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Factor Investment: Evaluating Persistence Effect for Investment Performance and Sustainability Exposure

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Abstract

This research includes two separate studies. The first study is devoted to evaluating the persistence effect by analyzing performances of portfolios ranked based on previous performances under various factor models. The result shows that the shorter the holding period, the stronger the predictability and that the Multi-factor model has the highest explaining power for the excess return regarding the underlying factors. The second study is devoted to exploring how sustainable investing influences alpha by introducing a new sustainable factor to reflect the premium due to exposure to sin industries. The study result shows that there is no significant alpha associated with sustainable investing and that there is no significant return differential between funds that have high/low exposure to the sustainable factor.

Keywords: asset pricing, ESG, factor investment, green finance, persistence effect, sustainable investment

1. Introduction

This research is comprised of two separate studies. The first study is devoted to detecting the persistence effect. This study conducts an empirical analysis by first constructing rank portfolios of mutual funds based on previous performances and then evaluating their performance and the persistence effect under various factor models. The result shows that the shorter the holding period, the stronger the predictability. Besides, the Multi-factor model has the highest explaining power for the excess return regarding the underlying factors.

The second study is devoted to exploring how sustainable investing influences alpha. In this study, I constructed a new sustainable factor to reflect the premium due to exposure to sin industries. Then I performed a 4-step Fama-Macbeth analysis based on the mutual fund database 'fund_data_largest_500.csv' by using this factor. This research is devoted to exploring whether there is significant alpha associated with sustainable investing and whether there is a significant return differential between funds with high/low exposure to the sustainable factor according to the Fama-Macbeth results. The study result shows that there is no significant alpha associated with sustainable investing and that there is no significant return differential between funds that have high/low exposure to the sustainable factor.

The whole research is conducted by Python programming language. An Intel Core i5-8250U CPU (1.60 GHz) laptop with 8 GB RAM is applied for carrying out all the calculations and analyses. The Python codes and the task-based database are available on the Github link XUAN-FENG9/AFM_Mutual-Fund-Analysis (github.com).

This paper develops in the following outline. Following Section 2 first briefly summarizes the literature of studies about the persistence effect and sustainable investing. Following that, Section 3 describes the methodology and the construction of models. Then this paper moves into the main analysis – Section 4 illustrates the steps of the empirical studies and discusses the analysis results. The final Section 5 evaluates the whole task, summarizes major conclusions, and presents insights into further researches.

2. Literature Review

2.1 Persistence Effect

Hendricks et al. (1993) and Elton et al. (1996)'s study analyzed the return differential between the top and

bottom decile funds, and they found a high level of persistence in the performance of mutual funds. However, Carhart (1997) includes the equity momentum (WML) as a fourth factor and concludes that persistence does not exist. Huij et al. (2007) mentioned that the model of Carhart (1997) might lead to a serious underestimation of the persistence effect. This is because sorting the mutual funds based on their performance in the last year can lead to high (low) beta funds appear at the top (down) decile when the market return is positive, and low (high) beta funds appear at the down (top) decile when the market return is negative. But the WML momentum factor will also present the same pattern – high (low) beta stocks appear at the top (down) decile when the market return is positive, and vice versa – simultaneously. Therefore, the alpha caused by persistence is absorbed in the WML factor, and the Carhart model shows that the outperformance disappears for mutual funds in high-ranked deciles. Berk (2005) argued that persistence could not exist in the long term if fund managers' skills are heterogeneous. And Bollen and Busse (2005) found that the persistence effect exists in the short term by analyzing high-frequency daily data.

2.2 Sustainable Investing

Environment, social, and governance issues are increasingly influencing financial activities and decisions worldwide. For example, the extent of the environmental impact of climate change is still uncertain, but the recent scientific evidence is increasingly worrisome and most governments are taking decisive steps in order to avert a catastrophe. The transition towards a low-carbon economy requires various financial tools and techniques that will have far-reaching implications for financial institutions, corporations, and investors. The ESG topic is also located in the area of impact investing, which focuses more on the intention to shift the future of the world. Impact investors proactively use their investments to generate a tangible, beneficial social or environmental impact alongside a financial return. For family foundations specifically, impact investing contributes to advance the core social and environmental goals while maintain or growing the overall endowment.

Many researchers have investigated whether investors can obtain superior risk-adjusted returns by implementing responsible investing strategies. Friede et al. (2015) found a positive association between a company's environmental, social, and governance (ESG) performance and its financial performance. However, there may be a publication bias, and the impact of ESG on stock returns depends on the extent to which climate risk and other ESG aspects are priced on the stock market. Hong and Kacperczyk (2009) find that "sin stocks" yield higher returns, while Hong et al. (2018) suggests that the pricing of ESG risks is incomplete. A recent study estimates the carbon premium across the world (Bolton & Kacperczyk, 2020). There are also many other scholars who studied the various financial instruments and techniques applied in the context of ESG issues, such as the evolving climate policies. For example, how to use capital markets to create emissions trading systems and fundamental investing (Cremers & Pareek, 2016; Schoenmaker & Schramade, 2019; Van Nieuwerburgh & Veldkamp, 2010).

It is also worthful to notice that the proxy used to represent the ESG level or rating varies across different rating agencies. This variation or disagreement on the ESG rating among different agencies may also influence the cross-section stock returns. In a 2021 working paper, Rajna Gibson, Philipp Krüger, and Peter Schmidt ("ESG Rating Disagreement and Stock Returns") study this influence by regressing the return on the independent variable called "Disp" (for "rating dispersion") – which is defined as the standard deviation across the ESG ratings for a particular firm in a particular year stemming from 7 different ESG databases – and a set of other controlling variables. Their results show that the coefficient on Disp is positively and statistically significant around the 5% level, a result suggesting that the stocks of firms with high ESG rating disagreement tend to have higher returns going forward than the stocks of firms with low ESG rating disagreement. The "high ESG rating disagreement premium" may be explained by the risk brought by the disagreement – investors with ESG preferences tend to ask for a higher return to compensate for the uncertainty about the ESG rating.

In this research, I am devoted to testing whether greater exposure on "sin stocks" can yield higher returns, as Hong and Kacperczyk (2009) concluded, and whether there is significant alpha associated with sustainable investing.

3. Methodology and Data

3.1 Study for Persistence Effect

This research analyzes the mutual fund performance and persistence based on the database of the largest 500 funds (the 'fund_data_largest_500.csv' database) through time. The first step is to summarize the funds' data and load the Fama French database. Figure 1 plots the asset value over time. Figure 2 presents the cumulative log returns over time for each factor in the Fama-French database. Then, this research evaluates the performance and the persistence effect based on the decile portfolio constructed using 60- and 36-month formation periods and

12-month holding periods. The models I used include CAPM model (Equation 1), Fama-French 3 factor model (Equation 2), and Carhart 4 factor model (Equation 3).

$$Actual\ Return = \alpha + R_F + \beta_{Mkt} Mkt - RF + \varepsilon \quad (1)$$

$$Actual\ Return = \alpha + R_F + \beta_{Mkt} Mkt - RF + \beta_{SMB} SMB + \beta_{HML} HML + \varepsilon \quad (2)$$

$$Actual\ Return = \alpha + R_F + \beta_{Mkt} Mkt - RF + \beta_{SMB} SMB + \beta_{HML} HML + \beta_{WML} WML + \varepsilon \quad (3)$$

Where the $Mkt - RF$ represents the stock market premium, the SMB represents the size premium (small minus big), the HML represents the value premium (mature stocks minus growth stocks), and the WML represents the momentum factor (win minus lose). α represents the abnormal return/excess return that is not expected.

For each model, I set the holding periods as 12-months but set the formation period as 60 and 36-months separately. Therefore, there are 6 models. Finally, I investigate short-run performance persistence as documented by Berk and Green (2005) and Bollen and Busse (2005) based on the Fama-French 3 factor model by constructing another 6 models - rank portfolios 12- and 3-month formation periods and 12-, 3- and 1-month holding periods. The results are detailed in Appendix 1.

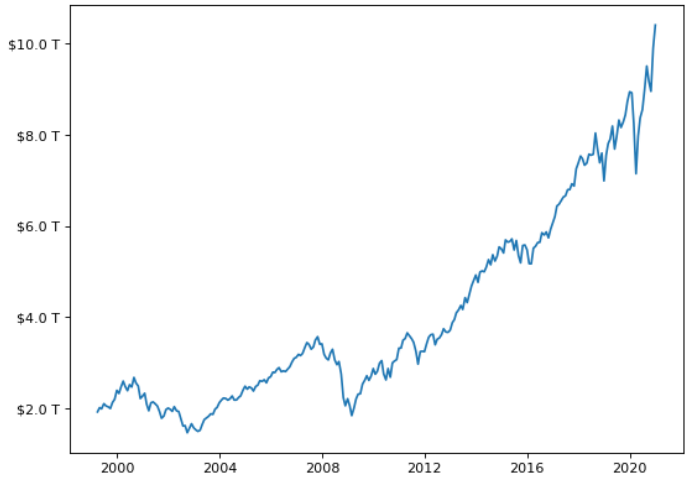


Figure 1. Asset over time of the largest 500 fund

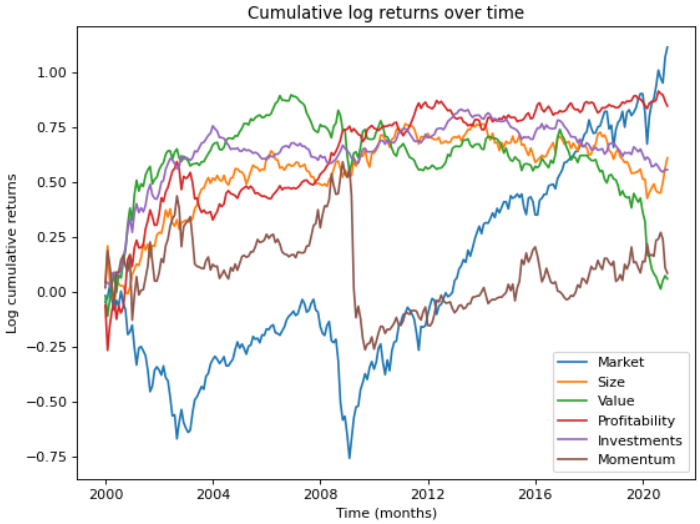


Figure 2. Cumulative log returns over time for Fama-French factors

3.2 Study for Sustainable Investing

This research firstly constructed a sin-premium factor to measure funds' exposure to the sin industry, then conducted a 4-step Fama-Macbeth analysis.

The sin-premium factor is constructed through two steps. The first step is calculating the arithmetic average of monthly stock returns of all stocks in three sin industries: tobacco industry (SIC code: 211, 212, 213, and 214), alcohol industry (SIC code: 2082-2085), and oil & gas industry (SIC code: 131, 132, 138). All the stock returns are collected on the WRDS database (WRDS – CRSP - Annual Update - Stock / Security Files – CRSP Monthly Stock) and set the period from July 1963 to December 2020. The original data and the after-aggregate monthly main data are available at the "sin industry.xlsx" document on https://github.com/XUAN-FENG9/AFM_assignment. The second step is to calculate the monthly sin-industry premium by subtracting the risk-free rate from the average sin-industry return defined in step 1. In this study, I defined this sin-industry premium as another factor – Sin-RF – and added it to the Fama-French data, as shown in Figure 3. The whole Fama-French data is available at the "FF.xlsx" document on https://github.com/XUAN-FENG9/AFM_assignment.

Date	Mkt-RF	SMB	HML	RMW	CMA	Sin-RF	RF	WML
196307	-0.0039	-0.0045	-0.0094	0.0066	-0.0115	0.0214	0.0027	0.0100
196308	0.0507	-0.0082	0.0182	0.0040	-0.0040	0.0662	0.0025	0.0103
196309	-0.0157	-0.0048	0.0017	-0.0076	0.0024	0.0085	0.0027	0.0016
196310	0.0253	-0.0130	-0.0004	0.0275	-0.0224	-0.0087	0.0029	0.0314
196311	-0.0085	-0.0085	0.0170	-0.0045	0.0222	-0.0096	0.0027	-0.0075
...	...	...	...	...	...	...	...	...
202008	0.0763	-0.0094	-0.0294	0.0427	-0.0144	-0.0004	0.0001	0.0051
202009	-0.0363	0.0007	-0.0251	-0.0115	-0.0177	-0.1418	0.0001	0.0305
202010	-0.0210	0.0476	0.0403	-0.0060	-0.0053	-0.0120	0.0001	-0.0303
202011	0.1247	0.0675	0.0211	-0.0278	0.0105	0.3577	0.0001	-0.1225
202012	0.0463	0.0474	-0.0146	-0.0216	-0.0008	0.1139	0.0001	-0.0234

Figure 3. Fama-French data with the sin-RF factor

Following Figure 4 presents the cumulative log-returns of the 7 factors in the Fama-French data since 2000. We can see that for the sin premium factor, the cumulative return is always positive and is significantly higher than returns of all other factors from 2004 to 2016. This is in line with Hong and Kacperczyk (2009)'s result that stocks in sin industries can yield higher returns.

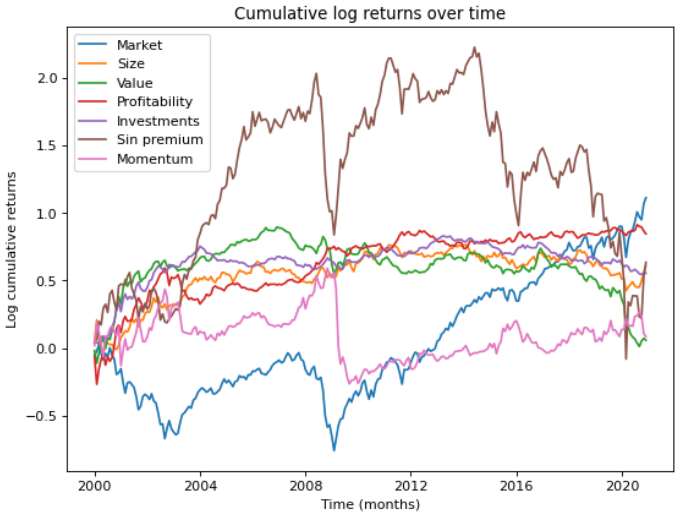


Figure 4. Fama-French cumulative return plot (after 2000)

After adding the Sin-RF factor to the Carhart-4 factor model, the adjusted model used for this analysis is presented in Equation (4).

$$Actual\ Return = \alpha + R_F + \beta_{Mkt} Mkt - RF + \beta_{SMB} SMB + \beta_{HML} HML + \beta_{WML} WML + \beta_{Sin-RF} Sin - RF + \varepsilon \quad (4)$$

Where the $Sin - RF$ factor represents the sin-industry premium (average return of companies in the sin industry minus the risk-free rate).

4. Empirical Analysis

4.1 Performance Persistence Effect (Long-Term)

The 36-months and 60-months lookback periods' cumulative return over the 12-months holding periods are presented in Figure 5 and Figure 6 separately. From the figures, we can see that the shorter lookback period leads to more accurate predictability. For example, the return of funds in the quantile 10 is significantly higher than others when using 36-months lookback period, but it is intertwined with the return of quantile 9 when using 60-months (longer) lookback period.

