Statistical Validity of the Fama French Carhart Four Model

by

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I dedicate this thesis to my immediate family members: my parents, my brothers David and Alvin, and my sister-in-law Lily. Thank you for all of their love and support throughout my life. In particular, I would like to thank my parents for always believing in me, their continuous love, and their support in all my life decisions. Without whom I could not have made it here. My bothers David and Alvin have never left my side and are very special.

I also dedicate this thesis to my friends who have supported me throughout the process. I will always appreciate all that they have done, especially Ben Chan, Kit Chan, and their wonderful children Ada and Paul, for being supportive and encouraging as always. They have been my best cheerleaders.

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Abstract

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We examine whether OLS is the right method to apply on the Fama French Carhart Four Model using the observed data of the four-factor and the monthly returns of each of the 10 portfolios formed monthly on momentum, where the 10 portfolios are constructed monthly using NYSE prior (2-12) return in ascending order with decile breakpoints. Next, we use Cook's distance and covariance ratio to measure the influence of an observation on betas and t-statistics respectively. Finally, we compare two mean-variance optimal portfolios, in which the portfolios are both comprised of the 10 portfolios formed on momentum but with two different weighted methods.

Chapter 1

Introduction

1.1 The Fama French Carhart Four Model

The Fama French Carhart Four Model [6] is a 4-factor model using Fama and French's 3-factor model plus an additional factor capturing Jegadeesh and Titman's one-year momentum anomaly. The Fama French Carhart Four Model is formulated as

$$r_{i,t} = \alpha_i + \beta_{i,RMRF} RMRF_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,MOM} MOM_t + \epsilon_{i,t} \tag{1.1}$$

where i = 1,...,10 indexes the 10 portfolios formed monthly on momentum factor, t indexes for month, r is the portfolio return in excess of the risk-free rate, RMRF, SMB, and HML are the Fama-French market, size, and value factors, MOM is the momentum factor, ϵ is the unobservable random error, and the various βs are the corresponding factor loadings. The paper focus on the empirical study of the equation (1.1) using the data from Kenneth R. French's Data Library. [1]

1.2 Data

We are using the following three sets of data from Kenneth R. French's Data Library [11].

- Fama/French Factors
- Momentum Factor (MOM)
- 10 Portfolios Formed Monthly on Momentum

[1] The Kenneth R. French's Data Library `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html` contains data for U.S. research returns, historical benchmark returns, U.S. research breakpoints, U.S. book equity, international research returns, and developed market factors and returns.

1.2.1 Fama/French Factors

This dataset includes the monthly data for the three Fama/French Factors RMRF, SMB, and HML. It also includes the risk-free rate factor R_f so that we can get the market rate factor R_m by adding the risk-free factor to RMRF factor.

SMB (Small Minus Big) [11] is the average return on the three small portfolios minus the average return on the three big portfolios, which is equal to

$$\frac{1}{3}(Small\ Value + Small\ Neutral + Small\ Growth) - \frac{1}{3}(Big\ Value + Big\ Neutral + Big\ Growth)$$

HML (High Minus Low) [11] is the average return on the two value portfolios minus the average return on the two growth portfolios, which is equal to

$$\frac{1}{2}(Small\ Value + Big\ Value) - \frac{1}{2}(Small\ Growth + Big\ Growth)$$

RMRF ($R_m - R_f$) [11] is the excess return on the market, value-weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ that have a CRSP share code of 10 or 11 at the beginning of month t, good shares and price data at the beginning of t, and good return data for t minus the one-month Treasury bill rate.

These Fama/French factors [11] are constructed using the 6 value-weight portfolios formed on size and book-to-market. The portfolios, which are constructed at the end of each June, are the intersections of 2 portfolios formed on size (market equity, ME) and 3 portfolios formed on the ratio of book equity to market equity (BE/ME). The size breakpoint for year t is the median NYSE market equity at the end of June of year t. BE/ME for June of year t is the book equity for the last fiscal year end in $t - 1$ divided by ME for December of $t - 1$. The BE/ME breakpoints are the 30th and 70th NYSE percentiles.

1.2.2 Momentum Factor (MOM)

This dataset includes the monthly data for the Momentum (MOM) factor [11], MOM is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios, which is equal to

$$\frac{1}{2}(Small\ High + Big\ High) - \frac{1}{2}(Small\ Low + Big\ Low)$$

1.2.3 10 Portfolios Formed Monthly on Momentum

This dataset includes the monthly data for return of 10 portfolios formed monthly on momentum.

The portfolios [11] constructed each month include NYSE, AMEX, and NASDAQ stocks with prior return data. To be included in a portfolio for month t (formed at the end of month $t-1$), a stock must have a price for the end of month $t-13$ and a good return for $t-2$.

Stocks are sorted at the beginning of the first trading day of each month from January 1925 to August 2013 into decile portfolios based on their previous calendar year's return. We have two sets of data; one is average equal weighted (AEW) and the other one is average value weighted (AVW). The portfolios are weighted monthly so the weights are readjusted whenever a stock disappears. Stocks with the lowest NYSE prior (2-12) return comprise decile 1 and stocks with the highest comprise decile 10 [11].

1.3 Programming Language and Reproducibility

We use the open-source programming language R for the computation and data analysis that are necessary for our research. All the figures and other output appeared in this thesis are reproducible using the R codes in appendix G together with the three sets of data from Kenneth R. French's Data Library. We will also use GitHub to facilitate reproducible computational results and share our research. All our datasets and programming files, together with this thesis, can be found here: `https://github.com/henrykmwong`.

1.4 Multiple Linear Regression

In this chapter, we set up a multiple linear regression model for the equation (1.1) and identify the influential observations for each of the portfolios. The model [10] is:

$$Y = X\beta + \epsilon \tag{1.2}$$

On the left, Y is an $N \times 1$ vector of observable random variables. The Y vector is called the *dependent* or *response* variable. On the right, the first term is X, an $N \times p$ matrix of observable random variables, one column for each data variable. The X matrix is called the *design matrix* and the data variables are called the *explanatory* or *independent* variables. We assume that $N > p$ and the design matrix has full rank. The second term on the right is β, a $p \times 1$ vector of unknown coefficents or parameters to be estimated. The final term on the right is ϵ, an $N \times 1$ vector of unobservable random errors.

In the application of the Fama French Carhart Four Model on our data, N is the number of monthly observations, which is equal to 1,039 and p is the number of coefficient variables, which is equal to 5 (intercept plus coefficients for the four factors).

We will write Y_i for the ith observation of Y, X_i for the ith row of X, and ϵ_i for the ith component of ϵ. The matrix equation (1.2) is equivalent to a set of N ordinary equations, one for each observation. For the ith observation, the equation is

$$Y_i = X_i\beta + \epsilon_i \tag{1.3}$$

To estimate the β in equation (1.2), we use the method of ordinary least squares (OLS) with the following assumptions [10].

