

Project A

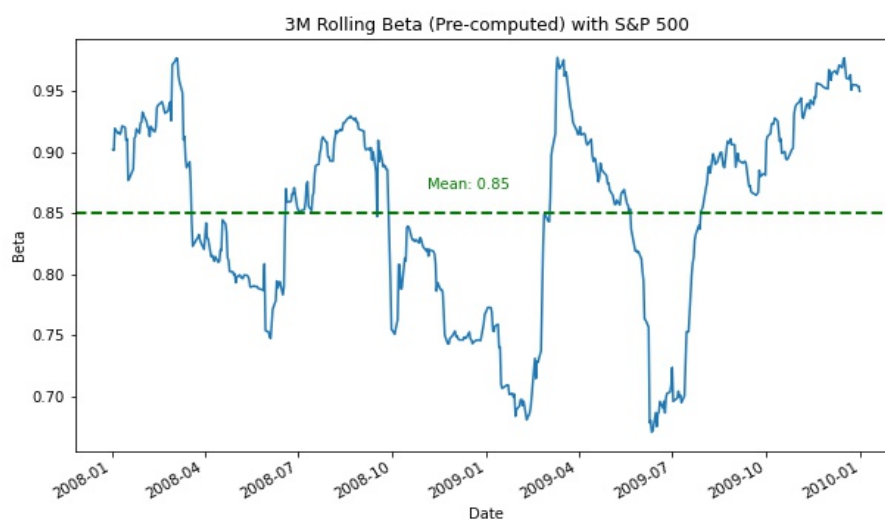
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October 16, 2020

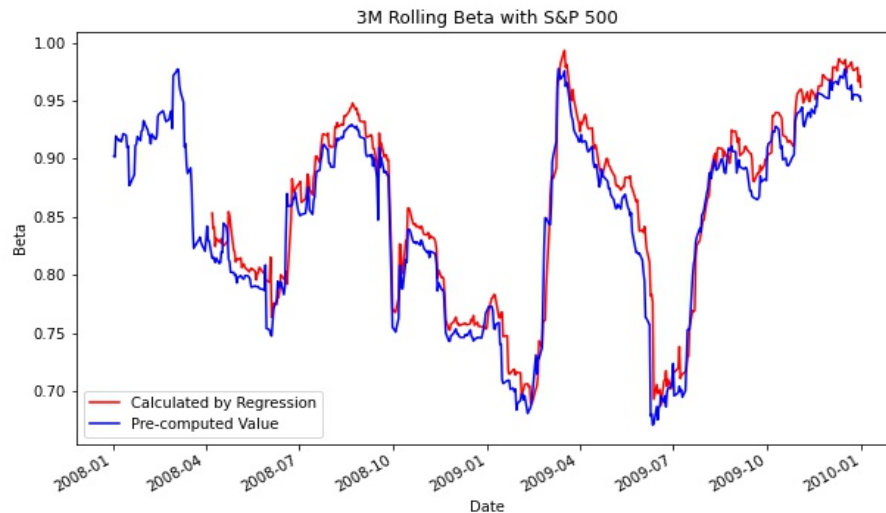
Exercise 1

For the purpose of this analysis, we have chosen **ADAMS EXPRESS CO. (ADX)**. ADX stands for Adams Diversified Equity Fund Inc. Adams Funds manages two of the country's oldest closed-end equity funds, Adams Diversified Equity Fund, Inc. (ADX), previously known as The Adams Express Company, and Adams Natural Resources Fund, Inc. (PEO), previously known as Petroleum Resources Corporation. [1]. The stock was in DJIA for the entire period of analysis i.e from 1-Jan-2008 to 31-Dec-2009.

(a) The plot for 3-month rolling beta of stock vs the S&P 500, using the pre-calculated beta present in crispy04 is shown below. As seen from the plot, the beta of our stock has changed between 0.7 to 0.95. The average of the beta over entire period is 0.85.



In addition of taking the pre-calculated beta values, we also calculated the beta from regression with a rolling window of 66 business days. This comparison will help us in ascertaining the accuracy of pre-calculated beta present in the data source. The close match between our calculated beta and the pre-calculated beta means that the data source is reliable.



(b) For calculating the best fit line between 1-day stock return and 1-day SPTR return, we have used Linear Regression. The result of linear regression is shown below. As evident from the p-value of the constant term, the constant in the linear regression is statistically-insignificant.

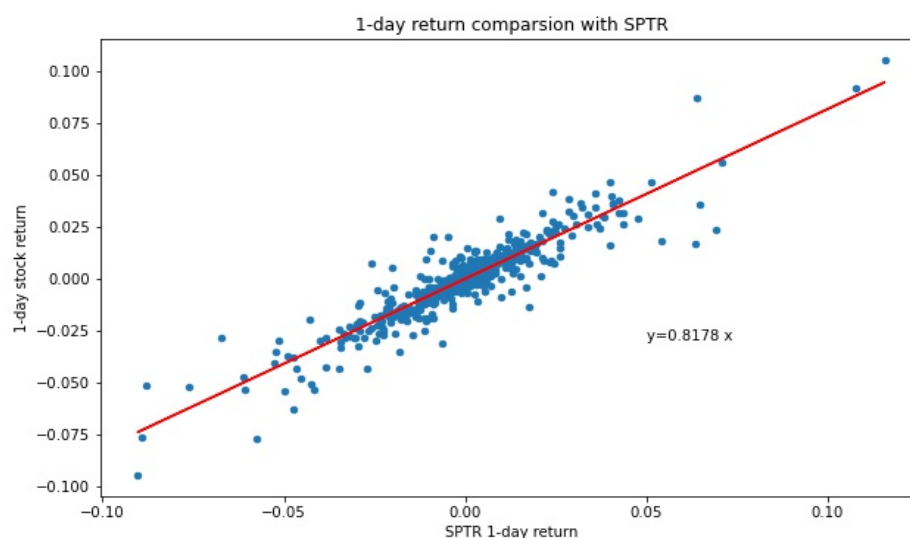
OLS Regression Results

Dep. Variable:	Return	R-squared:	0.847			
Model:	OLS	Adj. R-squared:	0.847			
Method:	Least Squares	F-statistic:	2791.			
Date:	Thu, 15 Oct 2020	Prob (F-statistic):	2.04e-207			
Time:	21:13:59	Log-Likelihood:	1746.8			
No. Observations:	505	AIC:	-3490.			
Df Residuals:	503	BIC:	-3481.			
Df Model:	1					
Covariance Type:	nonrobust					
	coef	std err	t	P> t 	[0.025	0.975]
Intercept	-6.382e-05	0.000	-0.188	0.851	-0.001	0.001
SPTR	0.8178	0.015	52.834	0.000	0.787	0.848
Omnibus:	62.071	Durbin-Watson:	2.260			
Prob(Omnibus):	0.000	Jarque-Bera (JB):	417.282			
Skew:	-0.234	Prob(JB):	2.45e-91			
Kurtosis:	7.429	Cond. No.	45.6			

