022: 5.58%
  - 2021: 5.35%
  - 2020: 6.29%
  - 2019: 3.04%
  - 2018: 4.82%
  - 2017: 6.86%

***McDonald's Corporation (MDC)***

Shares of McDonald's performed well in 2022, outperforming the falling market thanks to strong demand from the fast-food industry. The chain has managed to pass on most of the higher costs by gaining more foot traffic in most markets and increasing menu prices. McDonald's is a large cap stock with a low book to market value over past years. McDonald's belongs to the food service industry.

***Company description***

McDonald's (McDonald's) is a food service retail chain operator. The Company operates and franchises McDonald's restaurants that offer locally relevant food and drink menus. It operates in North America, Latin America, Europe, Asia Pacific, Middle East and Africa. Headquartered in Chicago, Illinois, USA.

***Sales***

McDonald's annual revenue for 2022 was $23.183B, a 0.17% decline from 2021, and for 2021 was $23.223B, a 20.9% increase from 2020.

***Profitability***

McDonald's profitability ratios have been on a slight up-warding tendency over the years:

- Gross profit margin:
  - 2022: 24.44%
  - 2021: 24.30%
  - 2020: 24.10%
  - 2019: 24.50%
  - 2018: 24.68%
  - 2017: 24.94%
- Operating profit margin:
  - 2022: 4.57%
  - 2021: 4.06%
  - 2020: 3.96%
  - 2019: 4.30%
  - 2018: 4.12%
  - 2017: 4.73%
- Net profit margin:
  - 2022: 2.41%
  - 2021: 2.43%
  - 2020: 2.86%
  - 2019: 1.31%
  - 2018: 1.99%
  - 2017: 2.83%
- Return on equity (ROE):
  - 2022: 16.42%
  - 2021: 16.69%
  - 2020: 19.93%
  - 2019: 9.20%
  - 2018: 12.66%
  - 2017: 17.54%
- Return on assets (ROA):
  - 2022: 5.58%
  - 2021: 5.35%
  - 2020: 6.29%
  - 2019: 3.04%
  - 2018: 4.82%
  - 2017: 6.86%

***Johnson & Johnson (JNJ)***

Johnson & Johnson should be on investors' shortlists with its impressive earnings and valuation fundamentals, excellent Zacks rankings,

and strong value and VGM style scores. JNJ is a large cap stock with a high book to market value over past years. JNJ belongs to the consumer, pharmaceutical, and medical devices industry.

***Company description***

JNJ is a multinational company specializing in pharmaceuticals, medical devices and consumer goods. J&J sells the pharmaceuticals and medical products to retailers, wholesalers, health care professionals and hospitals. They offer consumer products through retailers and distributors.

***Sales***

JNJ had sales of about $95 billion in 2022. This statistic shows the total worldwide sales of Johnson & Johnson from 2005 to 2022.

***Profitability***

JNJ's profitability ratios was having an up-warding tendency over the years until 2021, when it had a slight decrease:

- Gross profit margin:
  - 2022: 67.26%
  - 2021: 68.16%
  - 2020: 65.58%
  - 2019: 66.42%
  - 2018: 66.79%
- Operating profit margin:
  - 2022: 24.63%
  - 2021: 24.95%
  - 2020: 23.60%
  - 2019: 24.15%
  - 2018: 24.27%
- Net profit margin:
  - 2022: 18.90%
  - 2021: 22.26%
  - 2020: 17.82%
  - 2019: 18.42%
  - 2018: 18.75%
- Return on equity (ROE):
  - 2022: 23.36%
  - 2021: 28.20%
  - 2020: 23.25%
  - 2019: 25.42%
  - 2018: 25.60%
- Return on assets (ROA):

- 2022: 9.57%
- 2021: 11.47%
- 2020: 8.41%
- 2019: 9.59%
- 2018: 10.00%

***The Coca-Cola Company (KO)***

Coca-Cola finished 2022 strong with accelerating sales trends and profitability remaining resilient. Coca-Cola also forecasts big year for sales and earnings. Coca-Cola is a large cap stock with a high book to market value over past years. Coca Cola belongs to the beverage industry.

***Company description***

The Coca-Cola Company is a beverage company that manufactures, markets and distributes a wide range of non-alcoholic beverages worldwide. The company offers sparkling soft drinks, sparkling flavors. Water, sports, coffee, tea. Juices, value-added dairy products and plant-based beverages. And other drinks. We also provide beverage concentrates, syrups and fountain syrups to fountain retailers such as restaurants and convenience stores.

***Sales***

Net sales increased 11% to $6.2 billion in fiscal 2022, while physical housing volume remained flat year-over-year. Sparkling and Still net sales increased 16.6% and 8.5%, respectively, compared to fiscal 2021.