Figure 5. Cumulative returns over holding period based on 36-months lookback

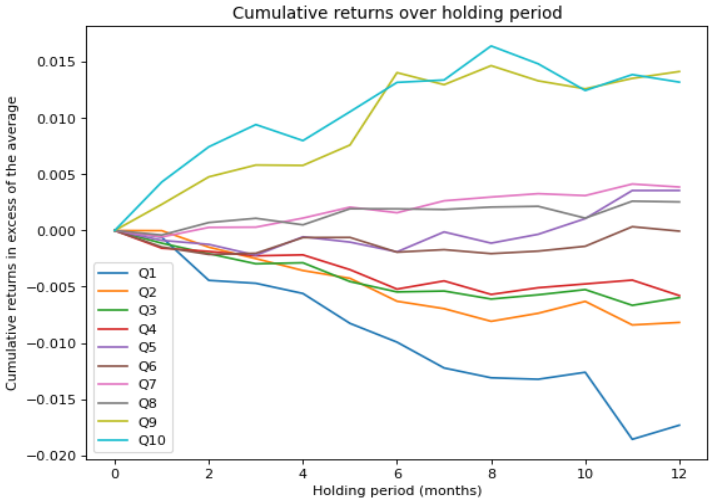


Figure 6. Cumulative returns over holding period based on 60-months lookback

Figure 7 summarizes the performance of quantile funds using three models – CAPM, FF-3 factors model, and the Carhart model – based on 36 and 60-months lookback periods. The detailed results are also available in Appendix 1. The results show that using the CAPM model leads to the strongest predictability for alpha. The other two models do not show significant persistence. This may be because the momentum factor in the Carhart model has already absorbed part of the persistence effect, and the HML and SMB factors are inherently conflicted – for example, small-cap stocks usually have a low book-to-market ratio.

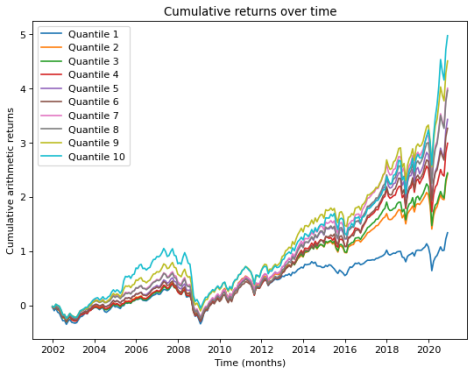
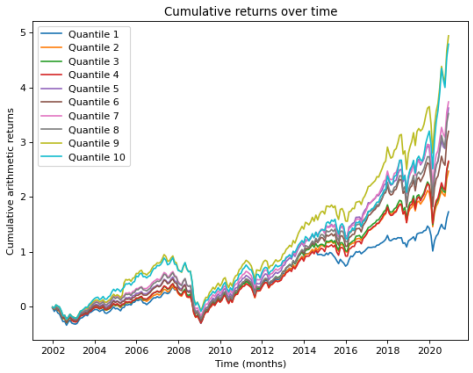
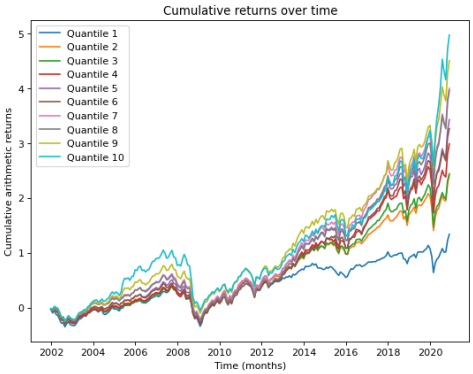
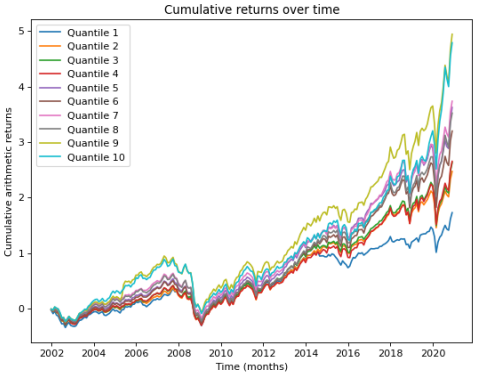
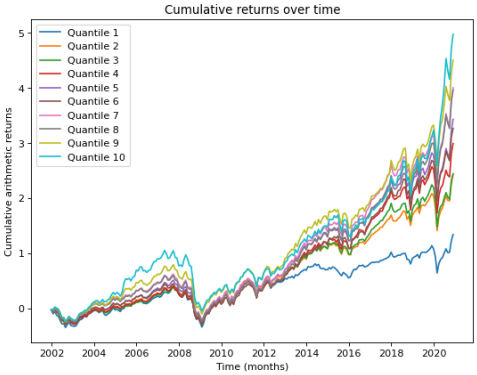
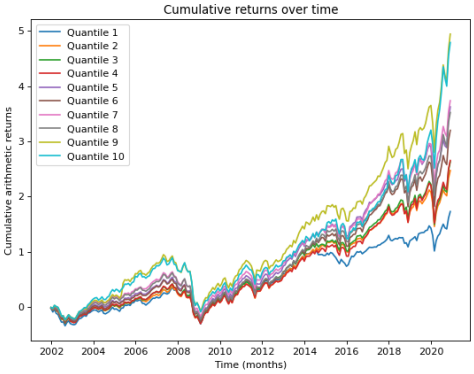
Model	36-months formation	60-months formation
CAPM		
FF-3 factor		
Carhart		

Figure 7. Quantile performance in holding periods under three models

Then I use the Fama-French 3 factor model to conduct the short-term persistence analysis. The result is presented in Figure 8, and the detail is available in Appendix 1.

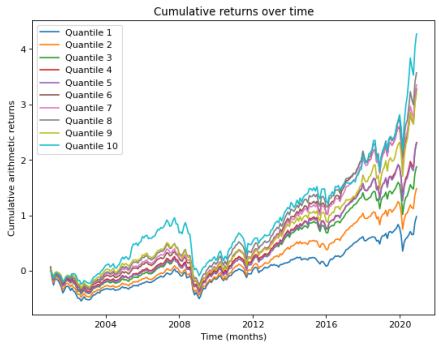
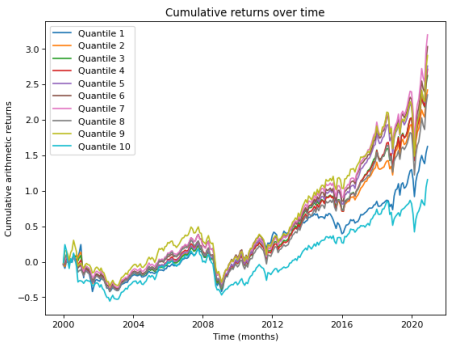
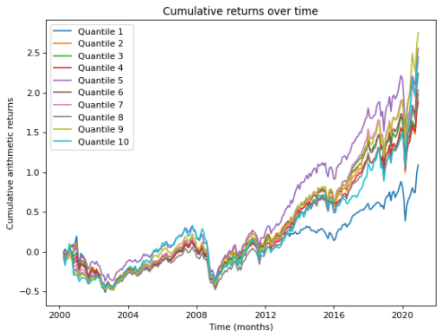
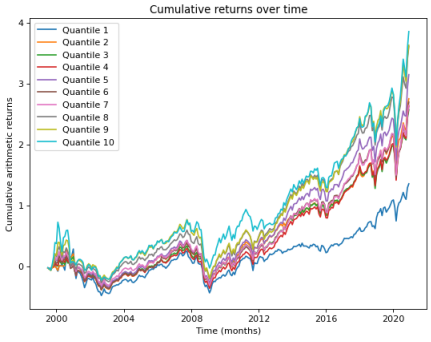
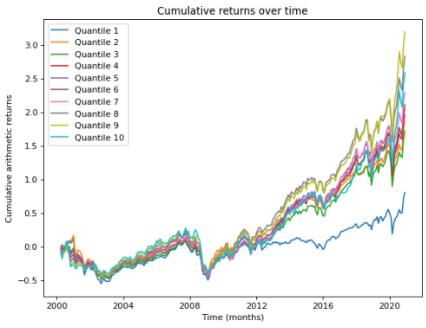
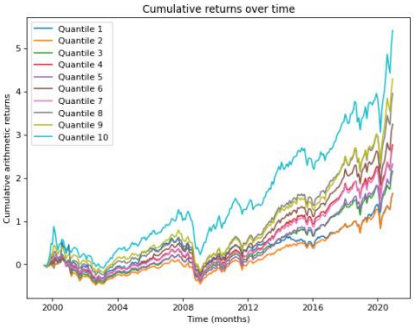
Look-forward period	Formation Period	
	12-months formation period	3-months formation period
12-months		
3-months		
1month		

Figure 8. Quantile performance and persistence for short-term analysis (FF-3 model)

Based on the 12-months and 3-months formation period and the 12-, 3-, and 1- month(s) holding period, the predictability is the strongest for the 12-months formation – 12-months look-forward combination and the 3-months formation – 1-month look-forward combination. This can be explained that the average return of the longer past can not predict the shorter near future. If we take the 12-months as the formation period, the average return of the past 12 months may include longer-past influence that may not appear in the nearly 1 or 3-months, so the 3 and 1-months look-forward period have less predictability. But the same length look-forward period – 12-months – appears to have a stronger persistence effect. The 3-months formation period is inherent a short period, so the strongest persistence effect appears when looking forward 1-month.

Furthermore, both the long-term and short-term analysis also shows that the top decile of funds does not always earn a statistically significant superior return, but the superior return between high and low deciles is significant.

4.2 Performance Persistence Effect (Short-Term)

Focusing on the short-term performance persistence, I set formation (12 and 3-months) and holding periods (12-, 3-, and 1-months), and I conduct my analysis based on the CAPM, FF-3 factor model, 4-factor Carhart model, FF-5 factors model (Equation 5, including profitability and investment quality factors), and a multifactor model (Equation 6) including all factors used in the previous models. Moreover, I conducted a separate analysis of a lag between formation and holding period of 1-month.

$$Actual\ Return = \alpha + R_F + \beta_{Mkt}Mkt - RF + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{RMW}RMW + \beta_{CMA}CMA + \varepsilon \quad (5)$$

$$Actual\ Return = \alpha + R_F + \beta_{Mkt}Mkt - RF + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{RMW}RMW + \beta_{CMA}CMA + \beta_{WML}WML + \varepsilon \quad (6)$$

Where the RMW factor is the return spread between profitable and unprofitable companies, and the CMA factor represents the return spread between companies that invest conversely and companies that invest aggressively. The $Mkt - RF$ represents the stock market premium, the SMB represents the size premium (small minus big), the HML represents the value premium (mature stocks minus growth stocks), and the WML represents the momentum factor (win minus lose). α represents the abnormal return/excess return that is not expected.

This analysis is devoted to comparing the model difference on the short-term performance persistence. The result is presented in Appendix 2. From the result, we can see that based on the 3- and 12-months formation period, the shorter the holding period, the stronger the predictability, and that the multi-factor model has the highest explaining power for the excess return regarding the underlying factors. We also find that the top decile of funds does not earn a statistically significant superior return. Some of the other decile funds earn, on the contrary, a higher superior return compared to the top decile. This finding is in line with the finding of core analysis.

Furthermore, by constructing a lag of 1-month under the Fama-French 5 factor model and setting the 12-months formation – 1-month holding period, I found that the lag of 1-month has a great impact on the top 3 decile funds that have overperformances. The results are presented in Figure 9 and Figure 10.

Based on Fama-French 5 factor model,
12 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0575149	0.0688206	0.0784184	0.0728707	0.0727581	0.0759005	0.0809365	0.0962108	0.0978525	0.111804
Avg excess returns	0.0344586	0.0457642	0.055362	0.0498144	0.0497017	0.0528442	0.0578801	0.0731545	0.0747961	0.0887474
Volatility	0.182539	0.15953	0.16085	0.154136	0.15391	0.154705	0.158186	0.168053	0.172692	0.195796
Sharpe ratio	0.188773	0.286869	0.344184	0.323184	0.322926	0.34158	0.3659	0.435306	0.433119	0.453264
Alpha	-0.012305	-0.00656777	-0.0048749	-0.00758558	-0.0109685	-0.00860109	-0.00541525	0.00490758	0.00976862	0.014119
Std. error (α)	0.00151128	0.000926698	0.000811752	0.000520373	0.000376352	0.000352162	0.000466945	0.000889304	0.000961414	0.00159726
t-stat (α)	-0.678511	-0.590607	-0.50045	-1.21477	-2.42868	-2.03531	-0.966434	0.459871	0.846724	0.736624
p-value (α)	0.498068	0.555311	0.617193	0.225588	0.0158514	0.0428624	0.33475	0.646004	0.397949	0.462034
Beta	1.00344	0.948755	0.988722	0.95614	0.973826	0.964335	0.961529	0.969428	0.917101	0.939483
SMB	-0.148308	-0.0648357	-0.0462055	-0.0238776	-0.0266012	0.0263161	0.0839441	0.171262	0.281605	0.41242
HML	0.239025	0.155692	0.101269	0.106429	0.0778953	0.0165455	-0.0175955	-0.0867703	-0.156314	-0.341642
RMW	-0.111869	-0.0110557	0.0185665	0.00576508	0.0209667	-0.00892052	-0.0491687	-0.0659141	-0.161005	-0.131703
CMA	-0.280953	-0.193921	-0.0665653	-0.103535	-0.0431201	-0.0286169	0.0241227	0.0845927	0.0696832	0.121382
R2 adjusted	0.811513	0.907374	0.930042	0.968752	0.983616	0.985824	0.976129	0.923082	0.914936	0.817011

Figure 9. FF-5 factor performance without lag

Based on Fama-French 5 factor model,
12 month formation period and 12 month holding period,
with a lag of 1 month,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0814872	0.085459	0.0925154	0.0791163	0.0817498	0.0819366	0.0804902	0.083878	0.077998	0.069759
Avg excess returns	0.0584308	0.0624026	0.069459	0.05606	0.0586934	0.0588802	0.0574338	0.0608217	0.0549416	0.0467027
Volatility	0.171633	0.152609	0.161428	0.153016	0.151229	0.155845	0.157379	0.169688	0.171551	0.188033
Sharpe ratio	0.34044	0.408905	0.43028	0.366368	0.388109	0.377814	0.364939	0.358432	0.320265	0.248375
Alpha	0.0029386	0.00544378	0.00613273	-0.00352049	-0.00588058	-0.00319552	-0.00259871	-0.00480533	-0.0120053	-0.0185571
Std. error (α)	0.00133456	0.000740132	0.000818406	0.000481685	0.000471171	0.000334989	0.000529286	0.000901414	0.00088152	0.00145408
t-stat (α)	0.183494	0.612929	0.624459	-0.609057	-1.04006	-0.794931	-0.409153	-0.44424	-1.1349	-1.0635
p-value (α)	0.85457	0.540521	0.532937	0.543082	0.299393	0.427466	0.682805	0.657283	0.257583	0.288659
Beta	0.927954	0.91728	0.958948	0.95196	0.969418	0.971892	0.960012	1.01006	1.00457	1.0475
SMB	0.08377	0.0258851	0.0660197	0.0210325	0.0053022	0.0344573	0.036854	0.0636763	0.0811588	0.0521336
HML	0.218011	0.169916	0.0553117	0.0809966	0.0896279	0.0101409	-0.0171957	-0.0663907	-0.127853	-0.164722
RMW	-0.187306	-0.0579316	-0.0955146	-0.0182115	0.0561504	-0.0303446	-0.0638558	-0.0476786	-0.0499824	-0.018304
CMA	-0.0350535	-0.0476214	0.0259347	-0.0498462	0.0202324	-0.0359911	-0.0502596	-0.0486793	-0.114906	-0.223862
R2 adjusted	0.847326	0.940789	0.93522	0.975162	0.975661	0.988432	0.971686	0.92926	0.93386	0.85032

Figure 10. FF-5 factor performance with a lag of 1-month

4.3 Sustainable Investing (Fama-Macbeth Analysis)

The Fama-Macbeth analysis is conducted by following 4 steps, and the python code is available at the "Estimating factor premiums.ipynb" document on https://github.com/XUAN-FENG9/AFM_assignment.