1. The ϵ_i are independent and identically distributed with mean zero and constant variance (or homoscedasticity) σ^2.

2. If X is random, ϵ is independent of X.

Using the method of OLS, we have:

$$\hat{\beta} = (X^TX)^{-1}X^TY \tag{1.4}$$

$$\hat{Y} = X\hat{\beta} \tag{1.5}$$

where

$$P = X(X^TX)^{-1}X^T \tag{1.6}$$

$$e = Y - \hat{Y} = (I - P)Y \tag{1.7}$$

$$\hat{\sigma}^2 = \frac{e^Te}{N-p} \tag{1.8}$$

$$\begin{aligned} \Psi &= cov(\hat{\beta}|X) \\ &= \sigma^2(X^TX)^{-1} \end{aligned} \tag{1.9}$$

$$cov(\hat{Y}|X) = \sigma^2P \tag{1.10}$$

and

$$cov(e|X) = \sigma^2(I - P) \tag{1.11}$$

We denote the vector of estimeated coefficients and the vector of fitted values by $\hat{\beta}$ and $\hat{Y}$. The $N \times N$ matrix P in equation (1.6) is called the *hat matrix*. It is also called the *projection matrix* because it projects Y into the column space of X. The vector of the (least squares) residuals is denoted by e in equation (1.7).

The following equation will be used in this chapter for identifying influential observations.

$$t_i = \frac{e_i}{\hat{\sigma}\sqrt{1 - p_i}} \tag{1.12}$$

where e_i is the ith component of the vector of residuals e and p_i is the ith diagonal element of P.

1.5 Regression Diagnostic

The OLS assumptions are difficult to check because ϵ is not observable [10]. One way to work around the difficulty is to use the OLS residuals.

We can use the Lilliefors test [12] to test the null hypothesis that the residuals come from the Gaussian distribution. The 2nd and 3rd columns of table 1.1 show the p-value of the Lilliefors test for each portfolio from each weighting method. We reject all the null that the residuals are Gaussian distributed with 5% α level and therefore the OLS estimates are not equivalent to the maximum-likelihood estimates. However, it does not violate the first OLS assumption as long as the residuals are independent and identically distributed with mean zero and constant variance.

Table 1.1: Lilliefors Test for Normality with 0.05 Alpha Level

portfolio	pvalAEW	pvalAVW	nullAEW	nullAVW
1	8.79e-40	1.65e-17	Reject	Reject
2	3.55e-28	8.10e-07	Reject	Reject
3	3.81e-24	2.31e-13	Reject	Reject
4	1.52e-15	2.17e-18	Reject	Reject
5	3.87e-22	1.03e-10	Reject	Reject
6	1.55e-20	2.57e-14	Reject	Reject
7	9.17e-20	1.92e-11	Reject	Reject
8	1.52e-24	8.64e-10	Reject	Reject
9	1.83e-19	2.79e-10	Reject	Reject
10	6.37e-15	9.20e-09	Reject	Reject

As shown in appendix A, each of the scatterplots of residuals versus the observed values of the independent variables does not show any pattern, therefore the second OLS assumption seem to be valid. For illustration, figure 1.1 shows the residual plots for portfolio 2 with average equal weighted (AEW) method. In addition, as shown in table 1.2, the mean of residuals for each portfolio and weighting method is equal to zero with accuracy of 18 decimal places.

Table 1.2: Mean of Residuals

portfolio	meanresidAEW	meanresidAVW
1	1.03e-19	-2.62e-19
2	1.19e-18	2.00e-18
3	-3.45e-19	-1.01e-18
4	8.90e-19	9.34e-20
5	1.53e-19	1.27e-19
6	2.61e-20	2.03e-19
7	-2.36e-19	4.82e-19
8	5.49e-19	-2.78e-19
9	6.30e-19	-1.83e-20
10	1.32e-19	1.09e-19

However, based on the times series of the residuals in appendix A, the residuals seem not to be independent and identically distributed because the residuals have larger fluctuations before 1940 and after 1980. The time series plots also suggest that the homoscedasticity (constant variance) assumption is violated. We can use the non-constant variance score test [5] to test the null hypothesis that the residuals are distributed with constant variance. The 2nd and 3rd columns of table 1.3 shows the p-value of the non-constant variance score test for each portfolio and weighting method. We reject all the null that the residuals are distributed with constant variance with 5% α level except for portfolios 7 and 10 with average value weighted method.

Our failure of meeting some of the OLS assumptions suggests that our dataset constains influential observations. Chapter 2 will discuss the identification of the influential observations. Even though we do not meet all the OLS assumptions, we can still apply the method of OLS on the multiple linear regression model for the equation (1.1), but we need to exercise care in interpreting the results. In particular, we can use Newey-West t-statistic to handle the autocorrelation and heteroscedasticity problem, which will be discussed next.

1.6 Heteroskedasticity and Autocorrelation Consistent Covariance

When random errors exhibit autocorrelation and/or heteroskedasticity, $cov(\epsilon|X)$ will not be equal to $\sigma^2 I$, therefore equation (1.9) no longer holds. In other words, $\hat{\sigma}^2(X^T X)^{-1}$,

Table 1.3: Non-constant Variance Score Test with 0.05 Alpha Level

portfolio	pvalAEW	pvalAVW	nullAEW	nullAVW
1	5.27e-94	8.65e-16	Reject	Reject
2	1.35e-155	2.86e-24	Reject	Reject
3	4.28e-57	1.62e-06	Reject	Reject
4	6.37e-107	3.84e-65	Reject	Reject
5	2.05e-192	1.55e-42	Reject	Reject
6	2.41e-81	1.28e-03	Reject	Reject
7	5.47e-160	4.88e-01	Reject	Accept
8	6.09e-256	6.89e-29	Reject	Reject
9	1.70e-109	8.00e-20	Reject	Reject
10	1.55e-11	2.52e-01	Reject	Accept

denoted by $\hat{\Psi}$, will be a biased estimator for $cov(\hat{\beta}|X)$. Instead, we have

$$E(\epsilon|X) = 0_{N\times 1} \tag{1.13}$$

$$cov(\epsilon|X) = \Omega \tag{1.14}$$

where Ω is a $N \times N$ matrix. The formula for $cov(\hat{\beta}|X)$ becomes:

$$\begin{aligned} cov(\hat{\beta}|X) &= (X^TX)^{-1}X^T\Omega X(X^TX)^{-1} \\ &= (\frac{1}{N}X^TX)^{-1}\frac{1}{N}\Phi(\frac{1}{N}X^TX)^{-1} \end{aligned} \tag{1.15}$$

where $\Phi = N^{-1}X^T\Omega X$.