***Profitability***

Coca-Cola's profitability ratios have been on a slight down-warding tendency over the years:

- Gross profit margin:
  - 2022: 58.14%
  - 2021: 60.27%
  - 2020: 59.31%
  - 2019: 60.77%
  - 2018: 63.05%
- Operating profit margin:
  - 2022: 25.37%
  - 2021: 26.67%
  - 2020: 27.25%
  - 2019: 27.06%
  - 2018: 27.31%
- Net profit margin:

  - 2022: 22.19%
  - 2021: 25.28%
  - 2020: 23.47%
  - 2019: 23.94%
  - 2018: 20.20%
- Return on equity (ROE):
  - 2022: 39.59%
  - 2021: 42.48%
  - 2020: 40.14%
  - 2019: 46.99%
  - 2018: 37.89%
- Return on assets (ROA):
  - 2022: 10.29%
  - 2021: 10.36%
  - 2020: 8.87%
  - 2019: 10.33%
  - 2018: 7.73%

For this article the historical prices were obtained from the webpage Yahoo Finance (www.finance.yahoo.com) and contains five different US. companies' historical prices in order to compound a portfolio equally weighted. The historical prices taken corresponds to the period from 2002 to 2022, and that period will also be divided into two subperiods, from 2002 to 2012 and from 2013 to 2022.

The monthly stock price time series was transformed into a monthly return time series using the following formula:

$$\text{Rate of return} = [\ (\text{Current Value} - \text{Initial value})/\text{Initial value}] \times 100$$

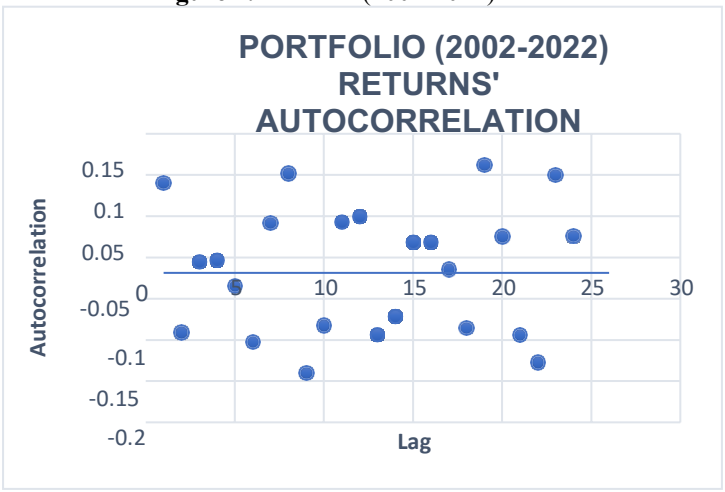
Here are some descriptive statistics for the full data and the subsamples:

**Table 1.** Descriptive statistics of the selected stocks (2002-2022)

| | AAPL | WMT | MCD | JNJ | KO |
|---|---|---|---|---|---|
| Mean= | 2.860 | 0.647 | 1.280 | 0.754 | 0.751 |
| Volatility= | 9.658 | 5.096 | 5.356 | 4.372 | 4.812 |
| Variance= | 93.277 | 25.974 | 28.685 | 19.116 | 23.156 |
| Max= | 35.226 | 14.776 | 18.257 | 14.421 | 14.193 |
| Min= | -32.956 | -15.923 | -25.673 | -14.527 | -17.274 |