The first step is adding new variables to the mutual funds' data (rolling regressions). In this step, I calculated the 3-year alpha, RMRF, SMB, HML, Sin-RF, and WML beta for each fund in each month. And I set a lookback period of 36-months.

The second step is creating a strategy based on mutual funds ("rank portfolios"). Following Huij & Verbeek (2009), I create **10** quantile portfolios based on the funds' exposures to the factors (low to high from 1 to 10). Then I sort stocks based on their exposure to the Sin premium factor (Sin-RF). Figure 11 presents the cumulative returns of quantile portfolios. We can see that there are no significant return differences among different quantiles, except for quantile 10, which has the highest exposure to sin industry and the long term significant lowest return as expected. But for funds at quantile 1 and 2, which are expected to have lower returns because of lower exposure to sin industry, the result shows that, as expected, they do have slightly lower returns than other quantiles except quantile 10. But the difference is not very significant.

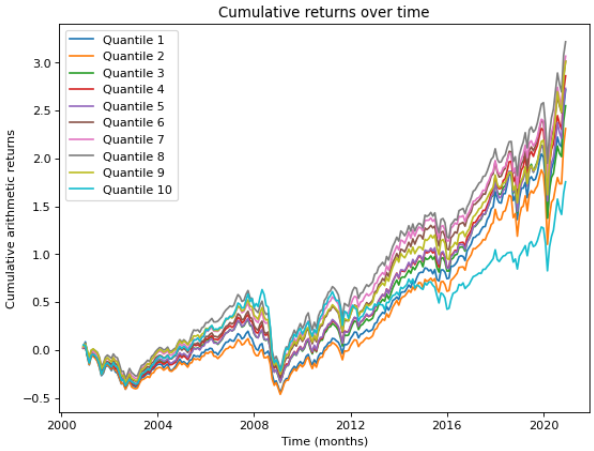


Figure 11. Plot of the cumulative returns of quantile portfolios

The third step is conducting a Cross-sectional Fama and MacBeth (1973) regression. In this step, I calculate the time-series Fama-French regressions on the 10 quantile portfolios to get betas. Then I run full-sample CAPM regressions on the quantile portfolios and plot annualized alphas, as shown in Figure 12:

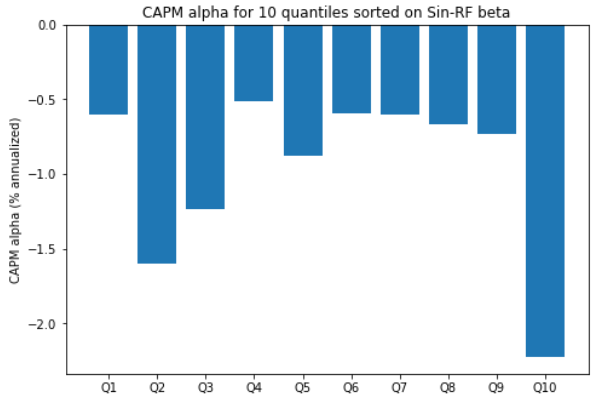


Figure 12. CAPM alpha for 10 quantiles sorted on Sin-RF factor beta

From Figure 12, we can see that alpha is not associated with sustainable investing. Funds that have higher exposure to the sin industry do not have higher alphas than funds with lower sin exposures, as suggested by Hong and Kacperczyk (2009). This result is aligned with the result presented in Figure 11.

The fourth step is calculating the Fama-MacBeth (1973) regressions on the quantiles. In this step, I calculate the cross-quantile regression on betas of the 10 quantiles to estimate the factor premium, and the result is presented

in Table 1. It is worth noting that I have already lagged the betas by one month in the previous code. The significance of the premiums is presented in Table 2.

Table 1. Result of estimating Fama-MacBeth premiums (sorting on Sin-RF beta)

Premium	Time-series average (monthly)	Hypothetical long-short (monthly)
Mkt	0.80%	0.57%
SMB	0.17%	0.23%
HML	0.35%	0.25%
WML	0.52%	0.64%
Sin	1.59%	0.76%

Table 2. The significance of the premiums

Premium	Significance
Gamma_Mkt	2.706251
Gamma_SMB	0.471360
Gamma_HML	1.022293
Gamma_WML	0.955124
Gamma_Sin-RF	1.321257

The result in Figure 13 shows that the estimated Sin premium is 1.59% per month - a positive value which means that funds that have higher exposures to the sin industry are expected to have higher returns, as concluded by Hong and Kacperczyk (2009). But the significance of this factor is not very significant (t-statistics 1.32), as shown in Figure 14. From this result, we can conclude that there is no significant return difference between funds that have high exposures to the Sin-RF factor and funds that have low exposures.

5. Conclusion and Recommendation

5.1 Persistence Effect

This research found the persistence effect of mutual funds, especially in the short term. The result is in line with the finding of Bollen and Busse (2005). From this research, I conclude that the shorter the holding period, the stronger the predictability. However, if the holding period is short, the lookback period cannot be very long because a long lookback period will bring historical factors that do not appear in the short-term forecasting period. The research result also shows that the Multi-factor model has the highest explaining power for the excess return regarding the underlying factors. Moreover, the result shows that the top decile of funds does not earn a statistically significant superior return. Some of the other decile funds earn, on the contrary, a higher superior return compared to the top decile.

Based on the results found in this research, I recommend to invest funds at quantile 7 to 10 that have higher returns than others. The investor can choose a benchmark not only based on the alpha but on the sharp ratio or information ratio. Investors are also recommended to use the Multi-factor model as a supplement to the CAPM model to explore the persistence effect.

This and previous researches do not reveal that how long the persistence will insist. Therefore, in future researches, it is interesting to investigate the length of the performance persistence. And it is also interesting to add other factors that can influence the fund performance, for example, the quality factors. Furthermore, I am also interested in exploring the impact of geographic differences on the persistence effect by conducting the above analysis on the US, EU, and emerging markets separately. The geographic difference is worth consideration because different markets have different trading limitations and different market efficiency, which can greatly influence the persistence effect. For example, it is reasonable to assume that emerging markets have less market efficiency than developed countries. Therefore, the persistence effect in emerging markets is more significant than that in developed countries.

5.2 Sustainable Investing

The result in this research shows that there is no significant alpha associated with sustainable investing. And there is no significant return differential between funds that have high/low exposure to the selected factor. By running the Fama-MacBeth regression, my result shows that there is a positive ‘sin premium’ – higher return for funds exposed more on the sin factor (comprise more stocks from companies in the sin industry). But this sin

premium is not significant, with a t statistic that equals 1.32. Therefore, from my study, funds that investing in the sin industry and that investing in the sustainable industry has no significant difference in abnormal returns.

In this research, I use the arithmetic average excess return of stocks in the tobacco, alcohol, and oil & gas industry as a factor proxy for the premium of exposure on sin industries. However, in future studies, this factor premium can be built more complex by using the weighted average and including stocks in other sin industries, although hard to find the data, such as unethical entertainment, weapon manufacturing., etc. Moreover, it is also interesting to investigating whether the sin premium varies geographically. For example, whether the effect of sin exposure is different between developed and developing countries.

Furthermore, the result in this research cannot totally deny the benefit of sustainable investing that prioritizes the delivery of social and environmental impacts. Sustainable investing needs a different assessment system that not only includes financial performance measured based on risk-adjusted returns. In future research, it is attractive to evaluate the non-financial outcomes of sustainable investing individually, with a tailored, predetermined matrix. More efforts are also needed to construct a suitable proxy that can reflect these non-financial outcomes thoroughly.

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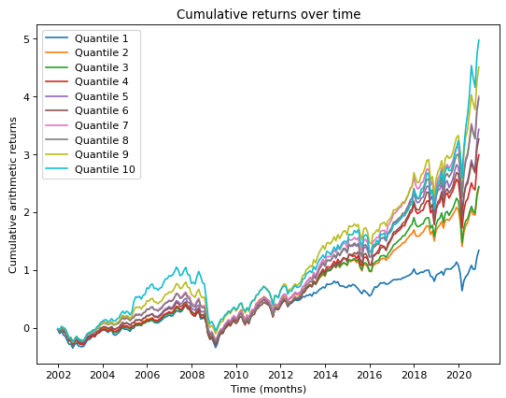
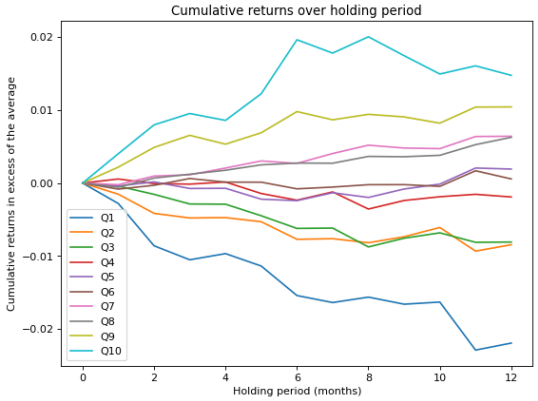
Appendix 1. Results for core analysis

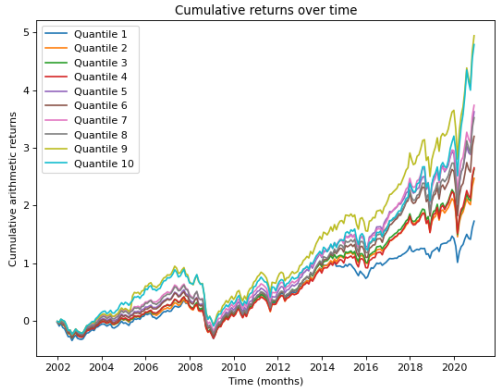
1. CAPM Model (**36-months** lookback period - **12-months** holding period)

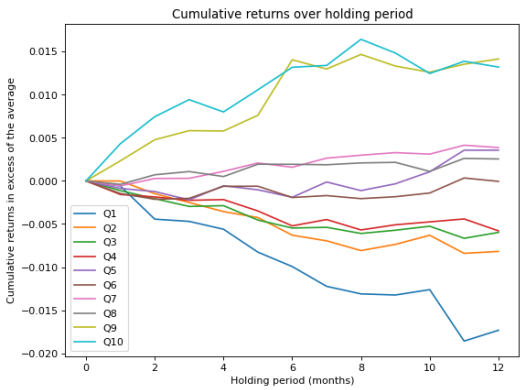




	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0566497	0.0756524	0.0761634	0.0848271	0.090166	0.0882847	0.0964259	0.0962094	0.101924	0.107889
Avg excess returns	0.0335934	0.0525961	0.053107	0.0617707	0.0671096	0.0652283	0.0733696	0.073153	0.0788677	0.0848322
Volatility	0.152518	0.145205	0.14648	0.152235	0.151005	0.15161	0.149642	0.150927	0.152551	0.162834
Sharpe ratio	0.220259	0.362219	0.362555	0.405759	0.444419	0.430238	0.4903	0.484691	0.516993	0.520975
Alpha	-0.0381602	-0.0186845	-0.019981	-0.0146319	-0.00928514	-0.011566	-0.00225469	-0.00296475	0.00297001	0.00714766
Std. error (α)	0.00107243	0.000650054	0.000479022	0.000496842	0.000325499	0.000316797	0.000322444	0.000392586	0.000612511	0.00111363
t-stat (α)	-2.96524	-2.39526	-3.47601	-2.45415	-2.37716	-3.04243	-0.582708	-0.629321	0.404075	0.534864
p-value (α)	0.00334886	0.0174241	0.000610132	0.0148776	0.0182803	0.00262424	0.560671	0.529775	0.686539	0.59327
Beta	0.931909	0.92657	0.946972	0.984387	0.984298	0.988809	0.975601	0.981172	0.978687	0.998857

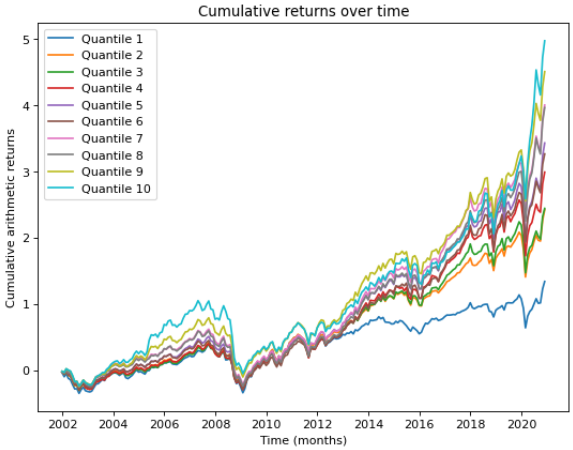
2. CAPM Model (**60-months** lookback period - **12-months** holding period)

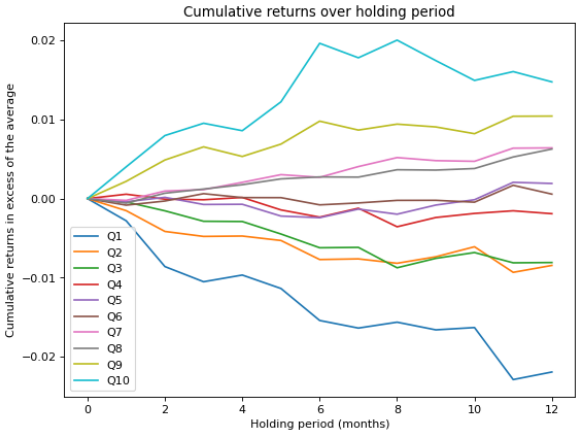




	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0632332	0.0761355	0.0792584	0.0795353	0.0926525	0.0875984	0.0930183	0.0911531	0.107178	0.105879
Avg excess returns	0.0401768	0.0530791	0.056202	0.0564789	0.0695962	0.064542	0.0699619	0.0680967	0.0841215	0.0828223
Volatility	0.14305	0.143905	0.148934	0.148736	0.152996	0.153226	0.146985	0.150512	0.160853	0.160793
Sharpe ratio	0.280859	0.368848	0.377361	0.379725	0.454888	0.42122	0.475979	0.452434	0.52297	0.515087
Alpha	-0.0272316	-0.0184289	-0.0184374	-0.0184377	-0.00787584	-0.0131697	-0.00404865	-0.00776455	0.00605559	0.00386169
Std. error (α)	0.000938644	0.000496432	0.000457488	0.000367838	0.000351808	0.00031674	0.000336487	0.000389977	0.000963442	0.00086115
t-stat (α)	-2.41764	-3.09356	-3.35845	-4.17705	-1.86556	-3.4649	-1.00268	-1.65919	0.523781	0.373695
p-value (α)	0.0164142	0.00222693	0.000919763	4.21929e-05	0.0633981	0.000634545	0.317089	0.0984642	0.600944	0.708982
Beta	0.882861	0.929137	0.964484	0.967613	0.996459	0.999164	0.957386	0.978277	1.00316	1.01326
SMB	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
HML	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