Therefore, the final regression equation for the best-fit line given as.

$$\text{1-day ADX Return} = 0.8178 * (\text{1-day SPTR Return})$$

In the first part of this question, the average beta of ADX for the period was calculated as 0.85 which is close to the slope (0.8178). A scatter plot of 1-day stock returns vs 1-day return of the SPTR (SP 500 total return index) is shown below.



(c) For calculating the best fit line between 1-day stock return and 1-day return of VIX return, we have used linear regression. The result of linear regressino is shown below. As evident from the p-value of the constant term, the constant in the linear regression is statistically-insignificant.

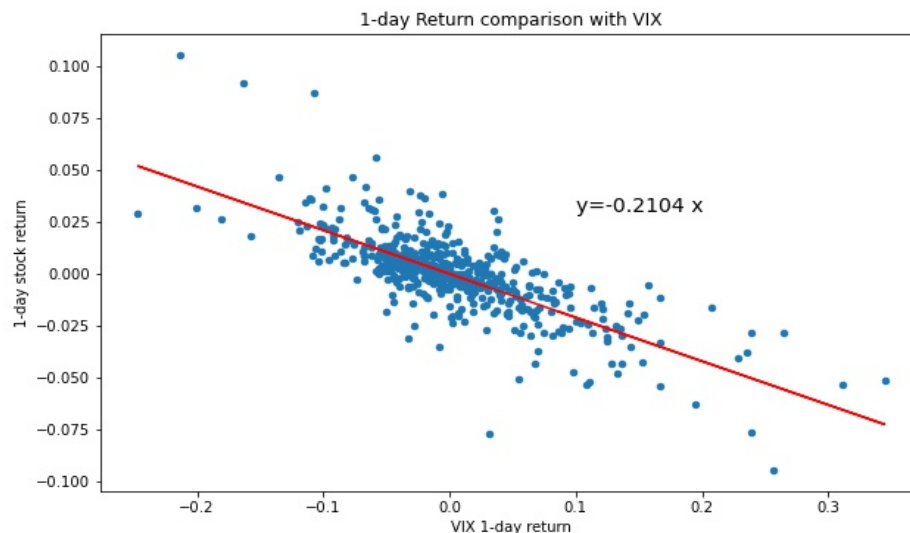
Dep. Variable:	Return	R-squared:	0.565
Model:	OLS	Adj. R-squared:	0.564
Method:	Least Squares	F-statistic:	652.9
Date:	Thu, 15 Oct 2020	Prob (F-statistic):	6.25e-93
Time:	22:26:19	Log-Likelihood:	1482.4
No. Observations:	505	AIC:	-2961.
Df Residuals:	503	BIC:	-2952.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Intercept	0.0002	0.001	0.364	0.716	-0.001	0.001
VIX	-0.2104	0.008	-25.552	0.000	-0.227	-0.194

Omnibus:	72.101	Durbin-Watson:	2.173
Prob(Omnibus):	0.000	Jarque-Bera (JB):	486.353
Skew:	0.373	Prob(JB):	2.45e-106
Kurtosis:	7.749	Cond. No.	14.4

$$1\text{-day ADX Return} = -0.2104 * (1\text{-day VIX Return})$$

A scatter plot of 1-day stock returns vs 1-day return of the VIX is shown below.



For checking if VIX can be considered as a new factor in addition to “the market”, we regressed the stock return on both market return and VIX return. Following are the results for that analysis.

Dep. Variable:	Return	R-squared:	0.850
Model:	OLS	Adj. R-squared:	0.850
Method:	Least Squares	F-statistic:	1426.
Date:	Fri, 16 Oct 2020	Prob (F-statistic):	8.85e-208
Time:	18:43:45	Log-Likelihood:	1752.0
No. Observations:	505	AIC:	-3498.
Df Residuals:	502	BIC:	-3485.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Intercept	-0.0002	0.000	-0.720	0.472	-0.001	0.000
mktrf	0.7950	0.026	30.944	0.000	0.745	0.846
VIX	-0.0088	0.008	-1.079	0.281	-0.025	0.007

The coefficient of VIX is statistically insignificant in the presence of Market Excess return, which means that the risk captured by VIX is already there in the market premium and therefore VIX does not offer a new dimension of risk and should not be considered as a new factor.

Exercise 2

For the purpose of this question, we have used data for long/short strategy “Contra01” in the OLAP database StatArb03 using the cube Positions. The ‘Weighted Return TC’ data from 2001 to the end of 2004 is used.

(a) Performance statistics for strategy from 2001-2004 is given in the table below.

	Strategy
Annualized Return	110.75 %
Volatility	24.45 %
Sharpe Ratio	4.53

(b) Result of regression for CAPM is shown below.