Source: Self made

**Figure 1.** Portfolio (2002-2022) returns



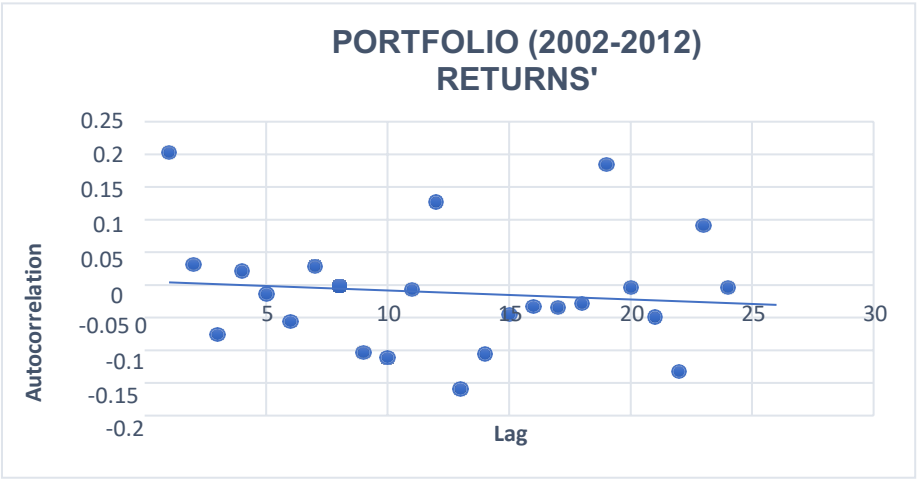

Source: Self made

**Table 2.** Descriptive statistics of the selected stocks (2002-2012)

| | AAPL | WMT | MCD | JNJ | KO |
|---|---|---|---|---|---|
| Mean= | 3.580 | 0.382 | 1.300 | 0.438 | 0.665 |
| Volatility= | 10.834 | 4.907 | 5.849 | 4.244 | 4.907 |
| Variance= | 117.369 | 24.077 | 34.210 | 18.009 | 24.078 |
| Max= | 35.226 | 11.730 | 18.257 | 10.920 | 14.193 |
| Min= | -32.956 | -15.584 | -25.673 | -14.527 | -16.087 |

Source: Self made

**Figure 2.** Portfolio (2002-2012) returns' autocorrelation



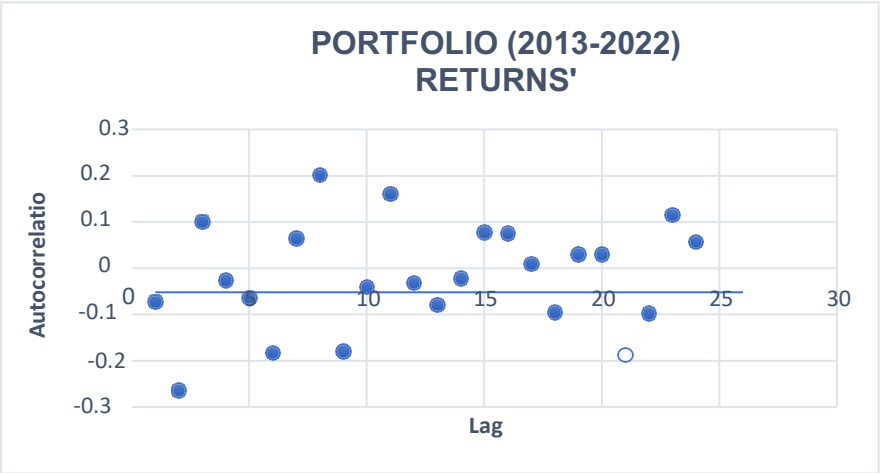

Source: Self made

**Table 3.** Descriptive statistics of the selected stocks (2013-2022)

| | AAPL | WMT | MCD | JNJ | KO |
|---|---|---|---|---|---|
| Mean= | 2.069 | 0.939 | 1.258 | 1.102 | 0.846 |
| Volatility= | 8.145 | 5.303 | 4.779 | 4.501 | 4.724 |
| Variance= | 66.333 | 28.117 | 22.842 | 20.262 | 22.318 |
| Max= | 21.438 | 14.776 | 18.168 | 14.421 | 13.764 |
| Min= | -18.404 | -15.923 | -14.310 | -11.592 | -17.274 |

Source: Self made

**Figure 3.** Portfolio (2013-2022) returns' autocorrelation




Source: Self made

For the Fama-French three factor model the factor's historical values were obtained from the online data library of Kenneth R. French (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

The methodology used to construct the three-factor model consists of a two-step process. The first step is gathering data on the independent variables (stock returns and model risk factors) and the second step involves constructing the dependent variable (portfolio). After having obtained the variables, a regression based on the time series was conducted.

The Fama-French factor model uses the next equation:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{it}$$

where:

- Rit=total return of a stock or portfolio I at time t
- Rft=risk free rate of return at time t
- RMt=total market portfolio returns at time t

- Rit−Rft=expected excess return
- RMt−Rft=excess return on the market portfolio (index)
- SMBt=size premium (small minus big)
- HMLt=value premium (high minus low)
- β1,2,3=factor coefficients

## Results

### *Summary Statistics*

**Table 4**. Summary Statistics on the Portfolio Return

| | Mean | Volatility |
|---|---|---|
| Portfolio (2002-2022) | 1.259 | 3.955 |
| Portfolio (2002-2012) | 1.273 | 3.975 |
| Portfolio (2013-2022) | 1.243 | 3.950 |
| Mkt-RF | 0.670 | 4.506 |
| SMB | 0.142 | 2.468 |
| HML | 0.057 | 3.038 |

Source: Self made

**Table 5.** Correlation Matrix of the three risk factors

| | *Mkt-RF* | *SMB* | *HML* |
|---|---|---|---|
| Mkt-RF | 1 | | |
| SMB | 0.308 | 1 | |
| HML | 0.142 | 0.088 | 1 |

### *Times series regression results*

### *Regression (2002-2022)*

**Table 6.** Portfolio 2002-2022: Regression Statistics

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.790 |
| R Square | 0.623 |
| Adjusted R Square | 0.619 |
| Standard Error | 2.443 |

| | |
|---|---|
| Observations | 252 |

Source: Self made

**Table 7.** Portfolio 2002-2022: Analysis of variance

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 2448.977 | 816.326 | 136.825 | 2.58E-52 |
| Residual | 248 | 1479.616 | 5.966 | | |
| Total | 251 | 3928.593 | | | |

