FINAL PROJECT
INVESTMENT THEORY

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Introduction

The following report will present an analysis of a total of 30 different companies performance over a 32-year period, from 1990 to 2022, with the aim of evaluating the impact and influence of past performances of this assets on the short-term and long-term future. Through the use of a recursive portfolio approach, 5 different portfolios composed with the selected companies will be updated and rebalanced on a regular basis. The goal is to differentiate each portfolio based on the past performances of the stocks. Different performance measures, as well as different financial models will be applied to the data to obtain a wider study of the problem and make it possible to extract more accurate conclusions.

The report will include a brief description of the data and companies selected, followed by an introduction of the methodologies used throughout the development of the project. The next stage will be the presentation of the empirical results achieved from the project as well as a personal view and analysis of the underlying meaning of the outputs gathered. Finally, a summary of the whole report will be presented in the conclusion section, where a brief overview of the problem results and findings will be outlined.

Data

The companies selected for this research include many distinct industries and sectors as well as a wide range of company dimensions and valuation. The goal of this asset selection was to gather a diverse environment to support the potential of the results pursued. The *Figure 1* contains the full list of the companies that were included in the study.

GD	General Dynamics Corporation
LNC	Lincoln National Corporation
TXT	Textron Inc.
TAP	Molson Coors Beverage Company
DDS	Dillards Inc
C	Citigroup, Inc.
CI	Cigna Corporation
CVX	Chevron Corporation
ECL	Ecolab Inc.
FMC	FMC Corporation
GPC	Genuine Parts Company
HAL	Halliburton Company
HAS	Hasbro, Inc.
HD	Home Depot, Inc.
JPM	JP Morgan Chase & Co.
KMB	Kimberly-Clark Corporation
LHX	L3Harris Technologies, Inc.
LLY	Eli Lilly and Company
LOW	Lowe's Companies, Inc.
MMM	3M Company
CLX	Clorox Company
IP	International Paper Company
NWL	Newell Brands Inc.
BAX	Baxter International Inc.
PCAR	PACCAR Inc.
VFC	V.F. Corporation
WHR	Whirlpool Corporation
AON	Aon, PLC
PG	Procter & Gamble Company
HSY	Hershey Co.

Figure 1 – List of the 30 selected companies for the project

The dataset, gathered from Bloomberg database, contained financial information regarding each of the companies, that were summarized in a *csv* file with the price evolution over the 32-year period analyzed. For the development of the project, was also required to extract from the Kenneth R. French website, the risk free rate as well as the risk factors for the different models used during the research, in this case the Small minus Big (SMB) factor, the High minus Low (HML) and the Momentum factor (MOM).

Methodology

This project demanded the introduction of different models and measures to assess the portfolios' performance. Beginning with the portfolio building process, it was required to understand how the past performance could be taken into account to divide the companies from the best to the worst past performers, to fulfill the purpose of this research. Moreover, the interest of study if there were a significant difference between the influence on a short-term and a long-term perspective of the company's future performance.

The recursive portfolio approach creates a dynamic portfolio, or in this case a group of portfolios, that are re-optimized on a defined regular basis. This rebalancing of the portfolio should meet the main goal of the investor/researcher to properly define each of the portfolios following the market changes over time. The first

challenge faced is how to introduce an adequate metric measure to implement the objective function to proceed to the rebalancing of the portfolio. In this project, the aim was to measure and keep track of past performance from the stocks to use it to build the portfolios. For this problem, the past returns of the companies, was used as the basis for evaluate its past performance, it was applied based on the average monthly returns achieved from each of the companies in the last PS months, that allow ranking the companies based on their past performance over the defined period. The second parameter that was required to establish was the rebalancing period, or how often should the portfolios be updated and optimized, based on the new ranking of the company's performance. It was clear that both of the parameters, PS and REB, should assume different values, when dealing with short or long term horizons, to properly incorporate the past and future performances adequately. Two groups of 5 portfolios were created, with the vision to attend both problems, one short-term and one long-term group of portfolios.

The financial models implemented in this project to calculate the expected returns of the different portfolios given the amount of risk associated with them, were the CAPM, Fama-French 3-Factor and Carhart models. The difference presented by these three models are the risk factors that each of them incorporate to determine the theoretically required rate of return of a given asset or portfolio considering the underlying risks. CAPM is seen as the simpler version of them, considering the market risk as the only factor and the asset's sensitivity to it to estimate returns. Both Fama-French as Carhart take in account more risk factors rather than just the market risk, while the former have a total of 2 additional factors, being them the size and value to explain the cross-section of stock returns. The Carhart model includes a momentum factor, beyond the previously introduced. When it comes to measuring the future performance of the created portfolios, different metrics from excess returns to risk adjusted measures as Sharpe ratio and Treynor ratio were used to evaluate the portfolios performance.