To tackle the biased problem, Newey and West [14] have suggested to use the heteroskedasticity and autocorrelation consistent (HAC) covariance estimator $\hat{\Psi}_{HAC}$, which can be computed by substituting $\hat{\Phi}$ into equation (1.15) with

$$\hat{\Phi} = \frac{1}{N}\sum_{i,j=1}^{N} \omega_{|i-j|}\hat{V}_i\hat{V}_j^T \tag{1.16}$$

where $\omega = (\omega_0, \ldots, \omega_{N-1})^T$ is a vector of weight with lag $l = |i-j|$. Furthermore, Newey and West [14] have proved that $\hat{\Psi}_{HAC}$ is positive semi-definite. Thus, in the presence of heteroskedasticity and autocorrelation, to test the null hypothesis that $\beta_k = 0$ against the alternative $\beta_k \neq 0$ with $k = 1, \ldots, p$, we should look at the Newey-West

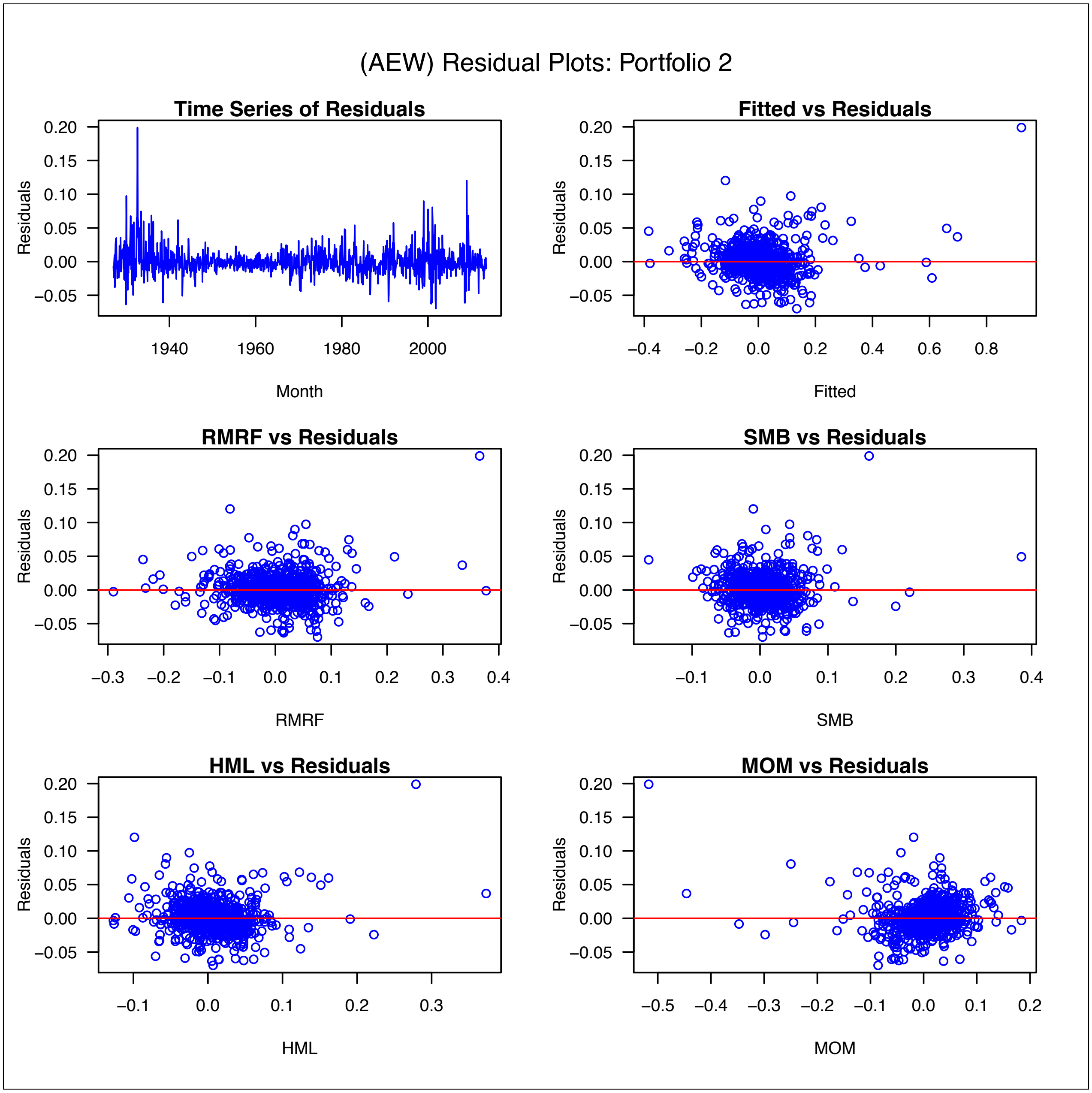


Figure 1.1: Residual Plots (e.g. AEW Portfolio 2)

t-statistic:

$$t_{NW} = \frac{\hat{\beta}_k}{\hat{SE}_{NW}(\beta_k)} \tag{1.17}$$

where $\hat{SE}_{NW}(\beta_k)$ is the kkth element of $\hat{\Psi}_{HAC}$, in addition to the ordinary t-statistic.

Chapter 2

Identification of Influential Observation

2.1 Influence Measure

Belsley, Kuh, and Welsch [3] have given an appropriate definition of influential observation.

> An influential observation is one which, either individually or together with several other observations, has a demonstrably larger impact on the calculated values of various estimates (coefficients, standard errors, t-values, etc.) than is the case for most of other observations. One obvious means for examining such an impact is to delete each row, one at a time, and note the resultant effect on the various calculated values. Rows whose deletion produces relatively large changes in the calculated values are deemed influential.

There are numerous influence measures and there is a great deal of redundancy among the measures [7]. After experiencing with several data sets, Chatterjee and Hadi [7] have concluded that only a few influence measures are sufficient for identifying influential observations. Influence measures can be classified into the following five groups [7]:

1. Measures based on residuals
2. Measures based on the prediction matrix
3. Measures based on the volume of confidence ellipsoids
4. Measures based on influence function
5. Measures based on on partial influence

In particular, measures based on the volume of confidence ellipsoids measure the impact of influential observations on the t-statistic of regression coefficient; whereas the measures based on influence function measure the impact of influential observations on the estimated regression coefficient. For instance, Anderson, Bianchi, and Goldberg [1] use covariance ratio to examine the impact of the influential observations on the Newey-West t-statistic of the FVIX betas. In this thesis, we will use *Cook's Distance* and *Covariance Ratio*, in which Cook's Distance is the measure based on influence function and Covariance Ratio is the measure based on the volume of confidence ellipsoid.

2.1.1 Cook's Distance

Cook's disance was proposed by Cook [9] in 1977.

$$C_i = \frac{t_i}{p}\frac{p_i}{1-p_i} \tag{2.1}$$

where t_i is defined in equation (1.12) and p_i is the ith diagonal element of P as defined in equation (1.6).

