Report Project 1 – AI for Finance

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Point 1

Parameters

Portfolio composition: FDX: 100%
Market index: S&P500 (^GSPC)
Fama/French 3 factor: RF

Results

- Average returns: The Procter & Gamble stock's average return is consistently higher than the market's average return across all time periods (5, 15 and 30 years), indicating that the portfolio has consistently outperformed the market.
- Sharpe ratios: are relatively stable across the time periods. The highest Sharpe ratio is observed in the last 5 years (0.2155), indicating the best risk-adjusted returns in that time frame.
- Alpha: values are positive across all time periods, suggesting that the portfolio has consistently generated excess returns relative to the market on a risk-adjusted basis.
- Beta: values are below 1 across all time periods, indicating that the portfolio is less volatile than the market.
- Standard deviation: standard deviation values show some fluctuations across the time periods. The lowest value is observed in the last 15 years (4.5174), indicating lower volatility during that time frame.
- Variance: Procter & Gamble stock variance has the lowest value in the last 15 years (20.4069) and the highest in the last 30 years (28.9824). This is consistent with the general expectation that volatility increases over longer periods. The market variance also shows fluctuations across the time periods, this indicates that market volatility has been higher in the most recent 5-year period compared to the other time frames.
- Covariance: (covariance between the portfolio and the market) is the highest in the last 5 years (12.7135) and the lowest in the last 30 years (7.5994). This suggests that the portfolio's returns have been more closely related to the market returns in the last 5 years compared to the other time frames.
- Correlation: (correlation between the portfolio and the market) is relatively low in the last 30 years (0.3256), indicating a weaker relationship between the portfolio and market returns in that period. In the other time frames (5 and 15 years), the correlation is moderate (0.4643 and 0.4583, respectively).

In summary, The Procter & Gamble stock has consistently outperformed the market across all the time periods, generating positive alpha and maintaining a lower volatility compared to the market. The correlation with the market is moderate, and the risk-adjusted returns (as measured by the Sharpe ratio) have been relatively stable across time periods. The highest risk-adjusted returns are observed in the last 5 years, while the lowest volatility is seen in the last 15 years.

Datas

	Start	End	Pf.Avg.Ret.%	Mk.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mk.Avg.Exc.Ret.%	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mk.Std.%	Pf.Var	Mk.Var	Cov	Corr
Last 5Y	2018-02	2023-01	1.1913	0.7585	1.0903	0.6575	0.1010	0.2155	0.8247	0.4039	5.0598	5.4121	25.6019	29.2911	12.7135	0.4643
Last 15Y	2008-02	2023-01	0.7818	0.7158	0.7327	0.6666	0.0492	0.1622	0.4474	0.4279	4.5174	4.7092	20.4069	22.1769	9.7505	0.4583
Last 30Y	1993-02	2023-01	1.0349	0.7160	0.8514	0.5325	0.1835	0.1582	0.6398	0.3974	5.3835	4.3358	28.9824	18.7991	7.5994	0.3256

Point 2

Parameters

portfolio composition:
MSFT:10%, INTC: 10%, JNJ: 10%, PFE: 10%, XOM: 10%, AXP: 10%, DIS: 10%, KO: 10%, BA: 10%, PG: 10%
Market index: S&P500 (^GSPC)
Fama/French 3 factor: RF

Results

- Average returns: the portfolio has outperformed the market across all the time periods. The highest average return is observed in the last 30 years (1.1690%), while the lowest average return is in the last 20 years (0.9982%).
- Average excess returns: portfolio's average excess returns are positive across all time periods, indicating consistent outperformance against the market. The highest excess return is in the last 30 years (0.9855%), and the lowest is in the last 20 years (0.9007%).
- Sharpe ratios: sharpe-ratio is highest in the last 10 years (0.1602) and lowest in the last 30 years (0.1351). This indicates that the portfolio's risk-adjusted returns were the best in the last 10 years.
- Alpha: portfolio has generated positive alpha across all time periods, indicating that it has consistently outperformed the market. The highest alpha is observed in the last 30 years (0.5082%), and the lowest is in the last 10 years (0.2913%).
- Beta: portfolio's beta is close to 0.9 across all time periods, suggesting that the portfolio is less volatile than the market but still has a strong relationship with market
- Standard deviation: portfolio's standard deviation is highest in the last 30 years (7.2956%) and lowest in the last 20 years (6.5837%). In comparison, the market's standard deviation is highest in the last 5 years (5.4121%) and lowest in the last 10 years (4.2773%). The portfolio has a higher standard deviation than the market across all time periods, indicating higher volatility.
- Variance: portfolio's variance is highest in the last 30 years (94.7687) and lowest in the last 10 years (30.0609). The market's variance is highest in the last 5 years (29.2911) and lowest in the last 10 years (18.2956). As with standard deviation, the portfolio's variance is higher than the market's, indicating higher volatility.
- Covariance: (covariance between the portfolio and the market) is highest in the last 30 years (16.8500) and lowest in the last 10 years (16.3724). Higher covariance values indicate that the portfolio's returns have a stronger relationship with the market returns.
- Correlation: (correlation between the portfolio and the market) is highest in the last 20 years (0.5837) and lowest in the last 30 years (0.5327). The positive correlation values indicate that the portfolio's returns generally move in the same direction as the market returns. However, the correlation is less than 1, indicating that the portfolio's returns do not perfectly follow the market.