Empirical Results

Portfolios

The first stage of the project was to be able to properly create a total of 5 portfolios with the 30 chosen companies where should be assure the division of the companies based on their past performance where the best ranking assets over time should be included in the same portfolio, as well as the worst and intermediate assets. As stated before 2 groups of portfolios were generated to answer the short term and long-term problem. The *Table 1* shows the parameters selection for each of the portfolio's creation, regarding the short-term approach, were consider the 6 past months to calculate the past averages returns from each asset and a rebalancing period of 12 months or 1 year. The goal was to maintain a dynamic with a faster updating regularity

to limit the long range of both past and future returns to be included in the analysis. The 6 to 12 months mark is for many authors and researchers commonly established as an adequate short-term window. When it comes to the long-term horizon, the previous 24 months or 2 years monthly returns were considered to obtain their average monthly return, as for the rebalancing it was established that the portfolios should be updated in every 36 months. The idea of selecting different intervals for the past and future periods and in this case lower windows on the months taken into account to estimate the past returns, was to guarantee that the rankings were created with the most recent previous earnings of the companies and then evaluating over a wider interval their future results.

Table 1 – Table with the parameters chosen to build the portfolio

PARAMETERS	SHORT-TERM PORTFOLIOS	LONG-TERM PORTFOLIOS
PS	6 Months	24 Months
REB	12 Months	36 Months

Returns

After generating the portfolios for the 32 year period analyzed and its returns, was performed a simple analysis of the difference between the rolling average monthly returns of the best and worst performers companies portfolio to evaluate its evolution over time, to verify if there was a linear conclusion over the premium value that could be taken from it. The window period for the moving averages of the returns were 12 and 36 months, for the short and long term applications, respectively. The plots below (*Figure 1*) shows that in both scenarios during the majority of the period covered the premium is above 0, indicating a higher return from the best past performers portfolios. Moreover, this premium observed is in general higher in the short-term horizon when compared to the long-term approach.

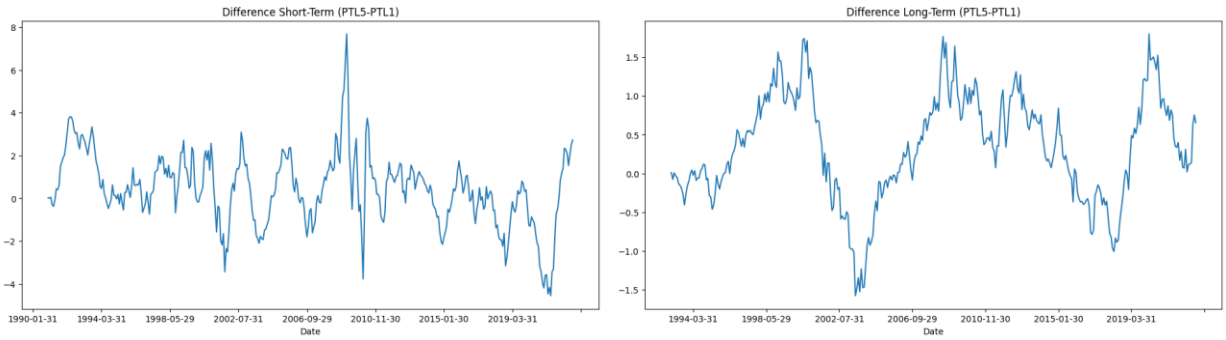

Figure 2 – Premium value between the best and worst performing portfolios

The excess returns of each of the portfolio were then calculated subtracting the risk-free rate, and the average monthly excess return summary can be seen in the table below, where is clear the high returns achieved by the best performer portfolios, as the portfolio 5 contains the best past performers companies while P1 the worst past performers. The difference observed in a short-term horizon is wider than when considered a longer time interval.

Table 2 – Average Monthly Excess Returns for each portfolio (1990-2022)

PORTFOLIO	SHORT-TERM	LONG-TERM
PTL 1	0.670 %	0.564 %
PTL 2	0.643 %	0.731 %
PTL 3	0.664 %	0.778 %
PTL 4	0.923 %	0.815 %
PTL 5	1.139 %	0.926 %

Financial Models

Gathered the portfolios and associated excess returns the next stage was the implementation of the three Financial models previously introduced into the created portfolios to assess their analysis of the data. The first model applied was the CAPM, and the *Table 3, Table 4* summarized the results obtained. The results for short and long term, don't differ much from each other, with the R^2 adjusted value ranging near the 0.5 mark, with near half of the variations of each of the portfolio can be explained by the movements of the market. The alpha values shows as well as their statistically significance a growing pattern for the best performers portfolios, in both situations, assuming the higher values in the last portfolios, that are the portfolios holding the best performer companies, that represents the returns obtained that are not a result of the general variations of the market, which is also visible from the beta values, as this portfolios, for both the short and long term scenarios have lower values, meaning a lower correlation with the market behavior.