We denote C_i as the Cook's distance for the ith observation. Chatterjee and Hadi [7] interpret C_i as:

> The scaled Euclidean distance between the two vectors of fitted values when the fitting is done by including or excluding the ith observation.

Cook [8] suggests that the ith observation can be considered as influential if C_i is greater than 1.

2.1.2 Covariance Ratio

Covariance Ratio was proposed by Belsley, Kuh, and Welsch [3] in 1980.

$$CVR_i = \left(\frac{N-p-{t_i}^2}{N-p-1}\right)^p (1-p_i) \tag{2.2}$$

We denote CVR_i as the covariance ratio for the ith observation. The data point with $|CVR_i - 1| > 3p/N$ is considered as influential observation.

2.2 Influential Observation

With the equations (2.1) and (2.2), along with the influential point criteria, we can easily find out the influential points for each of the ten portfolios and weighting methods based on the influence measures of Cook's distance and covariance ratio. Appendix B includes the plots of Cook's distance and covariance ratios for each of the ten portfolios and weighting methods. The influential observations for the corresponding influence measures are highlighted with solid red. Appendix D shows the information of the influential observations identified by the two influence measures for each portfolio and weighting methods.

The plots in appendix B show that that covariance ratio identifies more influential observations than Cook's distance. Figure 2.1 shows an example for portfolio 2. We then combine our identification results from the ten portfolios. Out of 1,039 total monthly observations, we find that for the average equal weighted method, Cook's distance and covariance ratio identify 5 and 187 influential observations respectively. For the average value weighted method, Cook's distance and covariance ratio identify 4 and 232 influential observations respectively. Appendix E shows the corresponding months of the influential observations.

2.2.1 Influential Observations Identified by Cook's Distance

Based on the combined identification results in appendix E, the average equal weighted method has one additional influential observation **1939-09** and the rest of four influential observations are the same as the ones for the average value weighted method. The influential observations identified by Cook's distance are as follows.

- Average Equal Weighted: 1932-07, 1932-08, 1933-04, 1933-05, and 1939-09
- Average Value Weighted: 1932-07, 1932-08, 1933-04, and 1933-05

The influential observations are noticeable from the plots of momentum factor MOM against portfolio returns in appendix F. The influential observations have the largest difference between the portfolio return and the MOM factor, in which the corresponding portfolio return are always the peaks and the corresponding MOM factor are always the troughs. For instance, as shown in figure 2.1 for portfolio 2 with average equal weighted method, the five influential observations are noticeable by inspecting the graphical distance between the MOM factor and the portfolio return.

It was not a coincidence that the influential observations happened in those five months. In fact, they were linked to the major historical events [4].

- **July - August 1932:** On July 8th, 1932, the Dow reached its lowest level of the 20th century and did not return to pre-1929 levels until the 23rd November, 1954.
- **April - May 1933:** FDR took office in March 1933. In the first 100 days many acts and agencies were introduced which were to form the basis of the New Deal. The acts and agencies included but not limited to the Economy Act, Emergency Banking Act, National Industrial Recovery Act, Agricultural Adjustment Act, and FDIC. The New Deal made huge impact on economy in years to come.

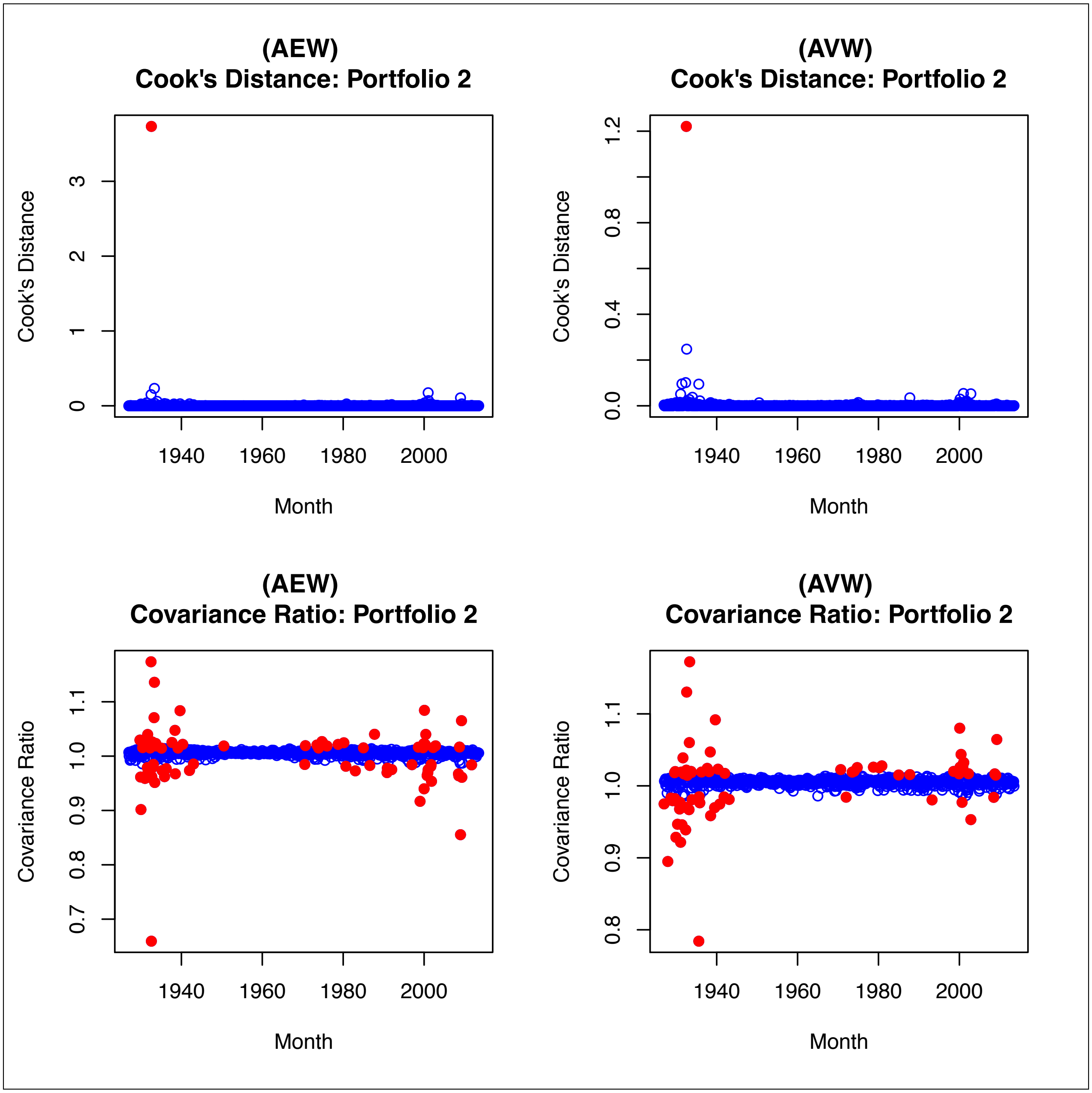


Figure 2.1: Plot of Cook's Distance and Covariance Ratio (e.g. Portfolio 2)

- **September 1939:** The start of World War II.