Dep. Variable:	TotalReturn		R-squared:	0.006		
Model:	OLS		Adj. R-squared:	0.005		
Method:	Least Squares		F-statistic:	6.067		
Date:	Thu, 15 Oct 2020		Prob (F-statistic):	0.0139		
Time:	23:23:17		Log-Likelihood:	2768.8		
No. Observations:	1004		AIC:	-5534.		
Df Residuals:	1002		BIC:	-5524.		
Df Model:	1					
Covariance Type:	nonrobust					
	coef	std err	t	P> t 	[0.025	0.975]
Intercept	0.0044	0.000	9.037	0.000	0.003	0.005
mktrf	0.0989	0.040	2.463	0.014	0.020	0.178

CAPM alpha is 0.0044 which is statistically significant. CAPM beta is 0.0989 (with 95% confidence interval) and the R-squared is 0.006. Standard error is 0.040 and t-statistics for beta coefficient is 2.463. CAPM equation is given as below.

$$(\text{Strategy Return}) = 0.0044 + 0.0989 * \text{Market Premium}$$

According to CAPM, alpha should be zero. In this case, although alpha is not zeros, but its value is very small.

Over the period from 2001 to end of 2004, beta, which measures the sensitivity to market, is just 0.0989 which is very low. It means that for a unit change in market excess return, the strategy will only be changed by 0.09%. Therefore, although the strategy is not totally market neutral (beta of 0), the strategy is close to market neutrality with a little positive exposure to market.

(c) Result of regression for Fama-French Regression is shown below.

Dep. Variable:	TotalReturn	R-squared:	0.013
Model:	OLS	Adj. R-squared:	0.009
Method:	Least Squares	F-statistic:	3.288
Date:	Fri, 16 Oct 2020	Prob (F-statistic):	0.0109
Time:	18:57:12	Log-Likelihood:	2772.3
No. Observations:	1004	AIC:	-5535.
Df Residuals:	999	BIC:	-5510.
Df Model:	4		
Covariance Type:	nonrobust		

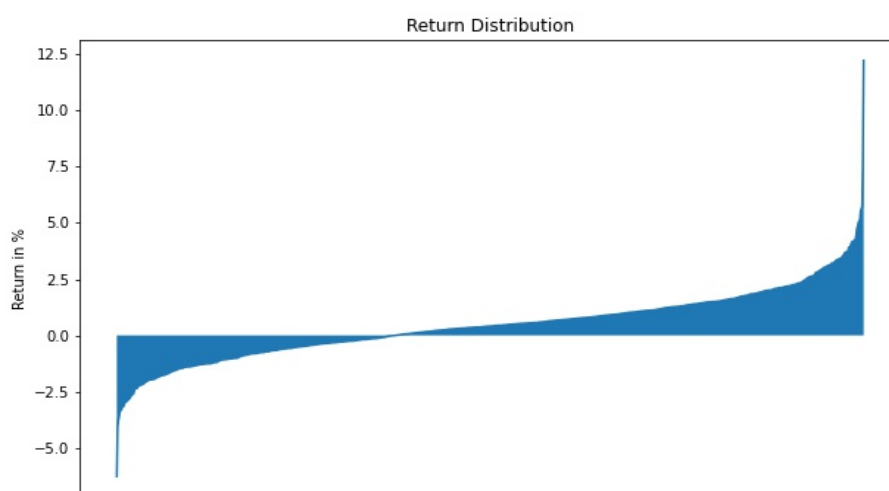
	coef	std err	t	P> t	[0.025	0.975]
Intercept	0.0044	0.000	9.116	0.000	0.003	0.005
mktrf	0.0528	0.051	1.034	0.301	-0.047	0.153
smb	-0.1506	0.087	-1.721	0.086	-0.322	0.021
hml	0.0512	0.113	0.452	0.651	-0.171	0.274
umd	-0.1129	0.066	-1.708	0.088	-0.243	0.017

Summarizing the final Fama-French regression equation for 90% confidence interval.

$$\text{Strategy Return} = 0.0044 - 0.1506 * SMB - 0.1129 * UMD$$

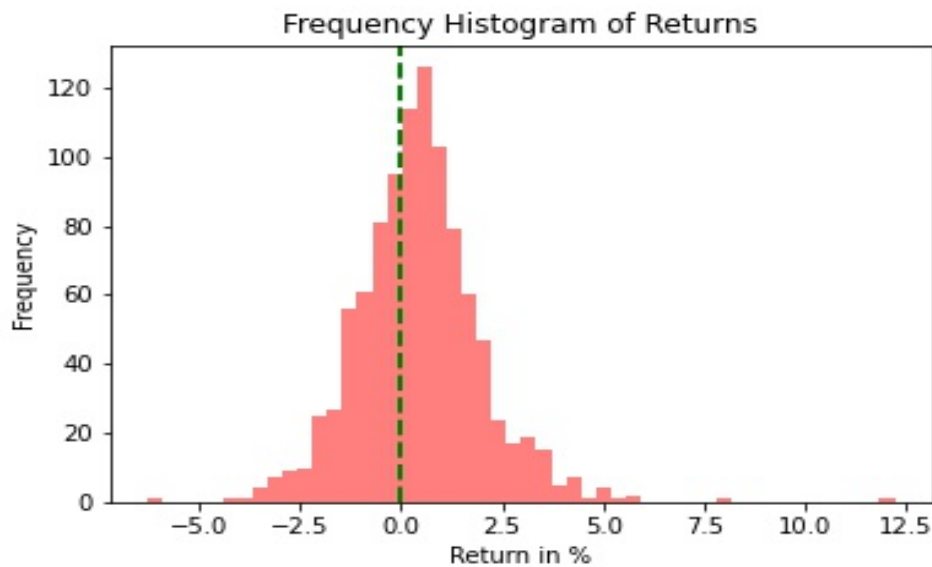
R-squared of the regression is 0.013. Interestingly, in the above regression the coefficient of market premium and HML factor are statistically insignificant. The insignificance of market beta suggests that the strategy is market neutral. Like CAPM, Fama-French model also requires the constant term to be statistically insignificant. So, the strategy return violates the fama-french models by having a statistically significant constant term (although small).

(d) Strategy one-day return in order is plotted in the chart below.



As evident from the chart, number of days with positive return is greater than the number of days with negative return, meaning the strategy on average is a good strategy. Moreover,

highest positive return is around 12.5% while the lowest return is around -5.5%. The positive skew of the one-day return can also be visualized by plotting an histogram of the return, as shown below.



As evident from the histogram, majority of returns lies to the right of 0 (marked by dashed green line on the plot), suggesting that strategy on average is performing positively.