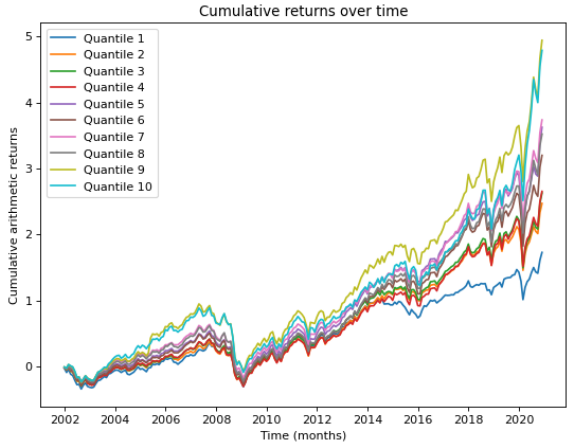
3. FF 3 factor model (36-months lookback period - 12-months holding period)

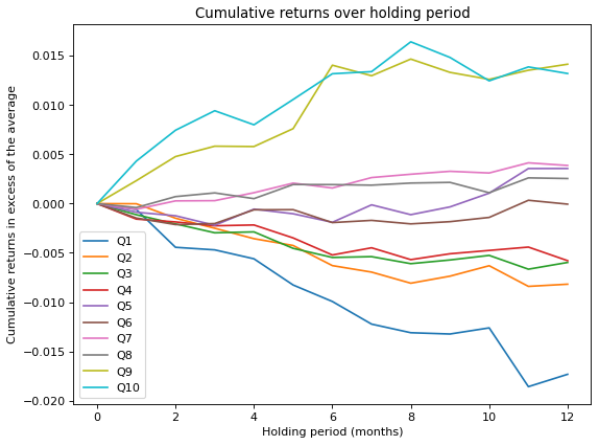




	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0566497	0.0756524	0.0761634	0.0848271	0.090166	0.0882847	0.0964259	0.0962094	0.101924	0.107889
Avg excess returns	0.0335934	0.0525961	0.053107	0.0617707	0.0671096	0.0652283	0.0733696	0.073153	0.0788677	0.0848322
Volatility	0.152518	0.145205	0.14648	0.152235	0.151005	0.15161	0.149642	0.150927	0.152551	0.162834
Sharpe ratio	0.220259	0.362219	0.362555	0.405759	0.444419	0.430238	0.4903	0.484691	0.516993	0.520975
Alpha	-0.034878	-0.0175281	-0.0185175	-0.0136673	-0.00825067	-0.0125492	-0.0024049	-0.00444989	-0.00118578	-0.00146578
Std. error (α)	0.00105049	0.000638363	0.000471678	0.00049272	0.000313667	0.000307741	0.000324646	0.000383082	0.000561557	0.00101539
t-stat (α)	-2.7668	-2.28816	-3.27157	-2.31154	-2.192	-3.3982	-0.617314	-0.968003	-0.175967	-0.120297
p-value (α)	0.00613389	0.0230611	0.00123845	0.0217116	0.0294098	0.000802724	0.537655	0.334087	0.860479	0.904356
Beta	0.898651	0.904913	0.934036	0.971513	0.97117	0.980019	0.972145	0.973552	0.963706	0.983676
SMB	0.0695493	0.0100866	0.158589	0.0790936	0.00629442	4.66961e-05	0.214673	0.000419689	3.37329e-08	1.08278e-06
HML	0.00848942	0.0945524	0.00991152	0.0868015	0.00438379	0.0310627	0.798178	0.00616018	1.8733e-07	1.5031e-09

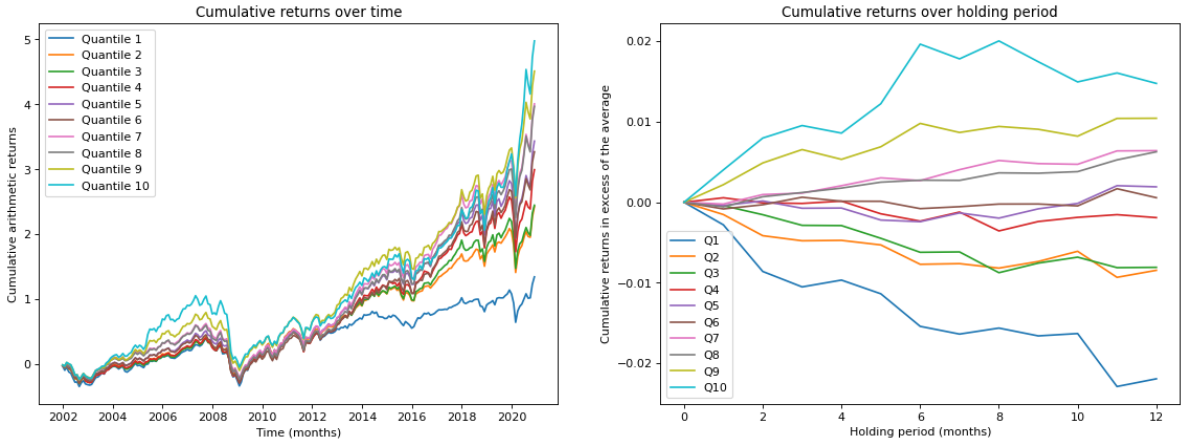
4. FF 3 factor model (60-months lookback period - 12-months holding period)





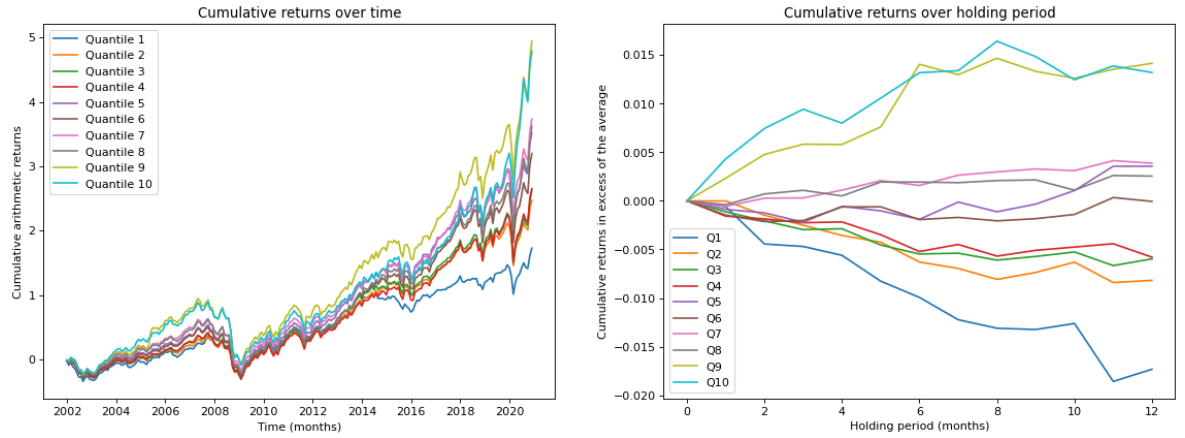
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0632332	0.0761355	0.0792584	0.0795353	0.0926525	0.0875984	0.0930183	0.0911531	0.107178	0.105879
Avg excess returns	0.0401768	0.0530791	0.056202	0.0564789	0.0695962	0.064542	0.0699619	0.0680967	0.0841215	0.0828223
Volatility	0.14305	0.143905	0.148934	0.148736	0.152996	0.153226	0.146985	0.150512	0.160853	0.160793
Sharpe ratio	0.280859	0.368848	0.377361	0.379725	0.454888	0.42122	0.475979	0.452434	0.52297	0.515087
Alpha	-0.0267479	-0.018617	-0.0173644	-0.0178108	-0.0061271	-0.0125582	-0.00441864	-0.00976206	0.00306042	-0.00342682
Std. error (α)	0.000944687	0.000497195	0.000449193	0.000368071	0.000338718	0.000308349	0.000328322	0.00037263	0.000931691	0.000736
t-stat (α)	-2.35951	-3.12033	-3.22141	-4.03246	-1.50743	-3.39393	-1.12152	-2.18315	0.273734	-0.388001
p-value (α)	0.0191587	0.00204395	0.00146532	7.56968e-05	0.133111	0.000814696	0.263267	0.0300639	0.784541	0.698384
Beta	0.87102	0.920182	0.949798	0.961141	0.985818	0.987107	0.945742	0.970335	0.97402	0.985029
SMB	0.306805	0.0540711	0.0265599	0.305885	0.343457	0.00269569	9.59753e-05	2.1557e-05	1.47672e-05	1.11321e-13
HML	0.616946	0.899812	0.0363106	0.148296	3.84076e-05	0.0648406	0.59095	0.000137835	0.0317707	1.04647e-11

5. Carhart model (36-months lookback period - 12-months holding period)



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0566497	0.0756524	0.0761634	0.0848271	0.090166	0.0882847	0.0964259	0.0962094	0.101924	0.107889
Avg excess returns	0.0335934	0.0525961	0.053107	0.0617707	0.0671096	0.0652283	0.0733696	0.073153	0.0788677	0.0848322
Volatility	0.152518	0.145205	0.14648	0.152235	0.151005	0.15161	0.149642	0.150927	0.152551	0.162834
Sharpe ratio	0.220259	0.362219	0.362555	0.405759	0.444419	0.430238	0.4903	0.484691	0.516993	0.520975
Alpha	-0.030151	-0.0157173	-0.0167583	-0.0122	-0.00720156	-0.0118695	-0.00254191	-0.00479772	-0.00294935	-0.00466853
Std. error (α)	0.00100972	0.000630925	0.000460071	0.000486089	0.000307842	0.000306288	0.000326422	0.000384643	0.00055277	0.00099931
t-stat (α)	-2.48839	-2.07596	-3.03546	-2.09152	-1.94947	-3.22939	-0.648932	-1.03943	-0.444631	-0.389313
p-value (α)	0.0135641	0.0390439	0.00268712	0.0376137	0.0524925	0.00142767	0.51705	0.299729	0.657017	0.697416
Beta	0.852716	0.887317	0.916941	0.957254	0.960975	0.973414	0.973476	0.976932	0.980843	1.0148
SMB	0.0430799	0.00715939	0.119683	0.0616247	0.0039218	3.16684e-05	0.220082	0.000465508	3.05725e-08	1.05046e-06
HML	0.15339	0.378106	0.118616	0.375981	0.0543959	0.00758868	0.89263	0.0161836	1.41871e-05	2.21069e-07
WML	6.93002e-06	0.00518555	0.000216093	0.00330961	0.000941462	0.0300931	0.680094	0.374676	0.00192885	0.00184061

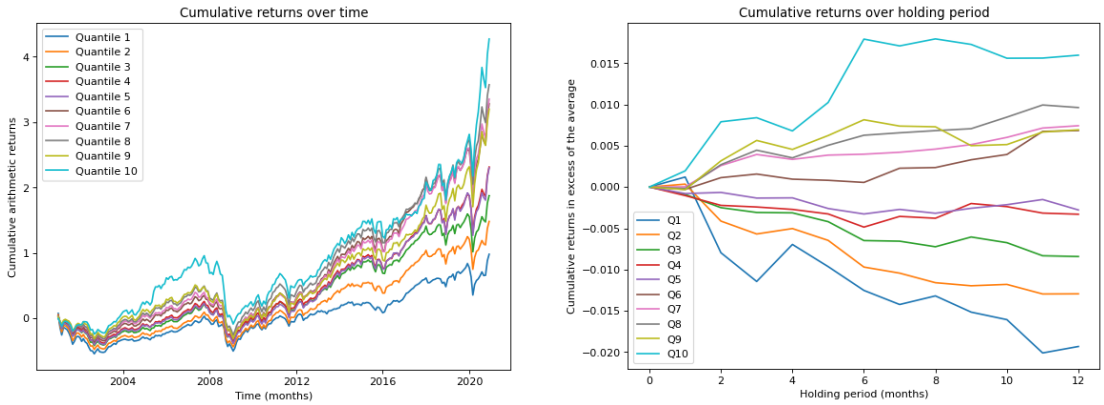
6. Carhart model (60-months lookback period - 12-months holding period)



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0632332	0.0761355	0.0792584	0.0795353	0.0926525	0.0875984	0.0930183	0.0911531	0.107178	0.105879
Avg excess returns	0.0401768	0.0530791	0.056202	0.0564789	0.0695962	0.064542	0.0699619	0.0680967	0.0841215	0.0828223
Volatility	0.14305	0.143905	0.148934	0.148736	0.152996	0.153226	0.146985	0.150512	0.160853	0.160793
Sharpe ratio	0.280859	0.368848	0.377361	0.379725	0.454888	0.42122	0.475979	0.452434	0.52297	0.515087
Alpha	-0.0238252	-0.0171175	-0.0157433	-0.0160388	-0.0048786	-0.0115431	-0.00395393	-0.010746	0.00174143	-0.00601554
Std. error (α)	0.000930511	0.000490255	0.000439024	0.000351344	0.000330627	0.000302861	0.000328822	0.000369166	0.000933111	0.000720403
t-stat (α)	-2.1337	-2.90962	-2.98832	-3.80414	-1.22963	-3.17612	-1.00204	-2.42573	0.155522	-0.695853
p-value (α)	0.0339593	0.00398514	0.0031193	0.000183779	0.22013	0.00170364	0.317409	0.0160728	0.876551	0.487245
Beta	0.842618	0.905611	0.934045	0.943922	0.973686	0.977243	0.941226	0.979896	0.986838	1.01018
SMB	0.259145	0.0409555	0.017436	0.223768	0.280598	0.00161044	8.0091e-05	2.3481e-05	1.69659e-05	6.15101e-14
HML	0.734871	0.352126	0.269675	0.892547	0.00178746	0.348342	0.372696	0.00232871	0.0883265	3.8242e-09
WML	0.00225832	0.00292516	0.000348805	1.38994e-06	0.000257397	0.00113756	0.165863	0.00935316	0.165778	0.00049626

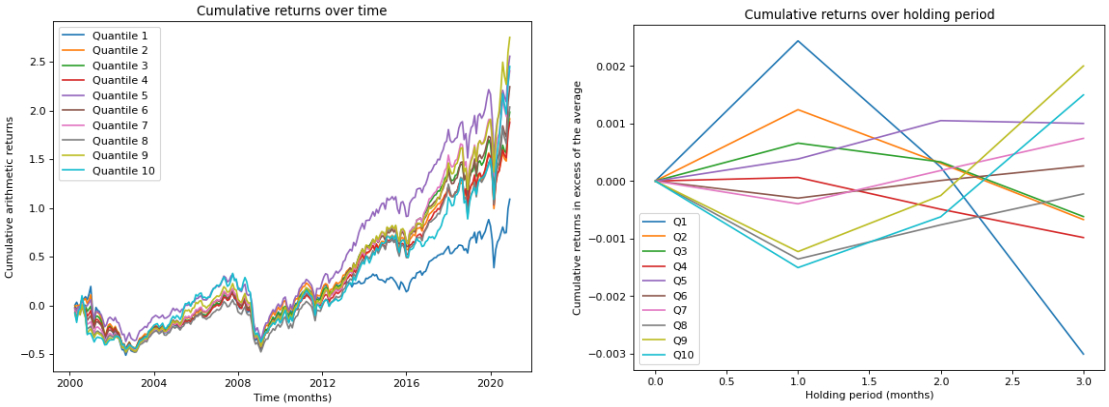
Models 7-11 are devoted to explore the short-term and long-term effect