In addition, momentum was noticeable on Dow Jones before and after July 1932. There was tendency for falling asset prices to keep falling from 1929 to July 1932 and tendency for rising asset prices to keep rising from July 1932 to 1937.

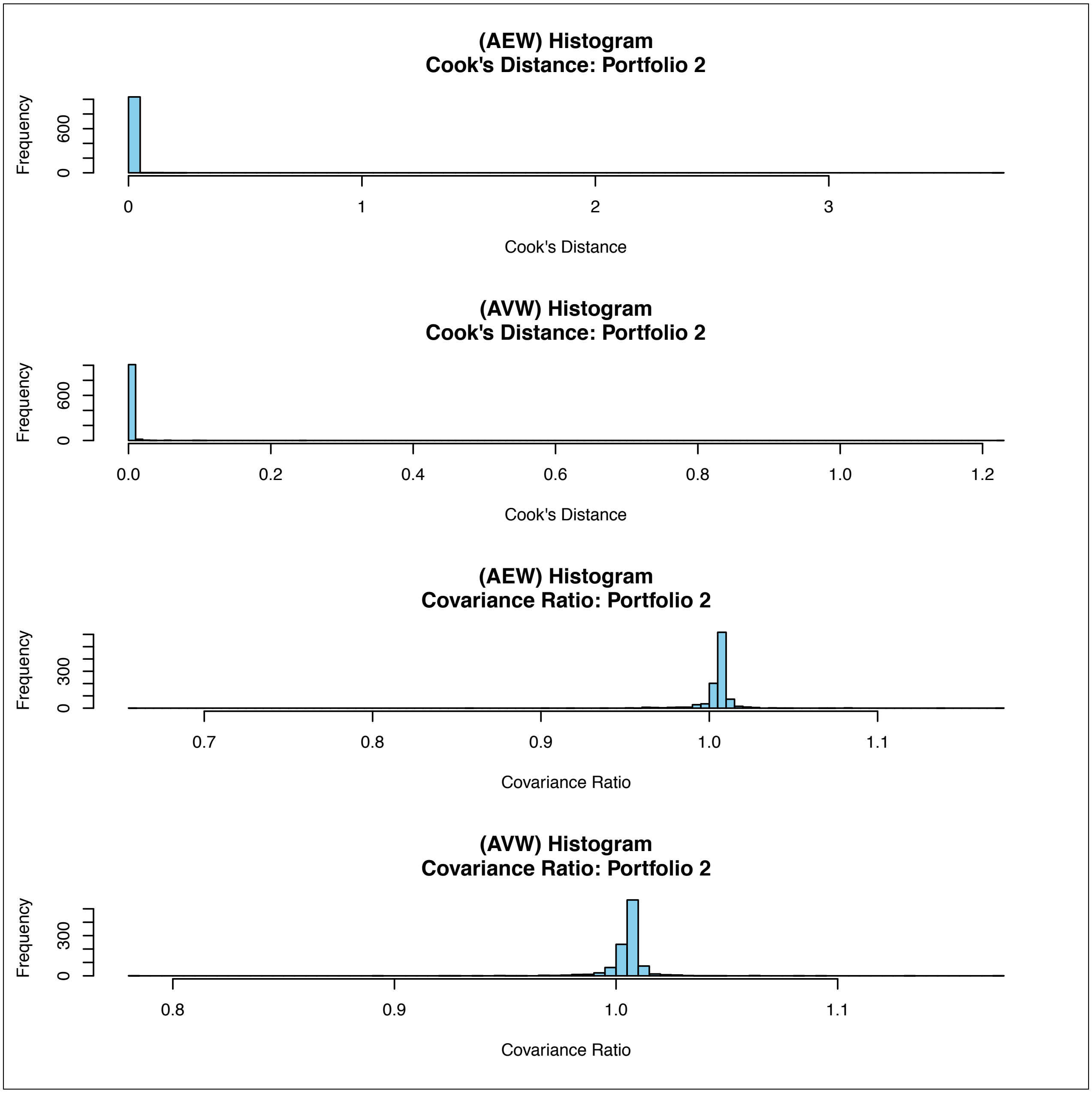


Figure 2.2: Histogram of Cook's Distance and Covariance Ratio (e.g. Portfolio 2)

Furthermore, momentum was noticeable on FT 30 but not Dow Jones before and after September 1939. There was tendency for falling asset prices to keep falling from 1936 to September 1939 and tendency for rising asset prices to keep rising from September 1939 to 1946.

In the next chapter, we will compare the the β estimates and the t-statistics between the full dataset and the same dataset with the set of influential observations excluded.