Table 3 – Values of the CAPM parameters for the short-term portfolios

	R2 Adj	Alpha	pvalues Alpha	beta Market	pvalues Market
PTL 1	0.496	-0.084	0.735	1.093	0.0
PTL 2	0.551	-0.017	0.930	0.956	0.0
PTL 3	0.542	0.117	0.480	0.793	0.0
PTL 4	0.565	0.371	0.020	0.799	0.0
PTL 5	0.525	0.520	0.007	0.896	0.0

Table 4 - Values of the CAPM parameters for the long-term portfolios

	R2 Adj	Alpha	pvalues Alpha	beta Market	pvalues Market
PTL 1	0.473	-0.066	0.762	0.913	0.0
PTL 2	0.518	0.204	0.221	0.764	0.0
PTL 3	0.482	0.205	0.292	0.830	0.0
PTL 4	0.558	0.210	0.234	0.876	0.0
PTL 5	0.527	0.368	0.035	0.809	0.0

The next model was the Fama-French 3-Factor, that the results are presented below. Higher values of the variations of each of the portfolio can be explained by the movements of the market compared to the CAPM model, but the alpha values obtained follow the some pattern as from the previous model. Regarding the additional risk factors considered by this model, the beta values of the size factor are very close to 0, for both scenarios and are only statistically significant for the Portfolio 3, while in the other and all the beta of the value factor are statistically significant and appear to present higher values on the worst performers portfolios.

Table 5 - Values of the FF3 parameters for the short-term portfolios

	R2 Adj	Alpha	pvalues Alpha	beta Market	pvalues Market	beta SMB	pvalues SMB	beta HML	pvalues HML
PTL 1	0.593	-0.237	0.293	1.147	0.0	0.001	0.994	0.670	0.0
PTL 2	0.661	-0.152	0.371	0.994	0.0	0.069	0.219	0.599	0.0
PTL 3	0.603	0.049	0.753	0.850	0.0	-0.199	0.000	0.285	0.0
PTL 4	0.633	0.284	0.053	0.832	0.0	-0.009	0.853	0.385	0.0
PTL 5	0.574	0.432	0.019	0.926	0.0	0.010	0.874	0.386	0.0

Table 6 - Values of the FF3 parameters for the long-term portfolios

	R2 Adj	Alpha	pvalues Alpha	beta Market	pvalues Market	beta SMB	pvalues SMB	beta HML	pvalues HML
PTL 1	0.593	-0.237	0.293	1.147	0.0	0.001	0.994	0.670	0.0
PTL 2	0.661	-0.152	0.371	0.994	0.0	0.069	0.219	0.599	0.0
PTL 3	0.603	0.049	0.753	0.850	0.0	-0.199	0.000	0.285	0.0
PTL 4	0.633	0.284	0.053	0.832	0.0	-0.009	0.853	0.385	0.0
PTL 5	0.574	0.432	0.019	0.926	0.0	0.010	0.874	0.386	0.0

Finally the last model applied was the Carhart model, with the additional momentum risk factor. Again the a higher percentage of the variations of each of the portfolio can be explained by the movements of the market compared to the previous models, with some portfolios obtaining a value of 0.7. The alpha values range in a smaller interval, although with the same trends seen before, just like the beta of the market, size and value risk factors. The momentum factor presented a growing trend from negative values for the worst performers portfolios to the best performs, although for the Portfolio 5 in the long-term it is not statistically significant.

Table 7 - Values of the Carhart parameters for the long-term portfolios

	R2 Adj	Alpha	pvalues Alpha	beta Market	pvalues Market	beta SMB	pvalues SMB	beta HML	pvalues HML	beta MOM	pvalues MOM
PTL 1	0.667	0.098	0.633	1.004	0.0	0.016	0.808	0.516	0.0	-0.433	0.0
PTL 2	0.687	0.014	0.932	0.922	0.0	0.077	0.155	0.523	0.0	-0.215	0.0
PTL 3	0.607	0.107	0.492	0.825	0.0	-0.196	0.000	0.259	0.0	-0.076	0.0
PTL 4	0.632	0.274	0.066	0.836	0.0	-0.009	0.846	0.390	0.0	0.013	0.0
PTL 5	0.578	0.362	0.051	0.956	0.0	0.006	0.917	0.418	0.0	0.091	0.0