	Winners	Losers
Fraction of days	62.75 %	37.25%
Median of returns	1.019 %	-0.802 %

(e) Based on the performance statistics of the strategy from 2001 to 2004, investor can expect a positive return in future. This is supported by following points.

- The strategy on a whole performed positively with an annualized return of 110.75%.
- Fraction of winning dates were greater than fraction of losing dates.
- Median of winners is greater (in absolute terms) than median of losers.

But all these facts assume, like any typical statistical analysis, that future will be similar to the past. In case, market dynamics in futures varies significantly from the past, then these assumptions will fail and the strategy may perform abnormally (can give negative return or low return).

Exercise 3

For the purpose of this question, we have used data for long/short strategy "Contra01" in the OLAP database StatArb03 using the cube Positions. The 'Weighted Return TC' data from 2005 to the end of 2009 is used. Moreover, the long and short leg of strategy is also studied.

(a) Performance statistics for Hedgefund from 2005-2009 is given in the table below.

	Strategy	Long Leg	Short Leg
Annualized Return	39.07 %	-18.45 %	57.52 %
Volatility	28.57 %	32.57%	28.68 %
Sharpe Ratio	1.37	-0.57	2.01

(b) Result of regression for CAPM for overall strategy return with market excess return is shown below.

Dep. Variable:	TotalReturn	R-squared:	0.000
Model:	OLS	Adj. R-squared:	-0.001
Method:	Least Squares	F-statistic:	0.3539
Date:	Fri, 16 Oct 2020	Prob (F-statistic):	0.552
Time:	01:06:46	Log-Likelihood:	3272.2
No. Observations:	1259	AIC:	-6540.
Df Residuals:	1257	BIC:	-6530.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P> t 	[0.025	0.975]
Intercept	0.0015	0.001	3.048	0.002	0.001	0.003
mktrf	0.0199	0.033	0.595	0.552	-0.046	0.085

CAPM alpha is 0.0015 which is statistically significant. CAPM beta is 0.0199 and is statistically insignificant and the R-squared is 0. Standard error is 0.552 and t-statistics for beta coefficient is 0.595.

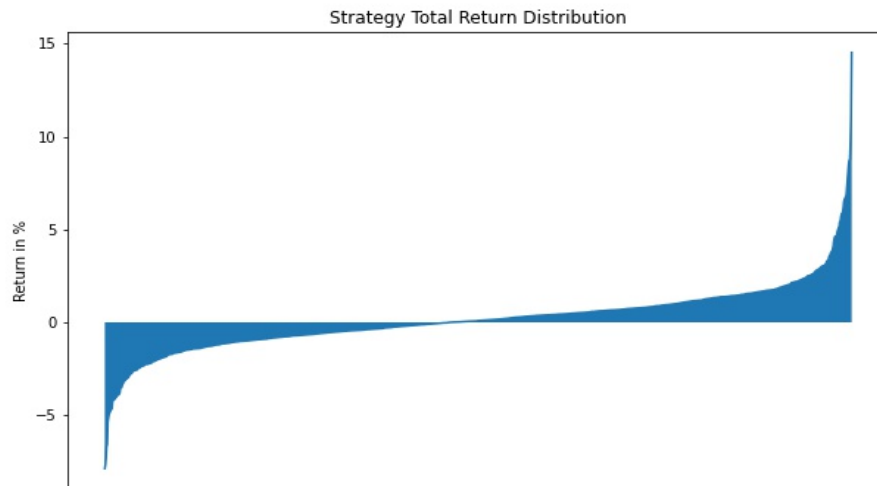
Interestingly, final regression equation (with only statistically significant terms) is shown as below, with only constant term.

$$\text{Strategy 1-day return} = 0.0015$$

According to CAPM, alpha should be zero. In this case, although alpha is not zero, but its value is very small.

Over the period from 2005 to end of 2009, beta, which measures the sensitivity to market, is statistically insignificant which means that the strategy is market neutral. It implies that strategy return is independent of market return.

(c) Strategy one-day return in order is plotted in the chart below.

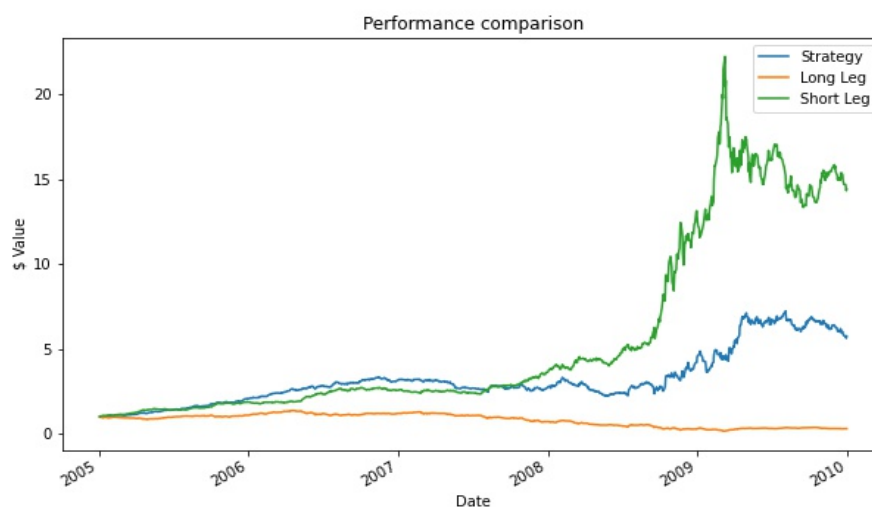


As evident from the chart, number of days with positive return is greater than the number of days with negative return, meaning the strategy on average is a good strategy. Moreover, highest positive return is around 15% while the lowest return is around -7.5%.

	Strategy		Long Leg		Short Leg	
	Winners	Losers	Winners	Losers	Winners	Losers
Fraction of days	53.61 %	46.38%	48.93 %	51.07 %	54.73%	45.27 %
Median of returns	0.84 %	-0.82 %	0.82 %	-0.92 %	0.82 %	-0.68 %

As evident from the table, during 2005-2009, the long leg of strategy has not performed well and has more losers (day with negative return) than winners. Moreover, for the long-leg of strategy, the magnitude of median return on losers is greater than that of winner.