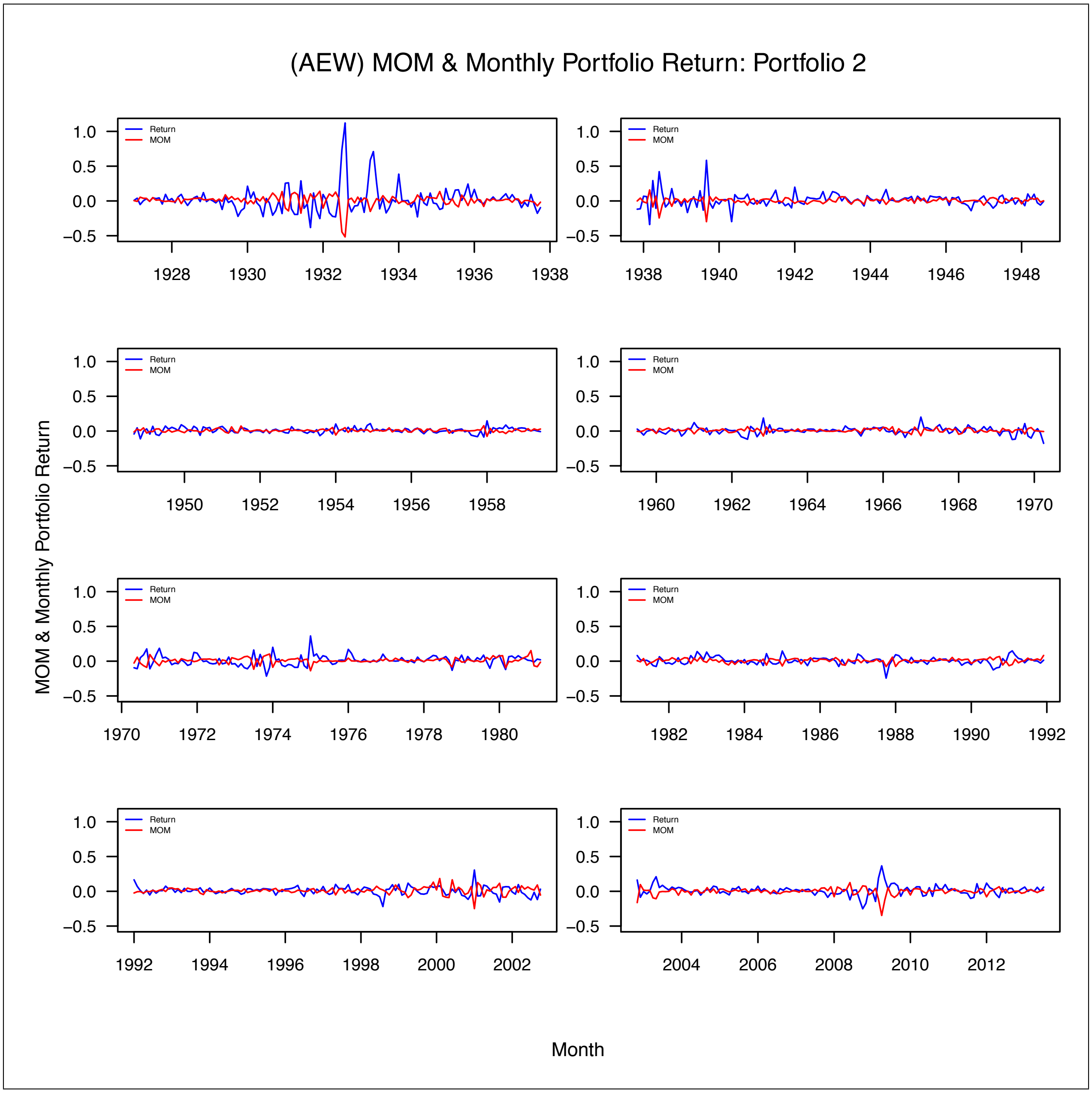


Figure 2.3: Plot of MOM vs Monthly Portfolio Return (e.g. AEW Portfolio 2)

Chapter 3

Influence of Influential Observation

In this chapter, we use the influence measures of Cook's distance and covariance ratio to measure the influence of an observation on the β estimates and the t-statistics respectively. We also use both influence measures to examine the impact on the OLS assumptions. To do so, we compare the results of the multiple linear regression on the full dataset and the same dataset with the set of influential observations excluded. **Panel A** refers to the regression result on the full dataset, **Panel B** refers to the regression result on the full dataset with the influential points identified by Cook's distance excluded, and **Panel C** refers to the regression result on the full dataset with the influential points identified by covariance ratio excluded.

3.1 Influence on Beta Estimates

Table 3.1 summarizes the key findings on each of the β estimates for both weighting methods. Figures 3.1 and 3.2 show the plots of each β estimate against the portfolio rankings for the average equal weighted method and the average value weighted method respectively. In sum, the β_{RMRF} and β_{SMB} estimates are positive and convex on the porfolio rankings for both panels, whereas the β_{HML} estimates are positive and concave on the porfolio rankings for both panels. As we should have expected, the β_{MOM} estimates are monotonically increasing on the portfolio rankings because the portfolios are constructed monthly using NYSE prior (2-12) return decile breakpoints in which stocks with the lowest NYSE prior (2-12) return comprise decile 1 (or portfolio 1) and stocks with the highest comprise decile 10 (or portfolio 10). Note that the β_{MOM} estimates are positive for the average equal weighted method, but for the average value weighted method, the β_{MOM} estimates are positive for portfolio ranking less than 7 and negative otherwise.

By excluding the influential observations identified by Cook's distance, the β_{RMRF} and β_{SMB} estimates are more convex on the porfolio rankings for the average equal weighted method. In addition, β_{HML} estimates are more concave on the porfolio rank-

Table 3.1: $\hat{\beta}$ vs Portfolio Ranking

$\hat{\beta}$	**AEW**	**AVW**
β_{RMRF}	Positive; Convex on portfolio ranking	Positive; Convex on portfolio ranking
β_{SMB}	Positive; Convex on portfolio ranking	Positive; Convex on portfolio ranking
β_{HML}	Positive; Concave on portfolio ranking	Positive; Concave on portfolio ranking
β_{MOM}	Positive; Monotonically increasing on portfolio ranking	Positive for portfolio ranking less than 7 and negative otherwise; Monotonically increasing on portfolio ranking

Table 3.2: $\hat{\beta}$ vs Portfolio Ranking: Change from Panel A to Panel B

$\hat{\beta}$	**AEW**	**AVW**
β_{RMRF}	More convex	Insignificant change
β_{SMB}	More convex	Insignificant change
β_{HML}	More concave	Insignificant change
β_{MOM}	Insignificant change	Insignificant change

ings for the average equal weighted method. For the rest of the β estimates, the graphical relationships and the percentage changes are insignificant. Table 3.2 summarizes the comparisons and the bottom right plots in figures 3.1 and 3.2 show the influence in terms of percentage changes.