7. FF 3 factor model (12-months formation period - 12-months holding period)



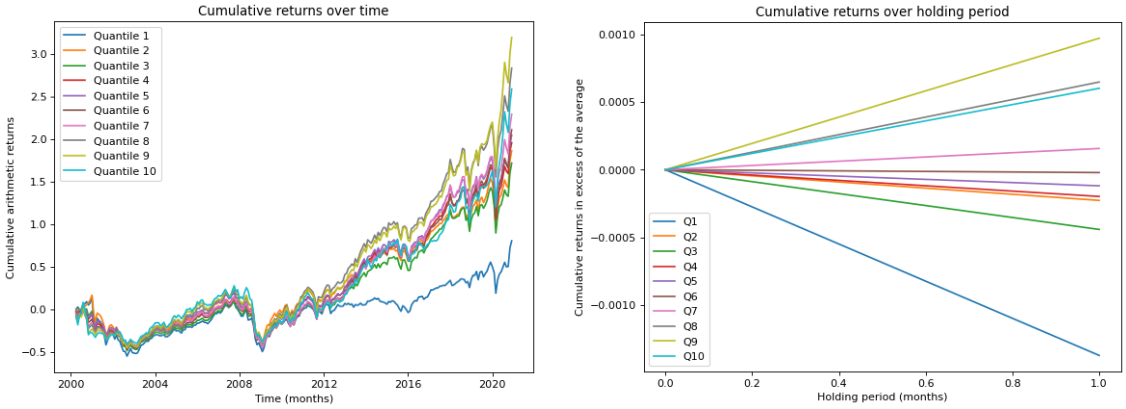
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0500125	0.0584729	0.0644541	0.0713007	0.072007	0.0848017	0.0855303	0.0884343	0.0848952	0.0967081
Avg excess returns	0.0269561	0.0354166	0.0413977	0.0482443	0.0489506	0.0617453	0.062474	0.0653779	0.0618388	0.0736517
Volatility	0.175533	0.159218	0.150625	0.149138	0.155007	0.153329	0.152653	0.155543	0.159943	0.162119
Sharpe ratio	0.153567	0.222441	0.27484	0.323488	0.315796	0.402699	0.409254	0.42032	0.386631	0.454308
Alpha	-0.0460242	-0.0339903	-0.0234375	-0.0156978	-0.0183553	-0.00436027	-0.00392067	-0.00300466	-0.00922541	0.00288222
Std. error (α)	0.00135976	0.000773537	0.000494088	0.000391225	0.000364134	0.000302676	0.000334434	0.000426884	0.000567743	0.00110663
t-stat (α)	-2.8206	-3.66178	-3.95299	-3.34373	-4.20068	-1.20048	-0.976942	-0.586549	-1.3541	0.217041
p-value (α)	0.0052012	0.00030916	0.000102031	0.000961257	3.77491e-05	0.231157	0.329598	0.558067	0.176998	0.828364
Beta	1.00781	0.978016	0.944862	0.945682	0.985453	0.971184	0.968312	0.975554	0.984456	0.931638
SMB	0.046833	0.0353721	0.0739323	0.5194	0.374651	0.0372586	0.0488625	0.000281924	6.51665e-07	1.99804e-05
HML	0.107405	0.000480193	0.602561	0.915304	0.150266	0.00867231	0.236319	0.0492819	0.0264871	0.00018053

8. FF 3 factor model (12-months formation period - 3-months holding period)



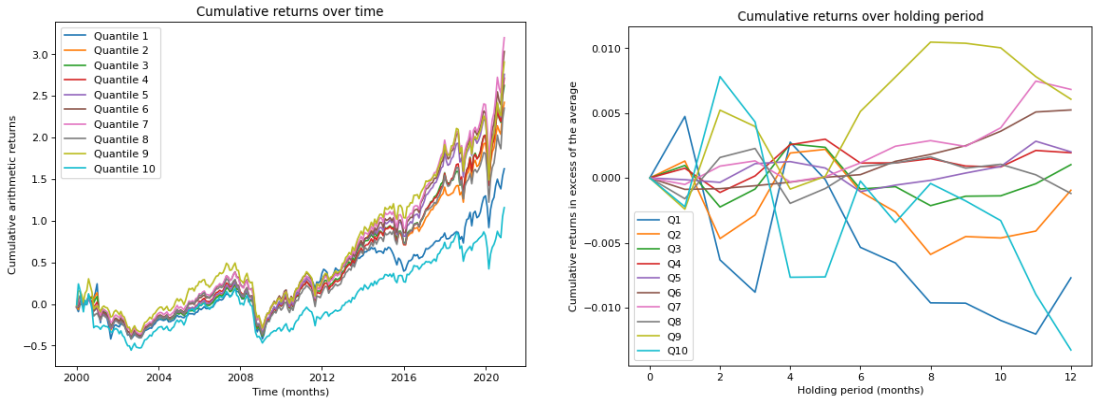
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.051763	0.0641979	0.0644608	0.0624844	0.0731073	0.069132	0.0716928	0.0665073	0.0784013	0.0757074
Avg excess returns	0.0287066	0.0411415	0.0414044	0.0394281	0.0500509	0.0460756	0.0486364	0.043451	0.0553449	0.0526511
Volatility	0.178215	0.157101	0.151701	0.150207	0.152378	0.155742	0.156813	0.159375	0.169146	0.175749
Sharpe ratio	0.161078	0.261879	0.272933	0.262492	0.328466	0.295846	0.310155	0.272634	0.327201	0.299582
Alpha	-0.0279731	-0.0131668	-0.0123133	-0.0138907	-0.00382723	-0.0108371	-0.00833629	-0.0146337	-0.00582695	-0.00595088
Std. error (α)	0.00156316	0.000871215	0.000576398	0.000454724	0.000597385	0.000307278	0.000392683	0.000476453	0.000816583	0.00133127
t-stat (α)	-1.49127	-1.25943	-1.78021	-2.54562	-0.533886	-2.93901	-1.76909	-2.55949	-0.594648	-0.372507
p-value (α)	0.137177	0.209075	0.0762809	0.0115221	0.593904	0.00360702	0.0781236	0.011084	0.552627	0.709838
Beta	1.00325	0.950865	0.944531	0.944406	0.949178	0.974857	0.974294	0.973024	0.990497	0.943133
SMB	0.431561	0.842479	0.438458	0.18016	0.172836	0.00804829	0.00134392	6.92317e-08	6.08385e-08	4.76087e-06
HML	0.17294	0.127945	0.00187216	0.00609008	6.71935e-06	0.0147316	0.113217	9.83115e-06	3.93621e-05	6.27194e-09

9. FF 3 factor model (12-months formation period - 1-months holding period)



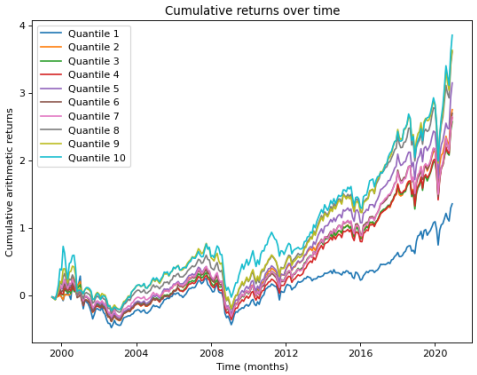
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0452338	0.0637976	0.0603213	0.0642705	0.0655436	0.06713	0.070013	0.0779715	0.0832083	0.0772206
Avg excess returns	0.0221774	0.0407412	0.0372649	0.0412141	0.0424872	0.0440736	0.0469566	0.0549152	0.0601519	0.0541642
Volatility	0.180294	0.159401	0.153574	0.152766	0.151575	0.155646	0.156224	0.160203	0.165535	0.173775
Sharpe ratio	0.123007	0.255589	0.242651	0.269785	0.280304	0.283165	0.300572	0.342785	0.363378	0.311691
Alpha	-0.0347736	-0.0131475	-0.0169316	-0.0132447	-0.0117541	-0.012335	-0.00961551	-0.00372933	0.000356537	-0.00429788
Std. error (α)	0.00158872	0.00104044	0.000605407	0.000490091	0.000385096	0.000318927	0.000381821	0.000601779	0.00081285	0.00131899
t-stat (α)	-1.82398	-1.05304	-2.33061	-2.25207	-2.54355	-3.22306	-2.09861	-0.516432	0.0365521	-0.271538
p-value (α)	0.0693727	0.293362	0.0205866	0.0252037	0.0115888	0.00144049	0.0368757	0.606018	0.970872	0.786206
Beta	1.01393	0.949756	0.955307	0.956483	0.956938	0.977764	0.97488	0.962852	0.964452	0.933809
SMB	0.454004	0.518517	0.418349	0.527125	0.0930471	0.21837	0.0262676	3.57587e-08	1.08287e-08	2.96431e-06
HML	0.645285	0.0408386	0.0313683	0.0153401	1.33334e-05	0.390966	0.323345	0.0225239	4.37576e-05	3.23281e-07

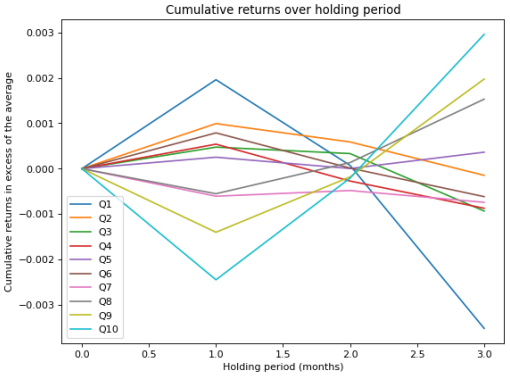
10. FF 3 factor model (3-months formation period - 12-months holding period)



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0628828	0.0711604	0.073585	0.0747077	0.0747319	0.0788034	0.0807985	0.0705507	0.0797185	0.0550556
Avg excess returns	0.0398264	0.048104	0.0505286	0.0516514	0.0516755	0.055747	0.0577422	0.0474943	0.0566621	0.0319992
Volatility	0.180451	0.156313	0.154545	0.15427	0.151113	0.155499	0.156106	0.159284	0.170317	0.190587
Sharpe ratio	0.220704	0.307742	0.32695	0.334812	0.341965	0.358503	0.369892	0.298174	0.332686	0.167898
Alpha	-0.0147389	-0.00428616	-0.00349268	-0.00388388	-0.00347667	-0.0014287	-0.000449277	-0.0120559	-0.0076739	-0.0352023
Std. error (α)	0.00176976	0.00099463	0.000697115	0.000493205	0.000316042	0.000331645	0.000437113	0.000576686	0.000927748	0.0015146
t-stat (α)	-0.694016	-0.359108	-0.417516	-0.656232	-0.916719	-0.358993	-0.0856523	-1.74212	-0.689295	-1.93683
p-value (α)	0.488322	0.71982	0.676662	0.512283	0.36018	0.719906	0.931812	0.0827266	0.491282	0.0539021
Beta	0.984246	0.944378	0.961525	0.970044	0.955372	0.97976	0.967073	0.964893	0.962656	0.946473
SMB	0.11527	0.012178	0.00820076	0.0329708	0.198721	0.871312	0.000264264	1.11917e-08	1.59891e-15	1.10433e-15
HML	0.287567	0.0214138	0.0492737	0.00334498	0.0087694	0.00965342	0.226419	0.00743056	0.00546733	6.98231e-10

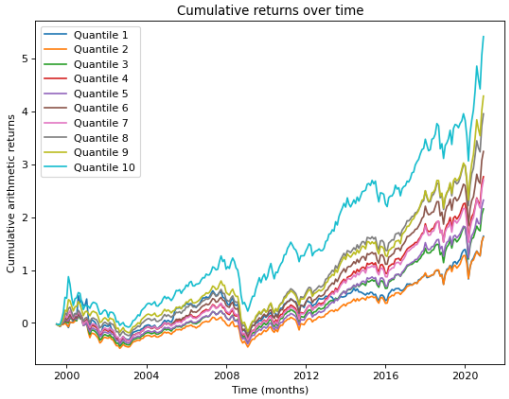
11. FF 3 factor model (3-months formation period - 3-months holding period)

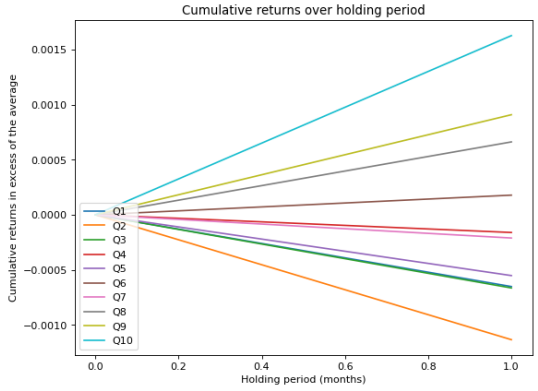




	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0583165	0.0756471	0.0715879	0.071894	0.0782472	0.07322	0.0725469	0.0842542	0.0865241	0.0915992
Avg excess returns	0.0352601	0.0525907	0.0485315	0.0488377	0.0551908	0.0501636	0.0494906	0.0611978	0.0634677	0.0685428
Volatility	0.190193	0.167037	0.155178	0.152202	0.153451	0.155309	0.155272	0.159915	0.1717	0.188232
Sharpe ratio	0.185391	0.314844	0.312747	0.320874	0.359664	0.322992	0.318734	0.382689	0.369643	0.364139
Alpha	-0.0247032	-0.00486795	-0.00763286	-0.00837056	-0.00383432	-0.0096696	-0.0121897	-0.00377088	-0.00689737	-0.00524287
Std. error (α)	0.00174468	0.00116548	0.000823085	0.000470643	0.000456363	0.000437841	0.000410985	0.000570639	0.000964186	0.00153503
t-stat (α)	-1.17993	-0.348065	-0.77279	-1.48211	-0.700159	-1.84039	-2.47164	-0.550681	-0.59613	-0.284623
p-value (α)	0.239133	0.728079	0.440365	0.139549	0.484469	0.0668769	0.0141058	0.582336	0.551619	0.776165
Beta	1.06922	0.997508	0.953514	0.962359	0.962443	0.976059	0.960192	0.956442	0.949879	0.884134
SMB	0.00172734	0.00332253	0.0143229	0.000350157	0.577348	0.392932	4.06514e-06	3.77464e-15	1.44163e-19	1.18281e-20
HML	0.803016	0.149324	0.0120362	0.00277433	0.043214	0.187703	0.00681948	0.000402243	0.00140724	8.98606e-10

12. FF 3 factor model (3-months formation period - 1-months holding period)





	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0663532	0.0588106	0.0661556	0.0740275	0.0679116	0.0793297	0.0732442	0.0868866	0.0907454	0.101975
Avg excess returns	0.0432968	0.0357542	0.0430992	0.0509712	0.0448552	0.0562733	0.0501879	0.0638302	0.067689	0.0789191
Volatility	0.206121	0.16521	0.157798	0.15549	0.15378	0.153922	0.155382	0.156074	0.161217	0.17629
Sharpe ratio	0.210055	0.216416	0.27313	0.32781	0.291684	0.365596	0.322997	0.408974	0.419862	0.447667
Alpha	-0.0231828	-0.0240432	-0.0160351	-0.00815831	-0.013868	-0.00359355	-0.0116291	0.000420965	0.00218253	0.0115764
Std. error (α)	0.00203164	0.00092143	0.000609511	0.000460834	0.000353226	0.000427691	0.000395812	0.000566113	0.000886765	0.00156353
t-stat (α)	-0.950906	-2.17444	-2.19234	-1.47528	-3.27175	-0.700184	-2.44836	0.0619671	0.205102	0.617003
p-value (α)	0.342556	0.0305953	0.0292625	0.141376	0.00121697	0.484453	0.0150277	0.950638	0.837657	0.537786
Beta	1.11035	1.01296	0.988772	0.98092	0.976469	0.962265	0.961738	0.930897	0.899765	0.809634
SMB	0.201184	0.00806137	0.00718945	0.0109368	0.000305185	0.308227	1.18786e-06	2.13953e-16	3.084e-18	3.85633e-18
HML	0.283096	0.435399	0.296608	0.00292514	0.0361007	0.0487336	0.0206655	0.0511964	0.00118614	2.95175e-06