Table 8 - Values of the Carhart parameters for the long-term portfolios

	R2 Adj	Alpha	pvalues Alpha	beta Market	pvalues Market	beta SMB	pvalues SMB	beta HML	pvalues HML	beta MOM	pvalues MOM
PTL 1	0.633	-0.067	0.719	0.880	0.0	0.148	0.014	0.626	0.0	-0.201	0.000
PTL 2	0.709	0.136	0.303	0.811	0.0	-0.162	0.000	0.548	0.0	-0.085	0.004
PTL 3	0.610	0.255	0.139	0.802	0.0	-0.003	0.956	0.438	0.0	-0.216	0.000
PTL 4	0.624	0.193	0.243	0.905	0.0	-0.160	0.003	0.317	0.0	-0.083	0.025
PTL 5	0.558	0.311	0.070	0.832	0.0	-0.014	0.797	0.276	0.0	-0.008	0.827

In order to test the how well the models could estimate the returns of the portfolios and the cross-regression quality, the estimated parameters for each of the risk factors considered by the models and their statically significance were analyzed as well as the goodness of fit for the data, from the R2 adjusted value. For neither model, the lambdas obtain a p value lower than 0.05, meaning that neither of the risk factors are considered as statistically significant with a confidence level of 5%. The coefficients value are high for most of

the factors, except for the market risk for CAPM, that assume a negative value. Regarding the R2 adjusted values, they are significantly higher in the Fama-French model when compared to the CAPM which indicates a lot better fitness of the former model to the data, indicating that the CAPM is not a good model for explaining the risk and return of the stock. In such cases, other factors that may affect the stock returns, such as macroeconomic factors, industry-specific factors, or firm-specific factors, should be considered in order to develop a better model for explaining the risk and return of the stock. The Carhart model cross-regression values obtained were not normal, as it must be some kind of error on the application of the procedure and for that reason they were not considered in this analysis. There were evident differences between the short and long term data, where both models were a better fit for the long-term horizon with the FF3 providing a good explanation of the risk and return of the stock, taking into account the three factors in the model.

Table 9 – Cross-Regression coefficients and corresponding p values for each model risk factors (Short-Term)

	CAPM		Fama-French 3-Factor		Carhart 4-Factor	
Parameter	**coeff**	**pv**	**coeff**	**pv**	**coeff**	**pv**
LAMBDA_0	1.298	0.237	0.165	0.853	3.331	NaN
LAMBDA_M	-0.541	0.614	2.613	0.286	4.901	NaN
LAMBDA_SMB			3.099	0.177	13.226	NaN
LAMBDA_HML			-3.785	0.197	-16.326	NaN
LAMBDA_MOM					-1.458	NaN
R2 ADJ	**-0.206**		**0.752**		**NaN**	

Table 10 - Cross-Regression coefficients and corresponding p values for each model risk factors (Long-Term)

	CAPM		Fama-French 3-Factor		Carhart 4-Factor	
Parameter	**coeff**	**pv**	**coeff**	**pv**	**coeff**	**pv**
LAMBDA_0	1.726	0.169	1.789	0.101	1.901	NaN
LAMBDA_M	-1.149	0.388	-0.806	0.246	-0.925	NaN
LAMBDA_SMB			-0.009	0.960	-0.047	NaN
LAMBDA_HML			-0.648	0.101	-0.737	NaN
LAMBDA_MOM					0.271	NaN
R2 ADJ	**0.253**		**0.946**		**NaN**	

The final analysis regarding the three models was the comparison between the realized returns of the portfolios and the estimated returns from the model. In the figures below are presented a plot for each of the models, comparing the realized return of the portfolio and the associated estimation from the model. It's perceived the improving accuracy from the more complete models, where the estimated values are closer to

the realized returns. It's also visible that the long-term approach ended up with a better fitness of the models, which consequently lead to better accuracy of the estimated returns.