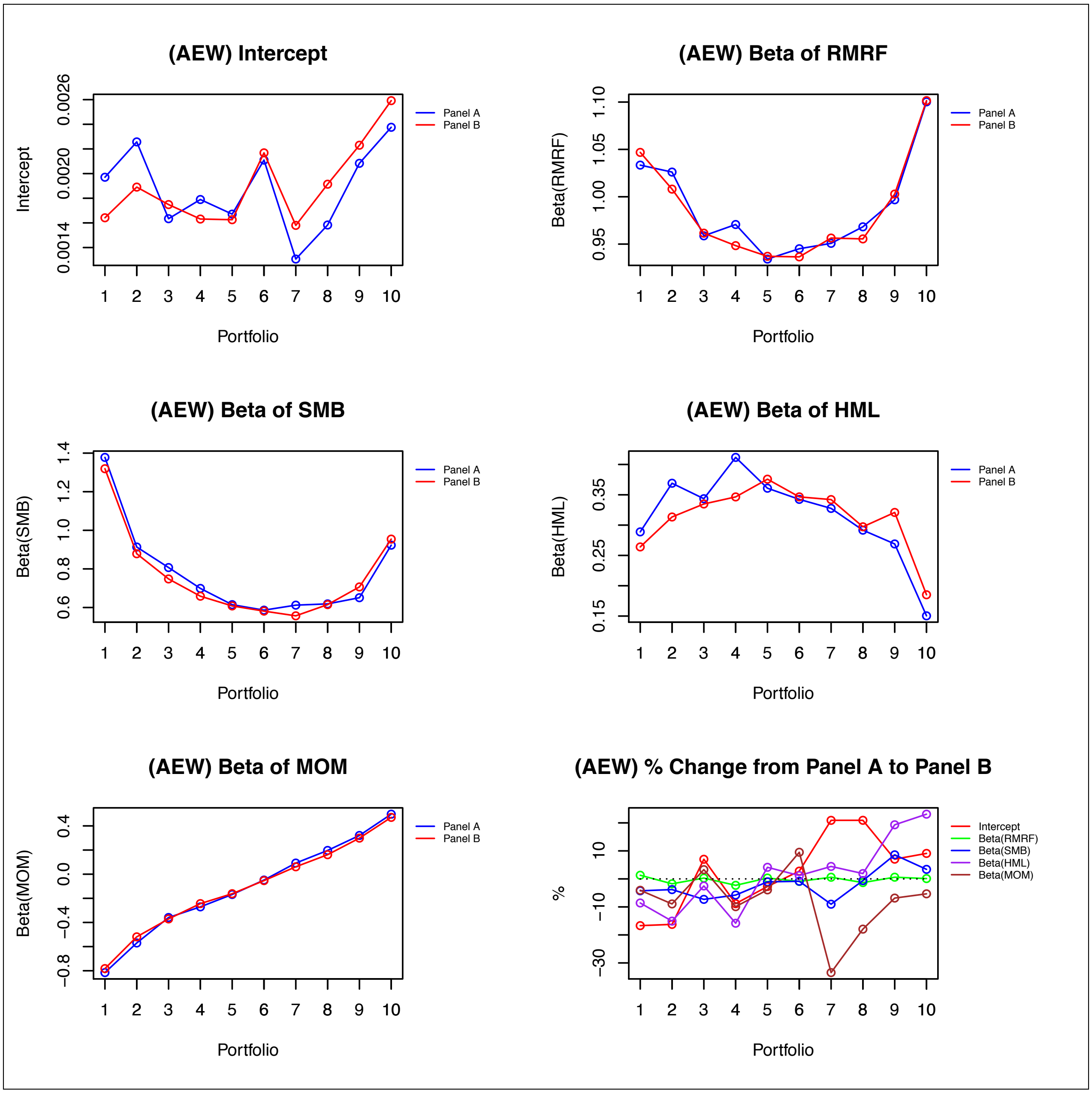


Figure 3.1: (AEW) Plots of β

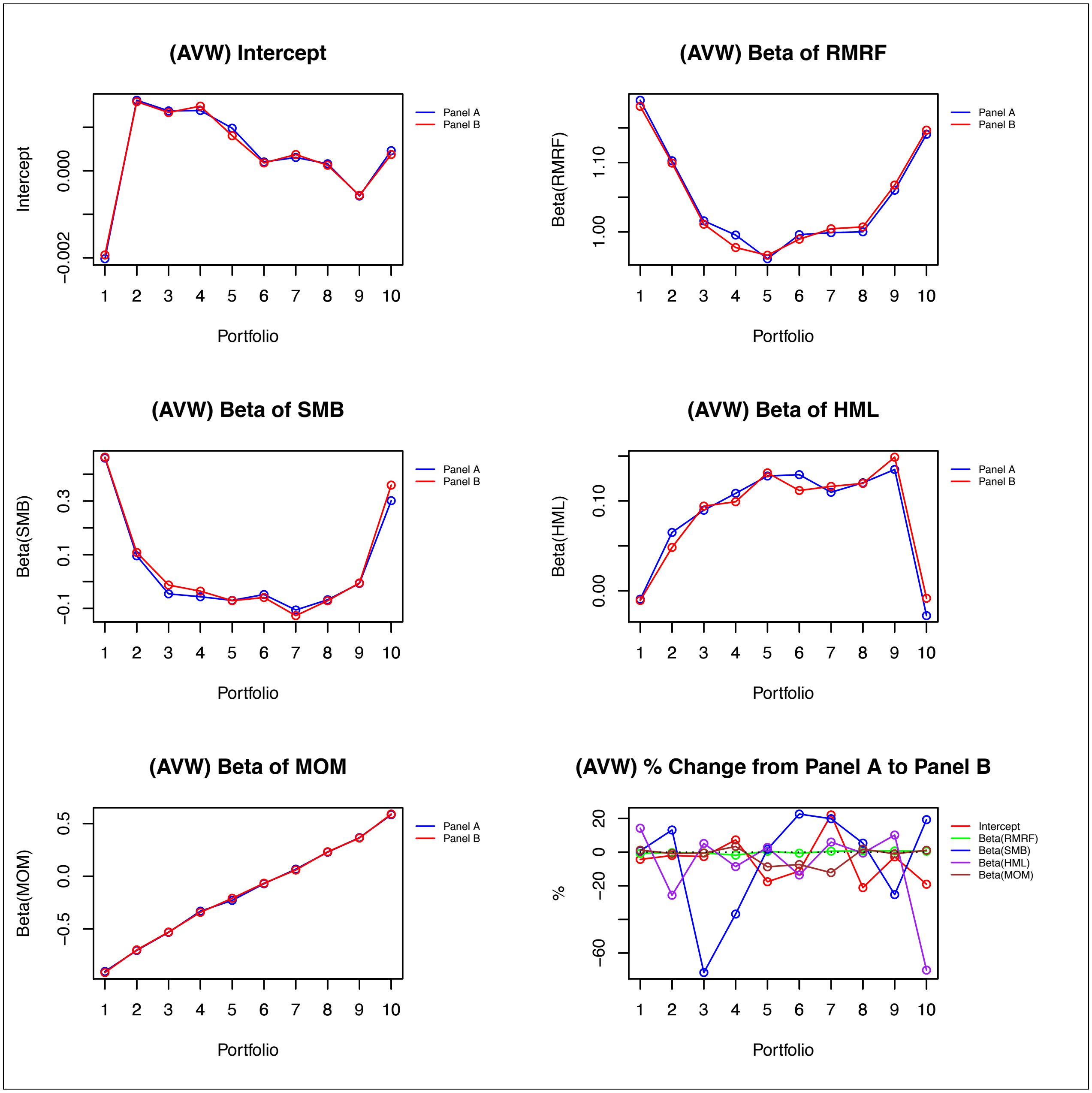


Figure 3.2: (AVW) Plots of β

3.2 Influence on t-statistics

In this section, we want to examine the influence on the t-statistic and also the Newey-West t-statistic. As we have discussed in section 1.6, we use the Newey-West t-statistic as defined in equation (1.17) to overcome autocorrelation and heteroskedasticity in the random errors in the Fama French Carhart Four Model (1.1). Tables 3.3 and 3.4 summarize the key findings on both versions of t-statistic of the β estimates for the average equal weighted method and the average value weighted method respectively. Figures 3.4, 3.5, 3.6, and 3.7 show the plots of both versions of t-statistic against the portfolio rankings for β_{RMRF}, β_{SMB}, β_{HML}, and β_{MOM} respectively. I also include the same kind of plots for the intercept in figure 3.3.