Appendix 2. Results for additional analysis

(1) CAPM Model

3-months formation period vs 12-months formation period

3-months formation period

Based on CAPM model,
3 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0703977	0.0624622	0.0734946	0.0776115	0.07419	0.0820348	0.0783976	0.0897094	0.0921987	0.108728
Avg excess returns	0.0473413	0.0394058	0.0504382	0.0545552	0.0511336	0.0589784	0.0553412	0.066653	0.0691424	0.0856714
Volatility	0.208928	0.168371	0.161434	0.158083	0.156615	0.154746	0.156936	0.157068	0.164093	0.181127
Sharpe ratio	0.226592	0.234042	0.312438	0.345106	0.326492	0.381129	0.352635	0.424359	0.421362	0.47299
Alpha	-0.024938	-0.02598	-0.0136335	-0.00869803	-0.0119388	-0.00294868	-0.00756887	0.00509428	0.00742516	0.0256969
Std. error (α)	0.00202304	0.000916404	0.000629954	0.000477875	0.000352259	0.000425666	0.000438273	0.00070694	0.00109206	0.00187173
t-stat (α)	-1.02725	-2.36249	-1.80351	-1.51679	-2.82434	-0.577268	-1.43915	0.600509	0.566599	1.14408
p-value (α)	0.305269	0.0188982	0.0724797	0.130549	0.00510917	0.564264	0.151326	0.548696	0.571481	0.253653
Beta	1.11666	1.01907	1.00047	0.988881	0.986322	0.970107	0.984024	0.964893	0.967137	0.942466
R2 adjusted	0.713566	0.910099	0.953815	0.972272	0.984663	0.977028	0.976348	0.93847	0.865212	0.674529

Based on CAPM model,
3 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0567718	0.0774028	0.0735932	0.0744109	0.0782481	0.0757025	0.0810197	0.0866122	0.0864197	0.0950337
Avg excess returns	0.0337155	0.0543464	0.0505368	0.0513545	0.0551917	0.0526461	0.0579633	0.0635558	0.0633633	0.0719774
Volatility	0.193676	0.171081	0.157659	0.155463	0.156034	0.158539	0.156814	0.162229	0.172859	0.191807
Sharpe ratio	0.174081	0.317665	0.320546	0.330334	0.353716	0.332071	0.369631	0.391765	0.366561	0.37526
Alpha	-0.032272	-0.00808616	-0.0081634	-0.0086278	-0.00523211	-0.00898712	-0.0027982	0.00155543	0.000410993	0.00930686
Std. error (α)	0.00177174	0.00115026	0.000870256	0.000495656	0.000446047	0.000419381	0.000448895	0.000690034	0.00118757	0.0019382
t-stat (α)	-1.5179	-0.585819	-0.781705	-1.45057	-0.977497	-1.78579	-0.51946	0.187844	0.02884	0.40015
p-value (α)	0.130273	0.558513	0.43511	0.148124	0.329246	0.0753168	0.603889	0.851147	0.977015	0.68938
Beta	1.05846	1.00671	0.952378	0.971042	0.97747	0.995075	0.982385	1.00042	1.01428	1.01018
R2 adjusted	0.74551	0.862855	0.907743	0.969269	0.975287	0.978843	0.975222	0.945271	0.856967	0.690276

Based on CAPM model,
3 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0703977	0.0624622	0.0734946	0.0776115	0.07419	0.0820348	0.0783976	0.0897094	0.0921987	0.108728
Avg excess returns	0.0473413	0.0394058	0.0504382	0.0545552	0.0511336	0.0589784	0.0553412	0.066653	0.0691424	0.0856714
Volatility	0.208928	0.168371	0.161434	0.158083	0.156615	0.154746	0.156936	0.157068	0.164093	0.181127
Sharpe ratio	0.226592	0.234042	0.312438	0.345106	0.326492	0.381129	0.352635	0.424359	0.421362	0.47299
Alpha	-0.024938	-0.02598	-0.0136335	-0.00869803	-0.0119388	-0.00294868	-0.00756887	0.00509428	0.00742516	0.0256969
Std. error (α)	0.00202304	0.000916404	0.000629954	0.000477875	0.000352259	0.000425666	0.000438273	0.00070694	0.00109206	0.00187173
t-stat (α)	-1.02725	-2.36249	-1.80351	-1.51679	-2.82434	-0.577268	-1.43915	0.600509	0.566599	1.14408
p-value (α)	0.305269	0.0188982	0.0724797	0.130549	0.00510917	0.564264	0.151326	0.548696	0.571481	0.253653
Beta	1.11666	1.01907	1.00047	0.988881	0.986322	0.970107	0.984024	0.964893	0.967137	0.942466
R2 adjusted	0.713566	0.910099	0.953815	0.972272	0.984663	0.977028	0.976348	0.93847	0.865212	0.674529

12-months formation period

Based on CAPM model,
12 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.05845	0.062681	0.0665155	0.0687885	0.0697876	0.0761433	0.0804221	0.0756961	0.083547	0.0888207
Avg excess returns	0.0353936	0.0396246	0.0434591	0.0457321	0.0467312	0.0530869	0.0573657	0.0526397	0.0604906	0.0657643
Volatility	0.177267	0.162346	0.154236	0.152075	0.156096	0.153016	0.154756	0.161119	0.175044	0.187855
Sharpe ratio	0.199662	0.244075	0.281771	0.30072	0.299374	0.346938	0.370685	0.326714	0.345574	0.350079
Alpha	-0.0231671	-0.0176591	-0.0119701	-0.00753838	-0.00828965	-0.0027424	0.00316265	-0.00564195	-0.000770657	0.00488358
Std. error (α)	0.00145568	0.000869213	0.000595725	0.00046835	0.000446521	0.000378285	0.000518026	0.000621605	0.0010879	0.001693
t-stat (α)	-1.32625	-1.69302	-1.67445	-1.3413	-1.54708	-0.604129	0.508766	-0.756368	-0.0590326	0.240381
p-value (α)	0.185968	0.0916982	0.0952926	0.181044	0.123114	0.546306	0.611366	0.450141	0.952973	0.810232
Beta	1.00352	0.984104	0.955913	0.950418	0.977841	0.961994	0.965029	0.999275	1.04457	1.03879
R2 adjusted	0.799707	0.91508	0.955849	0.972039	0.975895	0.981944	0.966992	0.956004	0.885704	0.759735

Based on CAPM model,
12 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.066374	0.0691344	0.0702555	0.0736961	0.0854811	0.0736564	0.0803788	0.079908	0.0880123	0.0982326
Avg excess returns	0.0433176	0.046078	0.0471991	0.0506397	0.0624247	0.0506	0.0573224	0.0568516	0.0649559	0.0751763
Volatility	0.185819	0.158254	0.154269	0.152895	0.160418	0.153829	0.1589	0.163449	0.173803	0.197104
Sharpe ratio	0.233118	0.291165	0.305954	0.331205	0.389137	0.328936	0.360744	0.347824	0.373734	0.381405
Alpha	-0.0216337	-0.0130375	-0.0118551	-0.00815999	0.00163416	-0.00921544	-0.00408557	-0.004014	0.00137497	0.00873611
Std. error (α)	0.00155269	0.000847978	0.000578153	0.000496773	0.000738984	0.000346732	0.000520779	0.000655932	0.00117223	0.0018693
t-stat (α)	-1.16109	-1.28123	-1.70876	-1.36883	0.18428	-2.21483	-0.653759	-0.509961	0.0977461	0.389456
p-value (α)	0.246688	0.201272	0.0887077	0.172251	0.85394	0.0276523	0.513854	0.61052	0.92221	0.697262
Beta	1.04338	0.958423	0.957531	0.953826	0.982808	0.968613	0.991796	1.01093	1.02343	1.06505
R2 adjusted	0.787569	0.913008	0.957519	0.968046	0.935622	0.984647	0.967538	0.951441	0.862274	0.727087

Based on CAPM model,
12 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0575149	0.0688206	0.0784184	0.0728707	0.0727581	0.0759005	0.0809365	0.0962108	0.0978525	0.111804
Avg excess returns	0.0344586	0.0457642	0.055362	0.0498144	0.0497017	0.0528442	0.0578801	0.0731545	0.0747961	0.0887474
Volatility	0.182539	0.15953	0.16085	0.154136	0.15391	0.154705	0.158186	0.168053	0.172692	0.195796
Sharpe ratio	0.188773	0.286869	0.344184	0.323184	0.322926	0.34158	0.3659	0.435306	0.433119	0.453264
Alpha	-0.0318956	-0.0153696	-0.00730707	-0.0114084	-0.0119791	-0.00942935	-0.00537001	0.00822135	0.0100029	0.0212943
Std. error (α)	0.00148788	0.000918882	0.000794799	0.000524925	0.000392391	0.000337602	0.000489964	0.000942583	0.00120455	0.00189776
t-stat (α)	-1.78641	-1.39387	-0.766134	-1.81111	-2.54403	-2.32753	-0.913334	0.726846	0.692023	0.935062
p-value (α)	0.0752108	0.164561	0.4443	0.0712913	0.0115442	0.0207142	0.361923	0.467982	0.489547	0.350634
Beta	1.03278	0.958878	0.980612	0.960136	0.966621	0.975012	0.988838	1.01266	1.01068	1.04834
R2 adjusted	0.79765	0.899132	0.925718	0.964782	0.980273	0.985571	0.97089	0.904293	0.852105	0.71389

(2) FF-3 factor Model

3-months formation period vs 12-months formation period

3-months formation period

Based on Fama-French 3 factor model,
3 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0655097	0.0725498	0.0797456	0.0784927	0.0713252	0.0806013	0.0820089	0.0659572	0.0738441	0.058134
Avg excess returns	0.0424533	0.0494935	0.0566892	0.0554363	0.0482688	0.0575449	0.0589525	0.0429008	0.0507878	0.0350776
Volatility	0.184804	0.161696	0.158856	0.15775	0.15338	0.156082	0.156503	0.159757	0.173299	0.193865
Sharpe ratio	0.22972	0.30609	0.356859	0.351418	0.314701	0.368683	0.376686	0.268538	0.293064	0.180939
Alpha	-0.0148552	-0.00619659	0.00207984	-0.00198811	-0.00589528	5.36515e-05	0.00269154	-0.0150369	-0.0119236	-0.033596
Std. error (α)	0.00176634	0.000974866	0.000694403	0.000475992	0.000350414	0.000284747	0.000478674	0.000572958	0.000995476	0.00154054
t-stat (α)	-0.700848	-0.529696	0.249596	-0.348064	-1.40198	0.0157015	0.468575	-2.18702	-0.998149	-1.81732
p-value (α)	0.484055	0.596797	0.803107	0.728087	0.162176	0.987485	0.639787	0.029679	0.319184	0.0703742
Beta	1.01394	0.977571	0.986461	0.991151	0.969116	0.984979	0.967305	0.963051	0.971933	0.954094
SMB	-0.0810852	-0.0555003	-0.0489713	-0.0254517	-0.0220265	0.00114939	0.0521617	0.133533	0.274909	0.463292
HML	0.0971185	0.0843033	0.0648734	0.0618263	0.042662	0.012082	0.0211803	-0.0510214	-0.0929334	-0.302982
R2 adjusted	0.729799	0.892785	0.943843	0.97319	0.984685	0.990204	0.972522	0.962252	0.902965	0.813854

Based on Fama-French 3 factor model,
3 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0567718	0.0774028	0.0735932	0.0744109	0.0782481	0.0757025	0.0810197	0.0866122	0.0864197	0.0950337
Avg excess returns	0.0337155	0.0543464	0.0505368	0.0513545	0.0551917	0.0526461	0.0579633	0.0635558	0.0633633	0.0719774
Volatility	0.193676	0.171081	0.157659	0.155463	0.156034	0.158539	0.156814	0.162229	0.172859	0.191807
Sharpe ratio	0.174081	0.317665	0.320546	0.330334	0.353716	0.332071	0.369631	0.391765	0.366561	0.37526
Alpha	-0.0281659	-0.00582881	-0.00621315	-0.00765483	-0.00473188	-0.00938052	-0.00470671	-0.00270055	-0.00758295	-0.00384896
Std. error (α)	0.00175186	0.00113624	0.000844233	0.000476896	0.000439529	0.000420169	0.000419591	0.000594306	0.000992541	0.00153683
t-stat (α)	-1.33981	-0.427493	-0.613294	-1.33761	-0.897151	-1.86047	-0.934781	-0.37867	-0.636661	-0.208706
p-value (α)	0.181505	0.669383	0.540231	0.182219	0.370488	0.063975	0.350789	0.705249	0.524919	0.834845
Beta	1.09254	1.02586	0.969154	0.979548	0.981908	0.991898	0.966334	0.964763	0.947413	0.899129
SMB	-0.1714	-0.0921794	-0.0784927	-0.0384871	-0.0194667	0.0168523	0.0786127	0.175987	0.331092	0.539925
HML	0.0156189	0.0633737	0.0853997	0.0605913	0.0397181	0.0100181	-0.0354575	-0.0608626	-0.0998976	-0.297057
R2 adjusted	0.752251	0.86675	0.913549	0.971673	0.976107	0.978855	0.978444	0.959576	0.900514	0.806103

Based on Fama-French 3 factor model,
3 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0703977	0.0624622	0.0734946	0.0776115	0.07419	0.0820348	0.0783976	0.0897094	0.0921987	0.108728
Avg excess returns	0.0473413	0.0394058	0.0504382	0.0545552	0.0511336	0.0589784	0.0553412	0.066653	0.0691424	0.0856714
Volatility	0.208928	0.168371	0.161434	0.158083	0.156615	0.154746	0.156936	0.157068	0.164093	0.181127
Sharpe ratio	0.226592	0.234042	0.312438	0.345106	0.326492	0.381129	0.352635	0.424359	0.421362	0.47299
Alpha	-0.0231411	-0.0241616	-0.0123343	-0.00792816	-0.0109503	-0.00328763	-0.00981032	0.000520739	5.37928e-05	0.0131612
Std. error (α)	0.00202806	0.000910245	0.000622154	0.00046673	0.000339722	0.000425378	0.000401332	0.000611368	0.000928596	0.00156336
t-stat (α)	-0.950876	-2.212	-1.65209	-1.41555	-2.68609	-0.644059	-2.03703	0.07098	0.00482743	0.701541
p-value (α)	0.342568	0.0278531	0.0997461	0.158128	0.00770417	0.520116	0.0426793	0.943469	0.996152	0.483605
Beta	1.13134	1.03387	1.01103	0.995116	0.994351	0.96733	0.965784	0.927661	0.907132	0.840488
SMB	-0.0778494	-0.0724327	-0.0500493	-0.0270302	-0.0374256	0.0156924	0.0890625	0.183429	0.295313	0.494314
HML	-0.0434075	0.0247356	0.0361108	0.0498201	0.0345622	0.0190909	-0.0329097	-0.0487313	-0.0820773	-0.225021
R2 adjusted	0.713433	0.9117	0.955153	0.973668	0.985799	0.977162	0.980256	0.954188	0.90298	0.773952