(d) In order to get a better idea of performance of strategy along with both of legs, we can construct a simple index. The index will give the value of 1 dollar invested at the start 2005 on strategy, the long leg and the short leg.



From the plot, it is very clear that the short leg is performing phenomenally while the long leg of the trade is pulling down the performance of overall strategy.

In Question 2, we predicted the strategy to perform positively in the future which it has full-filled. But the overall performance of strategy has taken a huge hit. The comparison of strategy performance is shown below.

	Strategy (2001-2004)	Strategy (2005-2009)
Annualized Return	110.75 %	39.07 %
Volatility	24.45 %	28.57 %
Sharpe Ratio	4.53	1.37

The sharpe Ratio of strategy has decreased significantly from 4.53 to 1.37.

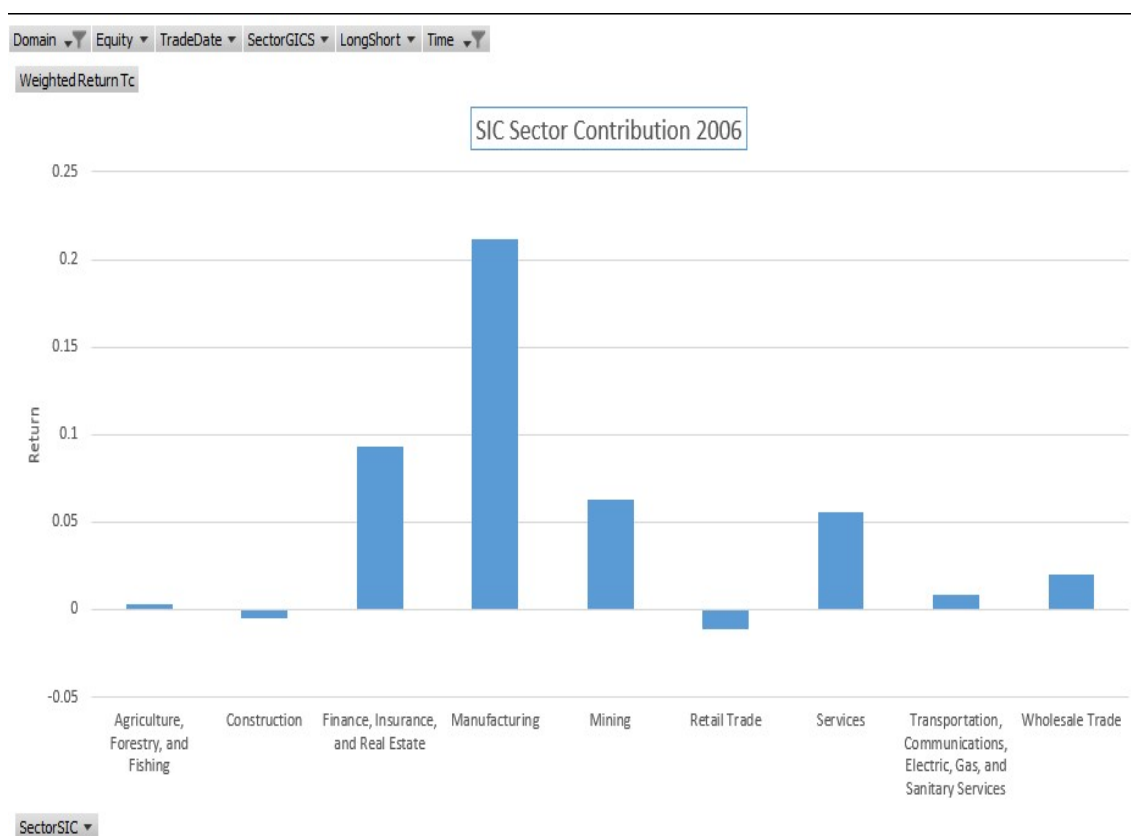
Possible Reason One of the possible reason of change in strategy performance can be attributed to 2008 Financial crisis. The crisis saw drop in prices across all of the equity class. As a result, the long leg saw a huge drawdown and couldn't recover from the drawdown by the end of 2009. Whereas, the short leg benefitted from the crisis.

In terms of portfolio's manager style, which can be gauged using the overall beta of the strategy. During 2001-2004, the overall beta of the strategy was positive 0.09 (statistically significant), while during the period 2005-2009, the beta of strategy became statistically insignificant. This alludes to a possible change in portfolio manager style, but as discussed earlier, the financial crisis of 2008 caused a significant disruption in market which also suggests that while portfolio manager style remained same, market dynamics changed, causing a change in portfolio statistics.

(e) For calculating the contribution for each SIC sector, 'Weighted Return TC' is summed over 2006, and the return from each sector is then compared to the total return of the strategy. The table below summarises the return and contribution for each SIC sector.

SIC Sectors	Weighted Return Tc (Aggregate)	Contribution
Agriculture, Forestry, and Fishing	0.27%	0.62%
Construction	-0.49%	-1.12%
Finance, Insurance, and Real Estate	9.34%	21.29%
Manufacturing	21.15%	48.24%
Mining	6.28%	14.31%
Retail Trade	-1.14%	-2.61%
Services	5.61%	12.79%
Transportation, Communications, Electric, Gas, and Sanitary Services	0.80%	1.82%
Wholesale Trade	2.04%	4.66%
Grand Total	43.86%	

Total return from each SIC sector is also plotted below.