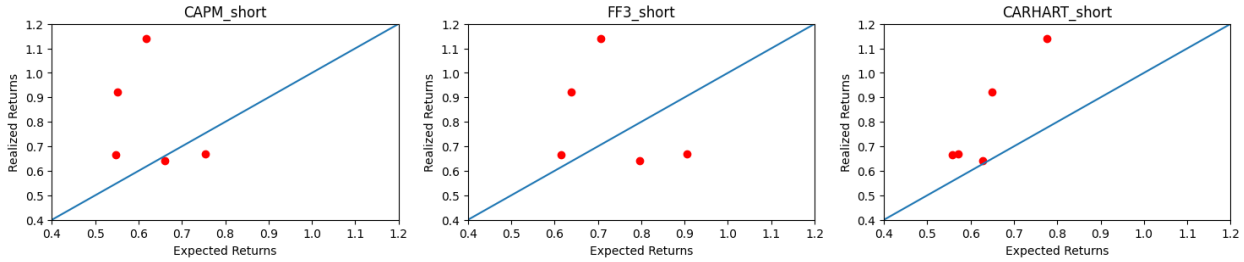

Figure 3 – Plots of the Realized Returns and the estimated Expected Returns for each of the models (Short-Term)

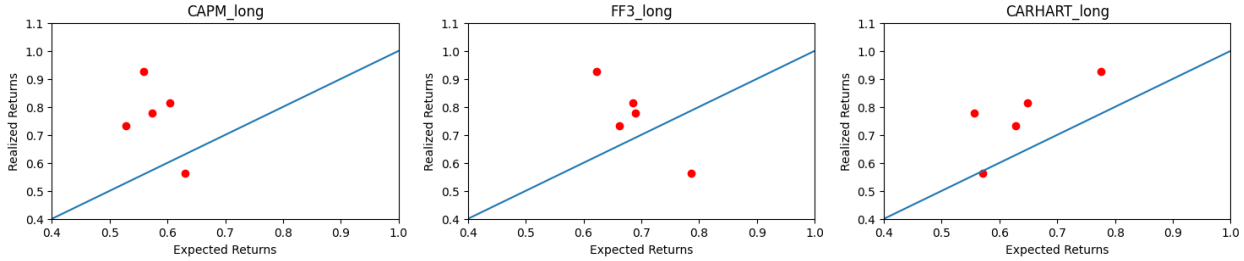

Figure 4 - Plots of the Realized Returns and the estimated Expected Returns for each of the models (Long-Term)

Risk Adjusted Performance Measures

One last evaluation to assess how the portfolios performed over the covered period was the Sharpe and Treynor ratio. The former, measures the amount of return generated by the portfolio for each unit of risk taken. In the data studied, the Sharpe ratio presents a growing trend from the worst performers to the best ones, but the difference between the portfolios is not as significant in the long-term environments as it is in the short-term returns. Regarding the Treynor ratio, it is used to assess the reward received for each unit of market risk taken by the portfolio or in other words, how much excess return was generated for each unit of risk taken on by a portfolio. Just like the Sharpe ratio there is a growing trend over the portfolios and again the difference between them is wider on the short-term approach than in the long-term.

Table 11 – Sharpe and Treynor Ratio for each portfolio, both long and short term

	Sharpe Short	Sharpe Long	Treynor Short	Treynor Long
PTL 1	0.10	0.10	0.61	0.62
PTL 2	0.11	0.16	0.67	0.96
PTL 3	0.14	0.15	0.84	0.94
PTL 4	0.20	0.16	1.16	0.93
PTL 5	0.21	0.19	1.27	1.15

These results suggest that there is a persistence from the past performance to the future, where the best past performers tend to continue to perform better in the future than the worst past performers, although this difference is more significant on the short-term than in the long term. These conclusions are consistent with some of the previous analysis carried out in this report.

Conclusions

The recursive portfolio approach is a common technique that allows to build dynamic portfolios, in this case based on past performance was crucial to assess the purposed research, that was the study of the persistence of past returns on the future performance of a asset or portfolio. The two horizon portfolios were built, to evaluate if the assets that performed well in the past would continue to perfume better than the ones that performed badly in the past, both considering a short period of time as well as a longer interval.

Throughout the development of this report, and from the different analyses applied, there was evidence of this persistence of performance from the portfolios and corresponding portfolios. Both from the average monthly excess returns, as from the moving average returns, the portfolios that contained the best performing companies achieved higher returns over the studied period. These differences were more significant on a short-term basis, smoothing in a long-term analysis. This conclusions were later reinforced by the Sharpe and Treynor ratios of the portfolios that ended up being in accordance with the previous analysis.

Regarding the implementation of financial models over the data, the more complex and complete models achieved a better fitness for the data, where the additional risk factors considered helped increasing the proportion of the variation in the stock returns that is explained by the factors that each of the model include, therefore obtaining more accurate estimations of the expected returns for the portfolios. Although there was an error when evaluating the cross-regression of the Carhart 4-Factor model, the expected returns were closer to the realized returns than the estimations obtained from the other models. All the three models presented a

better fit to the long-term portfolios where a higher portion of the variation of the returns were justified by the movements of the distinct risk factors and consequently their estimated values were more accurate than on the short-term scenario.