Source: Self made

**Table 8.** Portfolio 2002-2022: Fama-French three model results

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0.732 | 0.156 | 4.708 | 4.17E-06 | 0.426 | 1.039 |
| Mkt-RF | 0.734 | 0.036 | 20.250 | 1.79E-54 | 0.662 | 0.805 |
| SMB | -0.409 | 0.066 | -6.221 | 2.09E-09 | -0.538 | -0.279 |
| HML | -0.094 | 0.051 | -1.832 | 0.068 | -0.195 | 0.007 |

Source: Self made

Adjusted R square represents a 62% approximately, the capacity of independent variables to explain variation of the dependent variable.

According to the results the market risk premium factor has the capacity to explain the variation in rate of return of the portfolio. Since all companies selected are large cap stocks, the results reflect an inverse relationship with the SMB factor and its statistically significant according to t Stat and p-value. However, the HML factor is not statistically significant for this model.

### *Regression (2002-2012)*

**Table 9.** Portfolio 2002-2012: Regression Statistics

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.782 |
| R Square | 0.611 |
| Adjusted R Square | 0.602 |

| | |
|---|---|
| Standard Error | 2.505 |
| Observations | 132 |

Source: Self made

**Table 10.** Portfolio 2002-2012: Analysis of variance

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 1264.414 | 421.471 | 67.154 | 3.76034E-26 |
| Residual | 128 | 803.350 | 6.276 | | |
| Total | 131 | 2067.764 | | | |

Source: Self made

**Table 11.** Portfolio 2002-2012: Fama-French three model results

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0.977 | 0.220 | 4.436 | 1.96E-05 | 0.541 | 1.412 |
| Mkt-RF | 0.734 | 0.053 | 13.960 | 1.73E-27 | 0.630 | 0.838 |
| SMB | -0.253 | 0.099 | -2.567 | 0.011 | -0.448 | -0.058 |
| HML | -0.181 | 0.090 | -2.008 | 0.047 | -0.359 | -0.003 |

Source: Self made

Adjusted R square was reduced to a 60%, the capacity of independent variables to explain variation of the dependent variable changed in this subperiod. According to the results the market risk premium factor has the capacity to explain the variation in rate of return of the portfolio. Since all companies selected are large cap stocks, the results reflect an inverse relationship with the SMB factor and its statistically significant according to t Stat and p-value. However, the HML factor also shows a negative relationship despite that almost every stock selected have a high book to market ratio.

### *Regression (2013-2022)*

**Table 12.** Portfolio 2013-2022: Regression Statistics

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.819 |
| R Square | 0.670 |
| Adjusted R Square | 0.662 |
| Standard Error | 2.300 |
| Observations | 120 |

Source: Self made

**Table 13.** Portfolio 2013-2022: Analysis of variance

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 1247.139 | 415.713 | 78.597 | 8.05E-28 |
| Residual | 116 | 613.540 | 5.289 | | |
| Total | 119 | 1860.679 | | | |

Source: Self made

**Table 14.** Portfolio 2013-2022: Fama-French three model results

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0.398 | 0.216 | 1.841 | 0.068 | -0.030 | 0.826 |
| Mkt-RF | 0.750 | 0.050 | 15.138 | 3.1E-29 | 0.652 | 0.848 |
| SMB | -0.569 | 0.086 | -6.626 | 1.1E-09 | -0.739 | -0.399 |
| HML | -0.062 | 0.060 | -1.039 | 0.301 | -0.181 | 0.056 |

Source: Self made

Adjusted R square was increased to a 66%, the capacity of independent variables to explain variation of the dependent variable also changed in this subperiod.

According to the results the market risk premium factor has the capacity to explain the variation in rate of return of the portfolio. Since all companies selected are large cap stocks, the results reflect an inverse relationship with the SMB factor and its statistically significant according to

t Stat and p-value. However, the HML factor is not statistically significant for this period.

The results for size and value effects and return variability are consistent with those of Banz (1981) and Haugen (1995) for US markets.

**Conclusion**

The main purpose of this study was to test whether the Fama-French three-factor model can explain five US. stock return variability. The data was also segregated in two subperiods to view more in detail in which period of time the model will be more effective, that is in the most actual period, from 2013 to 2022. Based on the regression results it's also notorious that the market risk premium factor has the biggest capacity to explain the variations of this portfolio, SMB factor had a negative relationship since all the selected stocks were large cap stocks, but HML was mostly not statically significant.

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