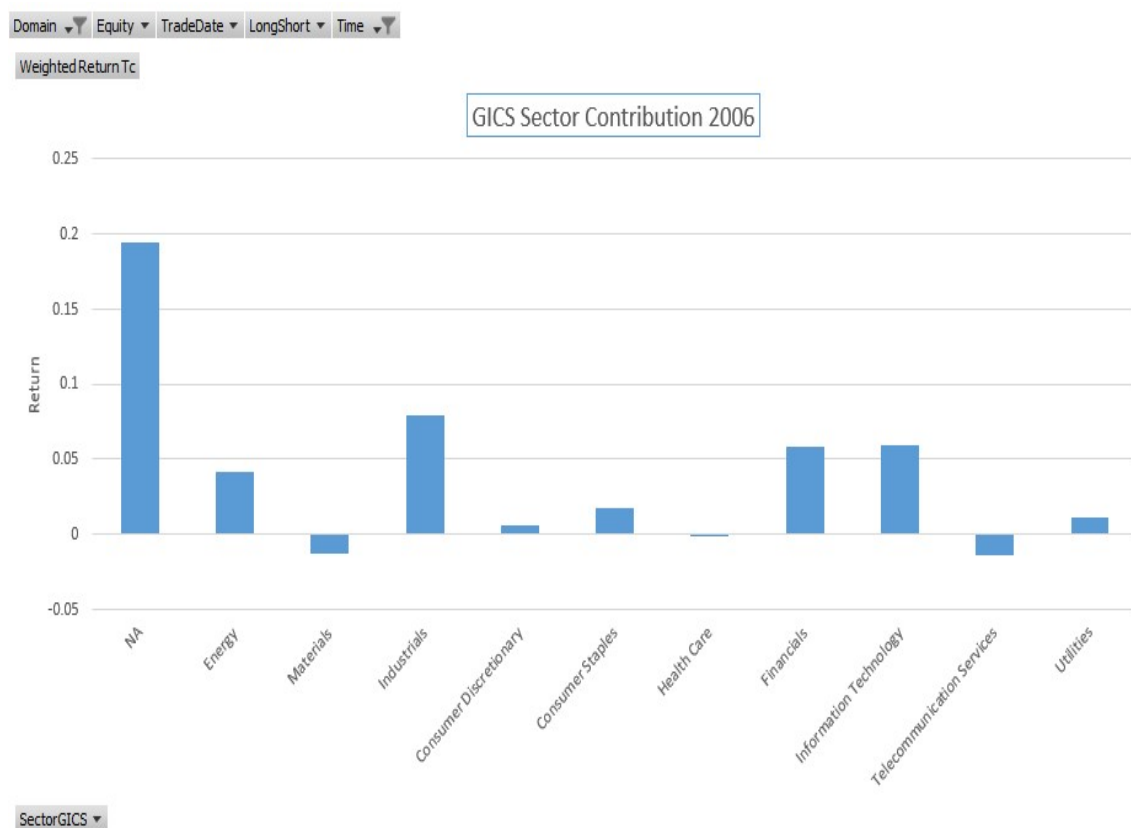


As evident from the plot and the table, Manufacturing sector was the best performer with a total return of 21.15 %, constituting a total contribution of 48.24 % of the strategy return. While Retail Trade was the worst performer with -1.14 % return.

(f) For calculating the contribution for each GICS sector, 'Weighted Return TC' is summed over 2006, and the return from each sector is then compared to the total return of the strategy. The table below summarises the return and contribution for each SIC sector.

GICS Sectors	Weighted Return Tc (Aggregate)	Contribution
NA	19.41%	44.27%
Energy	4.17%	9.50%
Materials	-1.31%	-2.98%
Industrials	7.94%	18.10%
Consumer Discretionary	0.59%	1.35%
Consumer Staples	1.71%	3.90%
Health Care	-0.16%	-0.35%
Financials	5.83%	13.30%
Information Technology	5.93%	13.53%
Telecommunication Services	-1.36%	-3.10%
Utilities	1.09%	2.48%
Grand Total	43.86%	

Total return from each GICS sector is also plotted below.



In case of GICS sector, many of the return were not attributed to any existing GICS sector and as result they were all aggregated under label "NA". And interestingly, this "NA" sector (can also be interpreted as every other sector except the ones mentioned here), was the best performer in 2006. As evident from the plot and the table, this "NA" had a total return of 19.41 %, constituting a total contribution of 44.27 % of the strategy return. While Telecommunication Services was the worst performer with -1.36 % return.

Exercise 4

(a) For the period from 2005 to 2009, the net exposure of each GICS sector is calculated by aggregating the weights. The highest and the lowest net exposure corresponds to "NA" sector, which means that they are related to all other sectors that are not in our current list. The highest and the lowest net exposure in % is shown below.

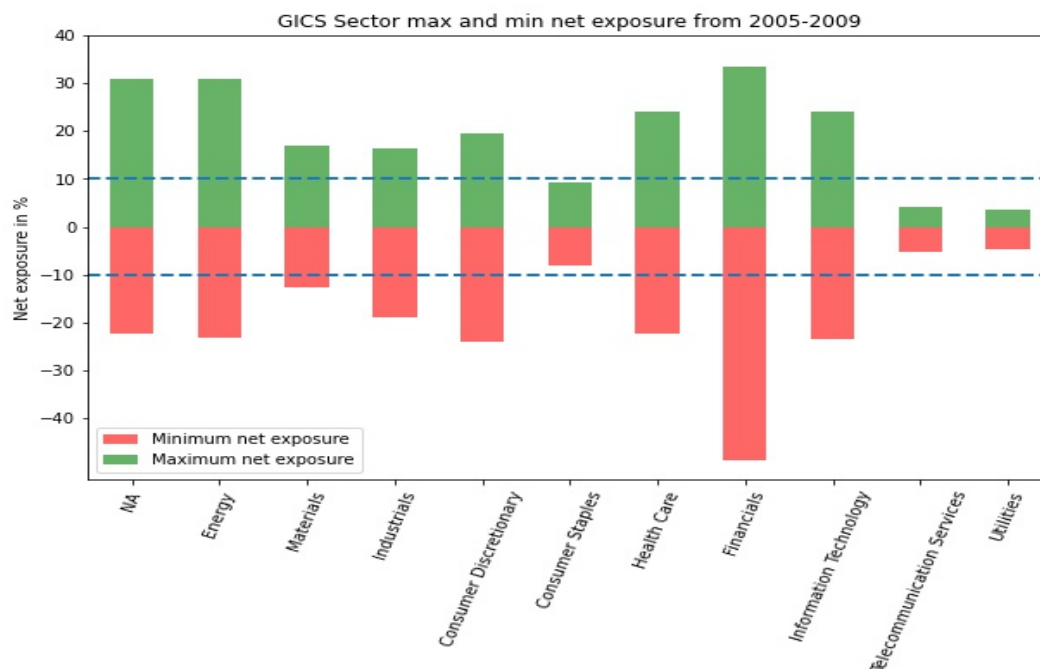
Lowest Net exposure for GICS sector

NA	-22.222222
Energy	-23.255814
Materials	-12.676056
Industrials	-18.987342
Consumer Discretionary	-24.000000
Consumer Staples	-8.000000
Health Care	-22.222222
Financials	-48.717949
Information Technology	-23.595506
Telecommunication Services	-5.128205
Utilities	-4.761905