In summary, the portfolio exhibits higher volatility than the market, as indicated by its higher standard deviation and variance across all time periods. However, the portfolio has consistently outperformed the market, generating positive excess returns, alpha, and a good Sharpe ratio. The covariance and correlation values show that the portfolio's returns have a positive relationship with the market returns, but do not move perfectly in sync. Overall, the portfolio has demonstrated solid performance over the different time periods analyzed.

Data

	Start	End	Pf.Avg.Ret.%	Mk.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mk.Avg.Exc.Ret.%	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mk.Std.%	Pf.Var	Mk.Var	Cov	Corr
Last 10Y	2013-02	2023-01	1.1286	0.9287	1.0687	0.8688	0.0599	0.1602	0.2913	0.8949	6.6690	4.2773	30.0609	18.2956	16.3724	0.5740
Last 20Y	2003-02	2023-01	0.9982	0.7446	0.9007	0.6471	0.0974	0.1368	0.3194	0.8982	6.5837	4.2778	41.7769	18.3000	16.4380	0.5837
Last 30Y	1993-02	2023-01	1.1690	0.7160	0.9855	0.5325	0.1835	0.1351	0.5082	0.8963	7.2956	4.3358	94.7687	18.7991	16.8500	0.5327

Point 3

Parameters

portfolio composition:
MSFT: 10%, INTC: 10%, JNJ: 10%, PFE: 10%, XOM: 10%, AXP: 10%, DIS: 10%, KO: 10%, BA: 10%, PG: 10%
Market index: S&P500 (^GSPC)
Fama/French 3 factor: RF

Results

- Average returns: during the crisis, the portfolio experienced a significant decline in returns, as indicated by the negative average returns (-4.1065%). However, it performs better than the market, which had an average return of -5.3155% during the same period.
- Average excess returns: average excess return for the portfolio during the crisis was -4.1590%, while the market's average excess return was -5.3680%. This demonstrates that, during the crisis, the portfolio outperformed the market after accounting for the risk-free rate of 0.0525%.
- Sharpe ratios: sharpe-ratio for the portfolio during the crisis was -0.4248, indicating that the portfolio underperformed the risk-free rate on a risk-adjusted basis and it is in contrast to the positive Sharpe ratios seen in the previous data (Point 2).
- Alpha: portfolio's alpha during the crisis was 0.7812, which is positive and shows that it generated positive risk-adjusted returns relative to the market benchmark
- Beta: is 0.9203, suggesting that the portfolio was slightly less sensitive to market movements compared to the benchmark. This is consistent with the previous data (Point 2)
- Standard deviation: The standard deviation of the portfolio during the crisis (9.7897%) was higher than the market's standard deviation (8.1917%), reflecting greater volatility.
- Variance: The variance values of the portfolio and the market (Pf.Var: 4.5212 and Mk.Var: 67.1044) were also higher during the crisis, indicating increased risk in both the portfolio and the market.
- Covariance: The covariance between the portfolio and the market during the crisis was 61.7565, which is higher than the previous periods (Point 2). This suggests a stronger relationship between the portfolio and market returns during the crisis.
- Correlation: The correlation coefficient was 0.7701, indicating a strong positive correlation between the portfolio and the market, meaning that they tended to move in the same direction during the crisis.

During the crisis, the portfolio experienced higher volatility and risk, as reflected by the increased standard deviation, variance, covariance, and correlation coefficient compared to the previous periods (Point 2). The positive alpha indicates that the portfolio generated positive risk-adjusted returns relative to the market benchmark. Despite the challenging market conditions during the crisis, the portfolio's performance remained quite good, outperforming the market.

Data

	Start	End	Pf.Avg.Ret.%	Mk.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mk.Avg.Exc.Ret.%	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mk.Std.%	Pf.Var	Mk.Var	Cov	Corr
08/09 Crisis	2008-08	2009-03	-4.1065	-5.3155	-4.1590	-5.3680	0.0525	-0.4248	0.7812	0.9203	9.7897	8.1917	4.5212	67.1044	61.7564	0.7701

Point 4

Parameters

portfolio composition:
^TNX:40%, MSFT: 6%, INTC: 6%, JNJ: 6%, PFE: 6%, XOM: 6%, AXP: 6%, DIS: 6%, KO: 6%, BA: 6%, PG: 6%
Market index: S&P500 (^GSPC)
Fama/French 3 factor: RF

Bond: ^TNX

Comparison

The new portfolio with the bond has a higher average return (-3.8508%) compared to the previous portfolio (-4.1065%). This means the new portfolio has performed better during the 2007-2009 crisis in terms of average returns.