12-months formation period

Based on Fama-French 3 factor model,
12 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.05845	0.062681	0.0665155	0.0687885	0.0697876	0.0761433	0.0804221	0.0756961	0.083547	0.0888207
Avg excess returns	0.0353936	0.0396246	0.0434591	0.0457321	0.0467312	0.0530869	0.0573657	0.0526397	0.0604906	0.0657643
Volatility	0.177267	0.162346	0.154236	0.152075	0.156096	0.153016	0.154756	0.161119	0.175044	0.187855
Sharpe ratio	0.199662	0.244075	0.281771	0.30072	0.299374	0.346938	0.370685	0.326714	0.345574	0.350079
Alpha	-0.023307	-0.0169338	-0.0123568	-0.00713449	-0.00787444	-0.0028546	0.00110369	-0.00816094	-0.00554218	-0.00173633
Std. error (α)	0.00142396	0.000850406	0.000562663	0.000422841	0.0004142	0.000372786	0.000483613	0.000547729	0.000863026	0.00132948
t-stat (α)	-1.36398	-1.65939	-1.83011	-1.40606	-1.58427	-0.638123	0.190182	-1.24163	-0.53515	-0.108836
p-value (α)	0.17381	0.0983019	0.0684332	0.160962	0.114412	0.523983	0.849323	0.215545	0.593026	0.913421
Beta	1.01569	0.997659	0.960678	0.962588	0.988612	0.964035	0.944721	0.970076	0.98411	0.948787
SMB	-0.0599155	-0.0668804	-0.0233709	-0.0613784	-0.0543033	-0.010021	0.101845	0.144274	0.29864	0.444436
HML	0.156391	0.0780362	0.0973751	0.0838201	0.0682455	0.0358816	0.0028087	-0.0638086	-0.180562	-0.321397
R2 adjusted	0.809118	0.919044	0.960773	0.977292	0.979334	0.982536	0.971336	0.965978	0.928362	0.852438

Based on Fama-French 3 factor model,
12 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.066374	0.0691344	0.0702555	0.0736961	0.0854811	0.0736564	0.0803788	0.079908	0.0880123	0.0982326
Avg excess returns	0.0433176	0.046078	0.0471991	0.0506397	0.0624247	0.0506	0.0573224	0.0568516	0.0649559	0.0751763
Volatility	0.185819	0.158254	0.154269	0.152895	0.160418	0.153829	0.1589	0.163449	0.173803	0.197104
Sharpe ratio	0.233118	0.291165	0.305954	0.331205	0.389137	0.328936	0.360744	0.347824	0.373734	0.381405
Alpha	-0.0190656	-0.0114072	-0.0109538	-0.00719758	0.00299527	-0.00936291	-0.00681725	-0.00812354	-0.00627961	-0.00225171
Std. error (α)	0.00153049	0.000828159	0.000557195	0.000471286	0.000712229	0.00034131	0.000471444	0.000532517	0.000927541	0.0015038
t-stat (α)	-1.0381	-1.14785	-1.63824	-1.27269	0.350457	-2.28603	-1.20503	-1.27125	-0.564181	-0.124779
p-value (α)	0.300212	0.252112	0.102609	0.204294	0.726286	0.0230767	0.229313	0.204808	0.573129	0.900797
Beta	1.0655	0.972498	0.965542	0.962333	0.994746	0.96765	0.96893	0.974219	0.958604	0.971479
SMB	-0.103185	-0.0653559	-0.0349971	-0.0376102	-0.0536433	0.00744294	0.113057	0.18255	0.313097	0.446874
HML	0.117076	0.0783146	0.0735931	0.0722117	0.0900409	0.0338551	-0.0363722	-0.0840161	-0.201003	-0.357069
R2 adjusted	0.794479	0.917381	0.960712	0.971364	0.940454	0.985187	0.973511	0.968115	0.914139	0.82413

Based on Fama-French 3 factor model,
12 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0575149	0.0688206	0.0784184	0.0728707	0.0727581	0.0759005	0.0809365	0.0962108	0.0978525	0.111804
Avg excess returns	0.0344586	0.0457642	0.055362	0.0498144	0.0497017	0.0528442	0.0578801	0.0731545	0.0747961	0.0887474
Volatility	0.182539	0.15953	0.16085	0.154136	0.15391	0.154705	0.158186	0.168053	0.172692	0.195796
Sharpe ratio	0.188773	0.286869	0.344184	0.323184	0.322926	0.34158	0.3659	0.435306	0.433119	0.453264
Alpha	-0.0287078	-0.013453	-0.00573884	-0.0104792	-0.0109287	-0.0101059	-0.00794806	0.00316772	0.00117996	0.00913314
Std. error (α)	0.00146625	0.000899656	0.00077332	0.00050425	0.000360779	0.000335406	0.000448517	0.000852645	0.000939946	0.00153058
t-stat (α)	-1.63158	-1.24612	-0.61842	-1.73182	-2.52432	-2.51086	-1.47673	0.309597	0.104613	0.49726
p-value (α)	0.104002	0.213863	0.536851	0.0845156	0.0121999	0.012663	0.140982	0.75712	0.916766	0.619434
Beta	1.05869	0.974434	0.993327	0.967653	0.975126	0.969497	0.96785	0.971544	0.938933	0.949508
SMB	-0.122418	-0.0714487	-0.0567507	-0.0317261	-0.0367405	0.0280377	0.103471	0.200324	0.345034	0.467859
HML	0.0927716	0.0790838	0.0831995	0.06982	0.0694787	0.00255883	-0.0266608	-0.0793757	-0.18948	-0.344689
R2 adjusted	0.804368	0.903742	0.929994	0.967647	0.983398	0.985821	0.975716	0.922036	0.910348	0.814726

3-months formation period

Based on Carthart 4-factor model,
3 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0655097	0.0725498	0.0797456	0.0784927	0.0713252	0.0806013	0.0820089	0.0659572	0.0738441	0.058134
Avg excess returns	0.0424533	0.0494935	0.0566892	0.0554363	0.0482688	0.0575449	0.0589525	0.0429008	0.0507878	0.0350776
Volatility	0.184804	0.161696	0.158856	0.15775	0.15338	0.156082	0.156503	0.159757	0.173299	0.193865
Sharpe ratio	0.22972	0.30609	0.356859	0.351418	0.314701	0.368683	0.376686	0.268538	0.293064	0.180939
Alpha	0.000642429	0.00102746	0.00689318	0.000664435	-0.00447025	3.54954e-05	0.00144621	-0.0194798	-0.0195127	-0.046227
Std. error (α)	0.00150823	0.000877458	0.000636398	0.000451003	0.000342042	0.000286419	0.000475743	0.000511388	0.000892511	0.00134737
t-stat (α)	0.0354957	0.0975787	0.902629	0.12277	-1.08911	0.0103273	0.253324	-3.17433	-1.82189	-2.8591
p-value (α)	0.971713	0.922346	0.367606	0.902389	0.277173	0.991768	0.800229	0.00169326	0.0696855	0.00461143
Beta	0.864151	0.907751	0.940741	0.965514	0.95558	0.985154	0.979134	1.00525	1.04402	1.07617
SMB	-0.0195439	-0.0268135	-0.0298421	-0.0149184	-0.0163631	0.00107729	0.0472125	0.115876	0.244749	0.413135
HML	-0.0109398	0.0339331	0.0317137	0.0433312	0.0328447	0.0122086	0.0297595	-0.0204137	-0.0406511	-0.214911
WML	-0.307673	-0.143418	-0.0940865	-0.0526608	-0.0278553	0.00036045	0.0243425	0.0868458	0.148345	0.250762
R2 adjusted	0.804503	0.913806	0.953205	0.976116	0.985523	0.990164	0.973071	0.970166	0.922615	0.858701

Based on Carthart 4-factor model,
3 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0567718	0.0774028	0.0735932	0.0744109	0.0782481	0.0757025	0.0810197	0.0866122	0.0864197	0.0950337
Avg excess returns	0.0337155	0.0543464	0.0505368	0.0513545	0.0551917	0.0526461	0.0579633	0.0635558	0.0633633	0.0719774
Volatility	0.193676	0.171081	0.157659	0.155463	0.156034	0.158539	0.156814	0.162229	0.172859	0.191807
Sharpe ratio	0.174081	0.317665	0.320546	0.330334	0.353716	0.332071	0.369631	0.391765	0.366561	0.37526
Alpha	-0.0125429	0.000372719	-0.000764993	-0.00428524	-0.00386503	-0.00872693	-0.00723606	-0.00857422	-0.017892	-0.0200861
Std. error (α)	0.00158582	0.00110274	0.000806545	0.0004504	0.000440778	0.00042212	0.000403721	0.000523099	0.000859337	0.00132237
t-stat (α)	-0.659118	0.028166	-0.0790402	-0.7927	-0.730721	-1.72284	-1.49362	-1.36593	-1.73506	-1.26579
p-value (α)	0.510419	0.977552	0.937063	0.428695	0.465625	0.0861398	0.136521	0.173173	0.0839477	0.206753
Beta	0.975151	0.979263	0.928218	0.95423	0.975394	0.986987	0.985338	1.0089	1.02487	1.02113
SMB	-0.120944	-0.0721508	-0.0608972	-0.0276046	-0.0166671	0.0189632	0.0704439	0.157017	0.297798	0.487486
HML	-0.0884672	0.0220569	0.0491021	0.0381418	0.0339428	0.00566362	-0.0186062	-0.0217301	-0.0312149	-0.188879
WML	-0.254215	-0.10091	-0.0886512	-0.0548293	-0.0141053	-0.0106351	0.0411569	0.095575	0.167747	0.264207
R2 adjusted	0.799253	0.875889	0.921974	0.975005	0.976239	0.978896	0.980266	0.969031	0.926257	0.858043

Based on Carthart 4-factor model,
3 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0703977	0.0624622	0.0734946	0.0776115	0.07419	0.0820348	0.0783976	0.0897094	0.0921987	0.108728
Avg excess returns	0.0473413	0.0394058	0.0504382	0.0545552	0.0511336	0.0589784	0.0553412	0.066653	0.0691424	0.0856714
Volatility	0.208928	0.168371	0.161434	0.158083	0.156615	0.154746	0.156936	0.157068	0.164093	0.181127
Sharpe ratio	0.226592	0.234042	0.312438	0.345106	0.326492	0.381129	0.352635	0.424359	0.421362	0.47299
Alpha	-0.00996544	-0.0169815	-0.00774212	-0.00524475	-0.0099704	-0.00311189	-0.0123246	-0.00517331	-0.00948301	-0.00169598
Std. error (α)	0.00194339	0.000849957	0.000586887	0.000452375	0.000339158	0.000428671	0.000386008	0.000551983	0.000815796	0.00140434
t-stat (α)	-0.427322	-1.66494	-1.09932	-0.966152	-2.4498	-0.604949	-2.6607	-0.781018	-0.968687	-0.10064
p-value (α)	0.669507	0.0971584	0.272669	0.334887	0.0149695	0.545753	0.00829455	0.435519	0.333623	0.919916
Beta	1.0359	0.981862	0.977765	0.975679	0.987253	0.966057	0.983996	0.968905	0.97621	0.948103
SMB	-0.0360725	-0.0496663	-0.0354887	-0.0185218	-0.0343187	0.0162496	0.0810903	0.165375	0.265074	0.447205
HML	-0.129766	-0.0223256	0.00601194	0.032232	0.0281399	0.017939	-0.0164301	-0.0114103	-0.0195695	-0.127642
WML	-0.208085	-0.113396	-0.0725245	-0.0423792	-0.0154751	-0.00277545	0.0397084	0.0899265	0.150615	0.23464
R2 adjusted	0.739969	0.923919	0.960565	0.975555	0.986013	0.977081	0.98195	0.963097	0.926004	0.819756

vs

12-months formation period

Based on Carthart 4-factor model,
12 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.05845	0.062681	0.0665155	0.0687885	0.0697876	0.0761433	0.0804221	0.0756961	0.083547	0.0888207
Avg excess returns	0.0353936	0.0396246	0.0434591	0.0457321	0.0467312	0.0530869	0.0573657	0.0526397	0.0604906	0.0657643
Volatility	0.177267	0.162346	0.154236	0.152075	0.156096	0.153016	0.154756	0.161119	0.175044	0.187855
Sharpe ratio	0.199662	0.244075	0.281771	0.30072	0.299374	0.346938	0.370685	0.326714	0.345574	0.350079
Alpha	-0.00934108	-0.00986451	-0.00833633	-0.00421968	-0.00502977	-0.0034803	-0.0013171	-0.0119592	-0.0127519	-0.014011
Std. error (α)	0.00115556	0.000740406	0.000510847	0.000387956	0.000380312	0.000373056	0.000464439	0.000500568	0.000750146	0.00111134
t-stat (α)	-0.673633	-1.11026	-1.35989	-0.90639	-1.10211	-0.77743	-0.236324	-1.99094	-1.4166	-1.05061
p-value (α)	0.501175	0.267967	0.175105	0.365616	0.271489	0.437649	0.813378	0.0475898	0.15786	0.294466
Beta	0.880715	0.929334	0.92182	0.934901	0.961592	0.970082	0.967716	1.00679	1.05379	1.06742
SMB	-0.00445665	-0.038808	-0.00740537	-0.0497943	-0.042998	-0.0125057	0.0922242	0.129191	0.27001	0.395693
HML	0.0590127	0.0287448	0.0693418	0.0637396	0.0486482	0.0402444	0.0194858	-0.037325	-0.130292	-0.235812
WML	-0.277264	-0.140347	-0.0798187	-0.056976	-0.0556049	0.012422	0.0473193	0.0754062	0.143134	0.243687
R2 adjusted	0.875256	0.939103	0.967913	0.981034	0.982714	0.982644	0.973773	0.971802	0.946291	0.897678

Based on Carthart 4-factor model,
12 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.066374	0.0691344	0.0702555	0.0736961	0.0854811	0.0736564	0.0803788	0.079908	0.0880123	0.0982326
Avg excess returns	0.0433176	0.046078	0.0471991	0.0506397	0.0624247	0.0506	0.0573224	0.0568516	0.0649559	0.0751763
Volatility	0.185819	0.158254	0.154269	0.152895	0.160418	0.153829	0.1589	0.163449	0.173803	0.197104
Sharpe ratio	0.233118	0.291165	0.305954	0.331205	0.389137	0.328936	0.360744	0.347824	0.373734	0.381405
Alpha	-0.00180279	-0.00209031	-0.0052346	-0.00403433	0.00435455	-0.00976896	-0.0102683	-0.0145443	-0.0172149	-0.0217372
Std. error (α)	0.0012823	0.00069466	0.000484412	0.000448174	0.000714469	0.000343315	0.000443083	0.000434354	0.00076091	0.00116659
t-stat (α)	-0.117158	-0.250759	-0.900508	-0.750142	0.507901	-2.37124	-1.93123	-2.7904	-1.88534	-1.55276
p-value (α)	0.906828	0.802204	0.368707	0.453866	0.611965	0.0184783	0.0545721	0.0056668	0.0605292	0.12173
Beta	0.935796	0.902495	0.92257	0.938565	0.984533	0.970701	0.99486	1.02169	1.04077	1.11789
SMB	-0.0474322	-0.0352659	-0.0165261	-0.0273941	-0.0492533	0.00613154	0.101911	0.161735	0.27778	0.383943
HML	0.00206505	0.0162423	0.0354896	0.051137	0.0809849	0.0365603	-0.0133799	-0.0417091	-0.128148	-0.227249
WML	-0.280897	-0.151602	-0.0930621	-0.0514717	-0.0221179	0.00660719	0.0561553	0.103038	0.177937	0.317064
R2 adjusted	0.857339	0.942518	0.970636	0.974392	0.940747	0.98518	0.976863	0.979029	0.942861	0.895341