Highest Net exposure for GICS sector

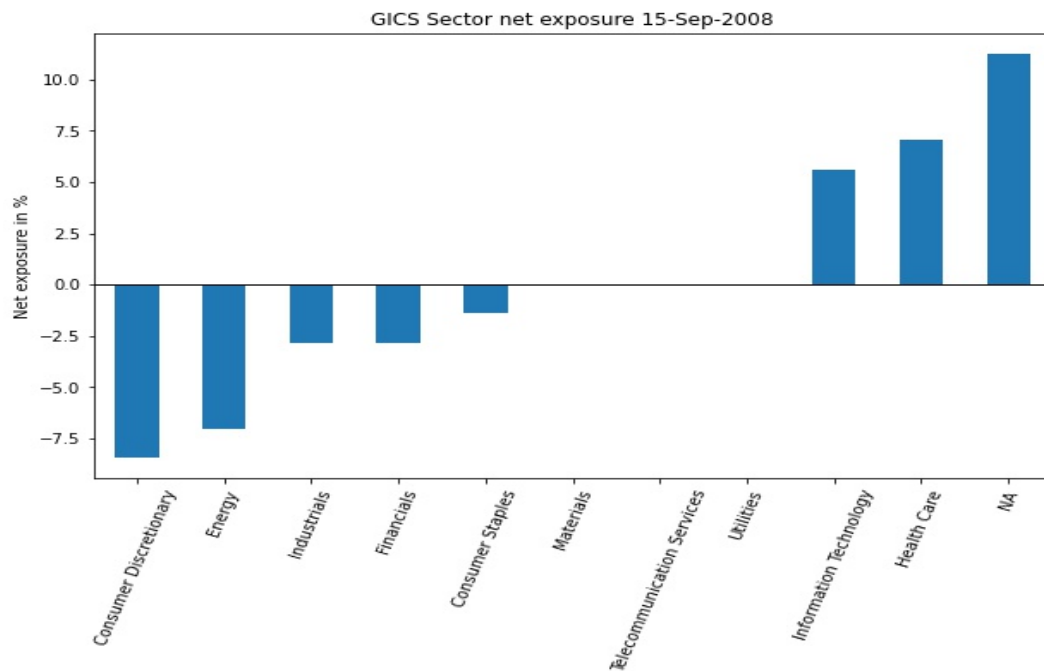
NA	30.985915
Energy	30.985915
Materials	16.901408
Industrials	16.279070
Consumer Discretionary	19.402985
Consumer Staples	9.230769
Health Care	24.137931
Financials	33.333333
Information Technology	24.096386
Telecommunication Services	4.210526
Utilities	3.529412

The highest and lowest net exposure can also be visualized as shown below.



As evident from the plot, only three GICS sector i.e Consumer Staples, Telecommunication Services and Utilities stayed within $\pm 10\%$ throughout.

(b) For 15-Sep-2008, GICS sector exposure is shown in the plot below. "NA" was the most unbalanced sector with 11.27 % weight.

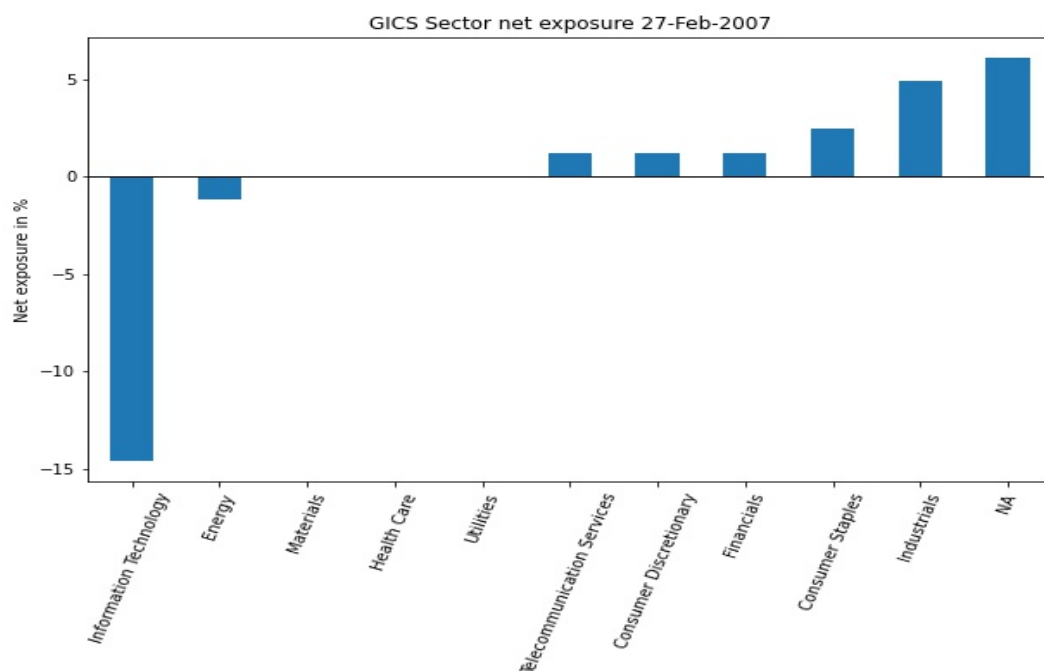


"NA", Health Care and Information Technology were positively unbalanced (had positive weights), while Consumer Discretionary, Energy, Industrials, Financials and Consumer Staples were negatively unbalanced (had negative weights).

Of all the GICS sectors, only Materials, Tele. Tech and Utilities were balanced.