The new portfolio also has a better Sharpe ratio (-0.3062) compared to the previous portfolio (-0.4248), indicating a better risk-adjusted performance.

However, the new portfolio has a higher standard deviation (12.7476%) than the previous portfolio (9.7897%), which indicates higher volatility and, therefore, higher risk. The new portfolio also has a lower correlation (0.1075) with the market compared to the previous portfolio (0.7701), which implies that the new portfolio's returns are less influenced by market movements.

In summary, the new portfolio with a bond has a better average return and risk-adjusted performance (Sharpe ratio) compared to the previous portfolio during the 2007-2009 crisis. However, it comes with higher volatility. If an investor is willing to tolerate the increased volatility, the new portfolio can be considered as a better-performing option during the crisis period.

Data

Portfolio with bond

	Start	End	Pf.Avg.Ret.%	Mk.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mk.Avg.Exc.Ret.%	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mk.Std.%	Pf.Var	Mk.Var	Cov	Corr
08/09 Crisis	2008-08	2009-03	-3.8508	-5.3155	-3.9033	-5.3680	0.0525	-0.3062	-3.0055	0.1673	12.7476	8.1917	9.2721	67.1044	11.2240	0.1075

Portfolio without bond

	Start	End	Pf.Avg.Ret.%	Mk.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mk.Avg.Exc.Ret.%	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mk.Std.%	Pf.Var	Mk.Var	Cov	Corr
08/09 Crisis	2008-08	2009-03	-4.1065	-5.3155	-4.1590	-5.3680	0.0525	-0.4248	0.7812	0.9203	9.7897	8.1917	4.5212	67.1044	61.7565	0.7701

Point 5

Parameters

portfolio composition:
MSFT:10%, INTC: 10%, JNJ: 10%, PFE: 10%, XOM: 10%, AXP: 10%, DIS: 10%, KO: 10%, BA: 10%, PG: 10%
Market index: S&P500 (^GSPC)
Fama/French 3 factor: Mkt-RF

Results

The Alpha values are positive for all periods, which indicates that the portfolio has performed better than what would be expected based on its Beta and the market excess returns. The Sharpe ratios are also positive, suggesting that the portfolio has generated positive risk-adjusted returns. The Beta values are close to 1, especially for the 10 and 20 years periods, indicating that the portfolio's returns move closely with the market's excess returns. The correlation coefficients are positive, ranging from 0.5145 to 0.5735, which means the portfolio's returns have a positive relationship with the market's excess returns, but the strength of the relationship is moderate.

The portfolio has outperformed the market in terms of Alpha and has generated positive risk-adjusted returns in all periods. However, the Sharpe ratios have slightly decreased compared to the analysis using the RF factor, which could be attributed to the change in the benchmark.

Data

Results with RF factor (Like point 2)

	Start	End	Pf.Avg.Ret.%	Mk.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mk.Avg.Exc.Ret.%	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mk.Std.%	Pf.Var	Mk.Var	Cov	Corr
Last 10Y	2013-02	2023-01	1.1286	0.9287	1.0687	0.8688	0.0599	0.1602	0.2913	0.8949	6.6690	4.2773	30.0609	18.2956	16.3724	0.5740
Last 20Y	2003-02	2023-01	0.9982	0.7446	0.9007	0.6471	0.0974	0.1368	0.3194	0.8983	6.5837	4.2778	41.7769	18.3000	16.4380	0.5837
Last 30Y	1993-02	2023-01	1.1690	0.7160	0.9855	0.5325	0.1835	0.1351	0.5082	0.8963	7.2956	4.3358	94.7688	18.7991	16.8500	0.5327

Results with Mkt-RF factor

	Start	End	Pf.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mkt.RF.Avg	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mkt.RF.Std.%	Pf.Var	Mkt.RF.Var	Cov	Corr
Last 10Y	2013-02	2023-01	1.1286	1.0687	1.0175	0.0599	0.1602	0.2074	0.8465	6.6690	4.4446	30.0609	19.7542	16.7224	0.5642
Last 20Y	2003-02	2023-01	0.9982	0.9007	0.8387	0.0974	0.1368	0.1842	0.8543	6.5837	4.4196	41.7769	19.5325	16.6863	0.5735
Last 30Y	1993-02	2023-01	1.1690	0.9855	0.7006	0.1835	0.1351	0.3984	0.8381	7.2956	4.4791	94.7688	20.0621	16.8131	0.5145