Based on Carthart 4-factor model,
12 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0575149	0.0688206	0.0784184	0.0728707	0.0727581	0.0759005	0.0809365	0.0962108	0.0978525	0.111804
Avg excess returns	0.0344586	0.0457642	0.055362	0.0498144	0.0497017	0.0528442	0.0578801	0.0731545	0.0747961	0.0887474
Volatility	0.182539	0.15953	0.16085	0.154136	0.15391	0.154705	0.158186	0.168053	0.172692	0.195796
Sharpe ratio	0.188773	0.286869	0.344184	0.323184	0.322926	0.34158	0.3659	0.435306	0.433119	0.453264
Alpha	-0.00801001	-0.0024356	-0.00012217	-0.00714018	-0.00914135	-0.0105397	-0.0120198	-0.00545176	-0.011225	-0.0113451
Std. error (α)	0.00109207	0.000735754	0.000731121	0.000482198	0.00035333	0.000337424	0.000407431	0.000752748	0.000735805	0.00118717
t-stat (α)	-0.611224	-0.275862	-0.0139249	-1.23396	-2.156	-2.60299	-2.45845	-0.603539	-1.27128	-0.796371
p-value (α)	0.541598	0.782879	0.988901	0.218357	0.032023	0.009785	0.014622	0.546689	0.204791	0.42656
Beta	0.908766	0.894632	0.952643	0.943467	0.96218	0.972639	0.997343	1.03398	1.02879	1.09784
SMB	-0.0567906	-0.0365154	-0.0389417	-0.0211389	-0.0310733	0.0266622	0.0905609	0.172994	0.305701	0.402927
HML	-0.0428894	0.00687172	0.0463858	0.0479347	0.0577639	0.00540209	2.68362e-05	-0.0228804	-0.108173	-0.210467
WML	-0.326881	-0.173998	-0.0887045	-0.0527337	-0.0282273	0.00685098	0.0643051	0.136128	0.195912	0.323415
R2 adjusted	0.892758	0.936381	0.938165	0.970764	0.984265	0.98582	0.980198	0.939952	0.94571	0.889854

(4) Fama-French 5 factor Model

3-months formation period vs 12-months formation period

Based on Fama-French 5 factor model,
3 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0655097	0.0725498	0.0797456	0.0784927	0.0713252	0.0806013	0.0820089	0.0659572	0.0738441	0.058134
Avg excess returns	0.0424533	0.0494935	0.0566892	0.0554363	0.0482688	0.0575449	0.0589525	0.0429008	0.0507878	0.0350776
Volatility	0.184804	0.161696	0.158856	0.15775	0.15338	0.156082	0.156503	0.159757	0.173299	0.193865
Sharpe ratio	0.22972	0.30609	0.356859	0.351418	0.314701	0.368683	0.376686	0.268538	0.293064	0.180939
Alpha	0.000465339	-0.00633854	0.000795025	-0.00406989	-0.0064164	0.0020287	0.000226436	-0.0110395	-0.0025865	-0.0167875
Std. error (α)	0.00179806	0.00101265	0.000717019	0.000483338	0.000356393	0.000296153	0.000501778	0.000593288	0.00101769	0.001534
t-stat (α)	0.0215667	-0.521616	0.0923992	-0.701698	-1.50031	0.570848	0.0376056	-1.55061	-0.211795	-0.911964
p-value (α)	0.982811	0.602407	0.926456	0.483531	0.134821	0.568624	0.970033	0.122286	0.832443	0.362681
Beta	0.957263	0.973505	0.986625	0.994102	0.968201	0.978123	0.975467	0.95316	0.948607	0.914752
SMB	-0.0599036	-0.0226174	-0.0179129	0.00589702	-0.00246791	0.000635024	0.0560606	0.103474	0.206274	0.321996
HML	0.27104	0.110581	0.0780663	0.0670505	0.0539264	0.0317672	-0.000813856	-0.0355189	-0.055383	-0.250889
RMW	-0.0151891	0.0650114	0.0656931	0.0691854	0.0403098	-0.00832176	0.0167234	-0.0737118	-0.169081	-0.339329
CMA	-0.457233	-0.135876	-0.100993	-0.0828448	-0.0705695	-0.0451995	0.043085	0.0310854	0.0659032	0.195275
R2 adjusted	0.745917	0.895021	0.945619	0.974915	0.985611	0.990384	0.972575	0.963239	0.90789	0.832512

Based on Fama-French 5 factor model,
3 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0567718	0.0774028	0.0735932	0.0744109	0.0782481	0.0757025	0.0810197	0.0866122	0.0864197	0.0950337
Avg excess returns	0.0337155	0.0543464	0.0505368	0.0513545	0.0551917	0.0526461	0.0579633	0.0635558	0.0633633	0.0719774
Volatility	0.193676	0.171081	0.157659	0.155463	0.156034	0.158539	0.156814	0.162229	0.172859	0.191807
Sharpe ratio	0.174081	0.317665	0.320546	0.330334	0.353716	0.332071	0.369631	0.391765	0.366561	0.37526
Alpha	-0.0143045	-0.00219892	-0.00856337	-0.00698354	-0.00428977	-0.00680945	-0.00386201	0.000818595	0.00112335	0.00979573
Std. error (α)	0.00182922	0.00119245	0.000882662	0.000492038	0.000451666	0.000438112	0.000439085	0.000617336	0.00102775	0.00159371
t-stat (α)	-0.651665	-0.153669	-0.808479	-1.18276	-0.791472	-1.29523	-0.732965	0.110501	0.0910849	0.512208
p-value (α)	0.515211	0.877994	0.419577	0.23802	0.429413	0.196428	0.464261	0.9121	0.927497	0.608954
Beta	1.04785	1.0127	0.974493	0.975358	0.978423	0.982867	0.964669	0.955396	0.922394	0.859341
SMB	-0.20926	-0.0887919	-0.0515698	-0.0217613	-0.00181013	0.0166215	0.0666035	0.148247	0.279371	0.464156
HML	0.126025	0.102702	0.082736	0.0804712	0.0580113	0.0358148	-0.0363268	-0.0470283	-0.0524322	-0.218527
RMW	-0.12741	-0.00596011	0.0638457	0.0320666	0.0348012	-0.00964037	-0.0277532	-0.0696962	-0.137593	-0.204743
CMA	-0.169436	-0.099815	-0.0567379	-0.085566	-0.0840351	-0.0597364	0.0301159	0.032548	0.0100475	-0.00629656
R2 adjusted	0.754672	0.866705	0.91417	0.972612	0.977084	0.979119	0.97856	0.960384	0.903119	0.810617

Based on Fama-French 5 factor model,
3 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0703977	0.0624622	0.0734946	0.0776115	0.07419	0.0820348	0.0783976	0.0897094	0.0921987	0.108728
Avg excess returns	0.0473413	0.0394058	0.0504382	0.0545552	0.0511336	0.0589784	0.0553412	0.066653	0.0691424	0.0856714
Volatility	0.208928	0.168371	0.161434	0.158083	0.156615	0.154746	0.156936	0.157068	0.164093	0.181127
Sharpe ratio	0.226592	0.234042	0.312438	0.345106	0.326492	0.381129	0.352635	0.424359	0.421362	0.47299
Alpha	-0.00873592	-0.0194606	-0.00928147	-0.00662264	-0.0107718	-0.00199193	-0.00686297	0.00157402	0.00317344	0.0278486
Std. error (α)	0.00211576	0.000942708	0.000643262	0.00048249	0.000352832	0.000447493	0.000416069	0.000626221	0.000958125	0.00161082
t-stat (α)	-0.344081	-1.72028	-1.2024	-1.14383	-2.54412	-0.370943	-1.37457	0.20946	0.276011	1.4407
p-value (α)	0.731071	0.0866051	0.230334	0.253775	0.0115507	0.71099	0.170482	0.834258	0.782765	0.150905
Beta	1.08175	1.01508	0.998494	0.988619	0.992204	0.962811	0.958104	0.928308	0.902438	0.801002
SMB	-0.0931106	-0.0591164	-0.0390474	-0.0143373	-0.0268484	0.0147354	0.0686185	0.152292	0.249537	0.400967
HML	0.0915438	0.0847029	0.0771028	0.0743036	0.0456063	0.0315911	-0.0203767	-0.0649976	-0.0898228	-0.15514
RMW	-0.0828906	0.0105276	0.011672	0.0213975	0.0210849	-0.00660193	-0.052535	-0.0677194	-0.105179	-0.244275
CMA	-0.279238	-0.170662	-0.121061	-0.0864948	-0.0502602	-0.0269234	0.018163	0.110085	0.124147	0.0534284
R2 adjusted	0.717141	0.914105	0.956521	0.974479	0.986107	0.977078	0.980754	0.956409	0.906325	0.782357

Based on Fama-French 5 factor model,
12 month formation period and 12 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.05845	0.062681	0.0665155	0.0687885	0.0697876	0.0761433	0.0804221	0.0756961	0.083547	0.0888207
Avg excess returns	0.0353936	0.0396246	0.0434591	0.0457321	0.0467312	0.0530869	0.0573657	0.0526397	0.0604906	0.0657643
Volatility	0.177267	0.162346	0.154236	0.152075	0.156096	0.153016	0.154756	0.161119	0.175044	0.187855
Sharpe ratio	0.199662	0.244075	0.281771	0.30072	0.299374	0.346938	0.370685	0.326714	0.345574	0.350079
Alpha	-0.00386431	-0.0119374	-0.010388	-0.00622481	-0.00759832	-0.00388167	-0.00300903	-0.00296463	0.00133554	0.00720335
Std. error (α)	0.00144669	0.000869036	0.000585681	0.000439181	0.000428471	0.000392413	0.000501282	0.000565537	0.000883826	0.00138093
t-stat (α)	-0.222595	-1.1447	-1.47805	-1.18114	-1.4778	-0.824317	-0.500222	-0.436846	0.125924	0.434691
p-value (α)	0.824035	0.253447	0.140673	0.238693	0.140747	0.410558	0.617368	0.662606	0.899895	0.664168
Beta	0.951495	0.97736	0.952492	0.957924	0.985622	0.966912	0.958663	0.956235	0.96793	0.926402
SMB	-0.0886716	-0.0468802	-0.0141395	-0.0511011	-0.0400148	-0.00479772	0.106062	0.112683	0.241419	0.379813
HML	0.3302	0.145795	0.125214	0.101889	0.0832176	0.0298231	-0.0358293	-0.0375105	-0.158745	-0.284817
RMW	-0.128384	0.0207215	0.0108133	0.0168265	0.0270316	0.0140462	0.02341	-0.0811921	-0.137681	-0.159833
CMA	-0.344596	-0.204571	-0.0863302	-0.0657278	-0.067453	0.00251361	0.0816126	0.00915696	0.0773857	0.0592765
R2 adjusted	0.821208	0.923282	0.961431	0.97775	0.979914	0.982439	0.972029	0.967087	0.931821	0.855528

Based on Fama-French 5 factor model,
12 month formation period and 3 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.066374	0.0691344	0.0702555	0.0736961	0.0854811	0.0736564	0.0803788	0.079908	0.0880123	0.0982326
Avg excess returns	0.0433176	0.046078	0.0471991	0.0506397	0.0624247	0.0506	0.0573224	0.0568516	0.0649559	0.0751763
Volatility	0.185819	0.158254	0.154269	0.152895	0.160418	0.153829	0.1589	0.163449	0.173803	0.197104
Sharpe ratio	0.233118	0.291165	0.305954	0.331205	0.389137	0.328936	0.360744	0.347824	0.373734	0.381405
Alpha	-0.00252177	-0.00337676	-0.008815	-0.00421289	0.000121435	-0.00822476	-0.00448047	-0.00413422	0.000791092	0.00206468
Std. error (α)	0.00158361	0.000848855	0.000579746	0.00048786	0.000748612	0.000358986	0.000493505	0.00055482	0.000956336	0.00157549
t-stat (α)	-0.132702	-0.331502	-1.26708	-0.719621	0.0135178	-1.90926	-0.756573	-0.620955	0.0689343	0.109209
p-value (α)	0.894535	0.740541	0.206298	0.472425	0.989225	0.0573648	0.450012	0.535193	0.945097	0.913124
Beta	1.01129	0.944165	0.957066	0.951348	1.00367	0.96397	0.962344	0.962445	0.939554	0.960899
SMB	-0.140386	-0.0649041	-0.026352	-0.0332841	-0.0426767	0.00443378	0.0979938	0.161135	0.259466	0.404519
HML	0.2551	0.159806	0.101973	0.105756	0.069592	0.0429983	-0.0245575	-0.0603071	-0.171559	-0.346624
RMW	-0.135617	-0.0276944	0.0101869	-0.00172638	0.0328382	-0.0102567	-0.0393641	-0.0582833	-0.135698	-0.102649
CMA	-0.235505	-0.191468	-0.0865291	-0.0884953	0.022134	-0.0143268	0.00762115	-0.00539272	0.0566221	0.0746462
R2 adjusted	0.800157	0.921164	0.96137	0.97213	0.940251	0.985117	0.973637	0.968537	0.9171	0.824675

Based on Fama-French 5 factor model,
12 month formation period and 1 month holding period,
the final results are (all numbers annualized):

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Avg returns	0.0575149	0.0688206	0.0784184	0.0728707	0.0727581	0.0759005	0.0809365	0.0962108	0.0978525	0.111804
Avg excess returns	0.0344586	0.0457642	0.055362	0.0498144	0.0497017	0.0528442	0.0578801	0.0731545	0.0747961	0.0887474
Volatility	0.182539	0.15953	0.16085	0.154136	0.15391	0.154705	0.158186	0.168053	0.172692	0.195796
Sharpe ratio	0.188773	0.286869	0.344184	0.323184	0.322926	0.34158	0.3659	0.435306	0.433119	0.453264
Alpha	-0.012305	-0.00656777	-0.0048749	-0.00758558	-0.0109685	-0.00860109	-0.00541525	0.00490758	0.00976862	0.014119
Std. error (α)	0.00151128	0.000926698	0.000811752	0.000520373	0.000376352	0.000352162	0.000466945	0.000889304	0.000961414	0.00159726
t-stat (α)	-0.678511	-0.590607	-0.50045	-1.21477	-2.42868	-2.03531	-0.966434	0.459871	0.846724	0.736624
p-value (α)	0.498068	0.555311	0.617193	0.225588	0.0158514	0.0428624	0.33475	0.646004	0.397949	0.462034
Beta	1.00344	0.948755	0.988722	0.95614	0.973826	0.964335	0.961529	0.969428	0.917101	0.939483
SMB	-0.148308	-0.0648357	-0.0462055	-0.0238776	-0.0266012	0.0263161	0.0839441	0.171262	0.281605	0.41242
HML	0.239025	0.155692	0.101269	0.106429	0.0778953	0.0165455	-0.0175955	-0.0867703	-0.156314	-0.341642
RMW	-0.111869	-0.0110557	0.0185665	0.00576508	0.0209667	-0.00892052	-0.0491687	-0.0659141	-0.161005	-0.131703
CMA	-0.280953	-0.193921	-0.0665653	-0.103535	-0.0431201	-0.0286169	0.0241227	0.0845927	0.0696832	0.121382
R2 adjusted	0.811513	0.907374	0.930042	0.968752	0.983616	0.985824	0.976129	0.923082	0.914936	0.817011

(5) Multi-factor Model