	15-Sep-2008
Total long weight	23.94 %
Total short weight	-22.53 %
Net portfolio weight	1.408 %
Day's Portfolio Return	-4.80 %

(c) For 27-Feb-2007, GICS sector exposure is shown in the plot below. Information Technology was the most unbalanced sector with -14.63 % weight.



"NA", Industrials, Financials, Consumer Staples, Tele. Tech and Consumer Discretionary were positively unbalanced (had positive weights), while Information Technology and Energy were negatively unbalanced (had negative weights).

Of all the GICS sectors, only Materials, Health Care and Utilities were balanced.

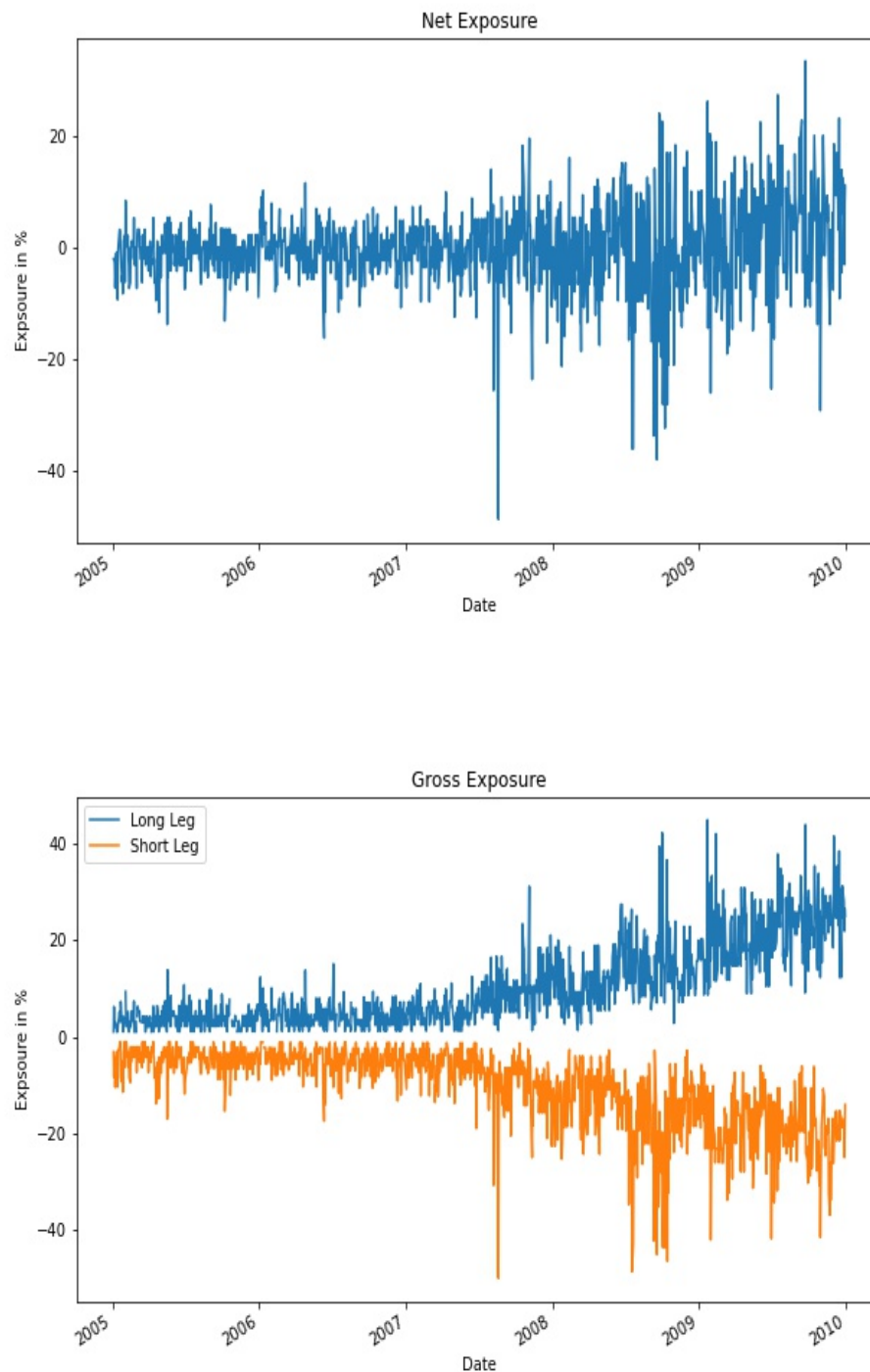
	27-Feb-2007
Total long weight	17.07 %
Total short weight	-15.85 %
Net portfolio weight	1.22 %
Day's Portfolio Return	0.437 %

(d) In our strategy, we filter with respect to GICS sector to select only the Financial sector. The return for the sub-strategy thus formed (with only Financial sector), is then regressed against the excess market return (that we used in Fama French regression) to ascertain the market neutrality of the sub-strategy. The output of the regression is shown below.

Dep. Variable:	TotalReturn	R-squared:	0.000			
Model:	OLS	Adj. R-squared:	-0.001			
Method:	Least Squares	F-statistic:	0.01771			
Date:	Fri, 16 Oct 2020	Prob (F-statistic):	0.894			
Time:	17:59:08	Log-Likelihood:	4623.1			
No. Observations:	1259	AIC:	-9242.			
Df Residuals:	1257	BIC:	-9232.			
Df Model:	1					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
Intercept	0.0003	0.000	1.508	0.132	-7.88e-05	0.001
mktrf	-0.0015	0.011	-0.133	0.894	-0.024	0.021

Both the beta and the alpha in this CAPM regression are statistically insignificant which means that this sub-strategy is market neutral over 2005 to 2009.

Furthermore, the temporal evolution of net and gross exposure of this sub-strategy can be viewed in the plots below.



As evident from the gross exposure plot, magnitude of weights assigned to Financial sector, both on the long and short leg increased after the financial crisis (after 2008) with a lot of volatility. But the contrarian construction of the strategy allowed the overall sub-strategy to remain market-neutral.

References

- [1] Adams Express Co,
<https://www.adamsfunds.com/about/>