Point 7

Parameters

portfolio composition:
MSFT:10%, INTC: 10%, JNJ: 10%, PFE: 10%, XOM: 10%, AXP: 10%, DIS: 10%, KO: 10%, BA: 10%, PG: 10%
Market index: S&P500 (^GSPC)
Fama/French 3 factors: Mkt-RF

Results

In last 10 years, the portfolio's average excess return is 0.1111%, with a Sharpe ratio of 0.0195, which is lower than the previous analyses using a single factor. Alpha is 0.7717%, indicating the portfolio has outperformed the multifactor model, beta is -0.1199, which implies that the portfolio returns have a weak negative relationship with the multifactor model. The correlation coefficient is -0.0026 which shows a negative relationship between the portfolio and the multifactor model. These considerations are also valid for 20 years period.

In last 30 years, average excess return is 0.4684%, with a Sharpe ratio of 0.0727. This is a relatively higher Sharpe ratio than the previous two time periods, suggesting better risk-adjusted performance over the last 30 years.

Overall, based on the multifactor model, the portfolio has a weak negative relationship with the market and additional factors and Alpha values show that the portfolio has outperformed the multifactor model across all time periods, with the highest outperformance in the last 30 years.

Data

	Start	End	Pf.Avg.Ret.%	Pf.Avg.Exc.Ret.%	Mkt.RF.Avg	RF.Avg	Pf.Sharpe-ratio	Alpha.%	Beta	Pf.Std.%	Mf.Std.%	Pf.Var	Mf.Var	Cov	Corr
Last 10Y	2013-02	2023-01	1.1286	0.1111	1.0175	1.0175	0.0195	0.7717	-0.1199	5.7084	11.6666	30.0609	39.7860	-0.1701	-0.0026
Last 20Y	2003-02	2023-01	0.9982	0.1594	0.8387	0.8387	0.0284	0.1366	-0.1114	5.6139	11.4552	41.7769	36.2455	-0.1781	-0.0028
Last 30Y	1993-02	2023-01	1.1690	0.4684	0.7006	0.7006	0.0727	0.7930	-0.1141	6.4466	12.4841	94.7687	42.6038	-0.1713	-0.0021

Point 8

Parameters

portfolio composition:
MSFT:10%, INTC: 10%, JNJ: 10%, PFE: 10%, XOM: 10%, AXP: 10%, DIS: 10%, KO: 10%, BA: 10%, PG: 10%
Market index: S&P500 (^GSPC)
Fama/French 3 factor: RF
Future: ES2306=F

Results

In all three time periods, the S&P 500 futures have a higher average return than the portfolio, indicating that using futures for hedging could potentially increase returns. The hedge ratio varies across the different time periods but generally stays around 0.898, which means that for every dollar invested in the portfolio, around 0.898 dollars would be invested in the S&P 500 futures.

In the last 10 years, hedge ratio (0.8950) indicates the proportion of the portfolio that needs to be hedged using futures contracts. In this case, I need to sell 6 S&P 500 futures contracts to hedge portfolio effectively against market risk. In the last 20 and 30 years, I need to sell 9 and 11 S&P500 futures respectively.

In summary, the analysis shows that the hedge ratio remains relatively stable across the three time periods, ranging from 0.8950 to 0.8983. The number of futures needed to hedge my portfolio varies depending on the period analyzed. As the time horizon increases, the number of futures needed to hedge the portfolio increase.

Data

	Start	End	Pf.Avg.Ret.%	Ft.Avg.Ret.%	RF.Avg	Future.Ret.	Pf.Value	Future.value	Hedge-Ratio	Futures.Needed
Last 10Y	2013-02	2023-01	1.1286	1.8479	1.0175	8.2908	999289.4193	137896.3970	0.8950	6
Last 20Y	2003-02	2023-01	0.9982	2.3259	0.8387	8.2908	999289.4193	99278.4855	0.8982	9
Last 30Y	1993-02	2023-01	1.1690	3.7121	0.7006	8.2908	999289.4193	81276.0166	0.8983	11

Data legend

Pf.Avg.Ret.%: Portfolio average return
Mk.Avg.Ret.%: Market average return
Pf.Avg.Exc.Ret.%: Portfolio average excess return
Mk.Avg.Exc.Ret.%: Market average excess return
RF.Avg: Average risk-free rate
Pf.Sharpe-ratio: Portfolio sharpe ratio
Pf.Std.%: Portfolio stock's standard deviation
Mk.Std.%: Market standard deviation
Pf.Var: Portfolio variance
Mk.Var: Market variance
Cov: Covariance
Corr: Correlation
Pf.Value: Portfolio value
Ft.Avg.Ret.%: future average returns
Future.Ret: returns on S&P500 future