For the average equal weighted method, both versions of t-statistic are positive and highly significant for all the β estimates except for the β_{MOM} estimates in portfolios 7-10. As for the average value weighted method, both versions of t-statistic are positive for all the β estimates except for the β_{SMB} estimates in portfolios 3-9 and the β_{MOM} estimates in portfolios 7-10. The β_{SMB} estimates are highly significant except for portfolios 3 and 9, whereas the β_{HML} estimates are highly significant except for portfolios 1 and 10. In addition, β_{MOM} estimates are monotonically increasing on portfolio ranking starting from portfolios 2 or 3 across the board.

By excluding the influential observations identified by covariance ratio, the sign of both t-statistic, the level of statistical significance, and the graphical relationship between the t-statistic and the porfolio rankings remain the same at large. However, when we look into the percentage change as shown in figure 3.8, the percentage changes from panel A to panel C are much higher for the Newey-West t-statistic than the ones for t-statistic across the board.

Table 3.3: (AEW) t-statistic and Newey-West t-statistic for $\hat{\beta}$

$\hat{\beta}$	**t-statistic**	**Newey-West t-statistic**
β_{RMRF}	Positive; Highly significant; Concave on portfolio ranking	Positive; Highly significant; Multi-modal on portfolio ranking
β_{SMB}	Positive; Highly significant; Multi-modal on portfolio ranking	Positive; Highly significant; Multi-modal on portfolio ranking
β_{HML}	Positive; Highly significant; Near concave on portfolio ranking	Positive; Highly significant; Near concave on portfolio ranking
β_{MOM}	Positive for portfolio ranking less than 7 and negative otherwise; Highly significant; Monotonically increasing on portfolio ranking starting from portfolios 2 or 3	Positive for portfolio ranking less than 7 and negative otherwise; Highly significant; Monotonically increasing on portfolio ranking starting from portfolios 2 or 3

Table 3.4: (AVW) t-statistic and Newey-West t-statistic for $\hat{\beta}$

$\hat{\beta}$	**t-statistic**	**Newey-West t-statistic**
β_{RMRF}	Positive; Highly significant; Multi-modal on portfolio ranking	Positive; Highly significant; Multi-modal on portfolio ranking
β_{SMB}	Positive for portfolios 1, 2, 10, and negative otherwise; Highly significant except for portfolios 3 and 9; Convex on portfolio ranking	Positive for portfolios 1, 2, 10, and negative otherwise; Highly significant except for portfolios 3 and 9; Convex on portfolio ranking
β_{HML}	Positive; Highly significant except for portfolios 1 and 10; Near concave on portfolio ranking	Positive; Highly significant except for portfolios 1 and 10; Near concave on portfolio ranking
β_{MOM}	Positive for portfolio ranking less than 7 and negative otherwise; Highly significant; Monotonically increasing on portfolio ranking starting from portfolios 2 or 3	Positive for portfolio ranking less than 7 and negative otherwise; Highly significant; Monotonically increasing on portfolio ranking starting from portfolios 2 or 3

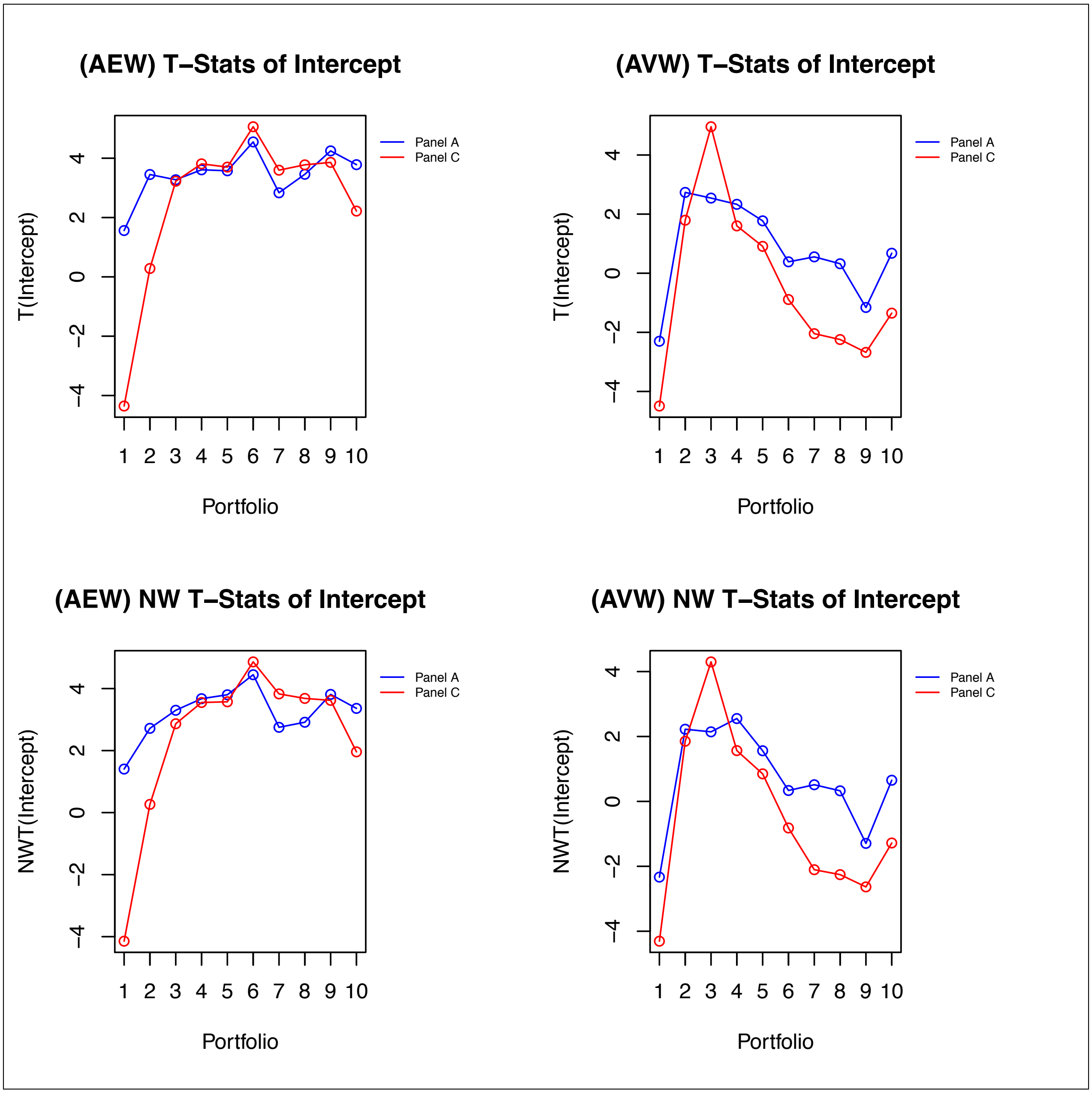


Figure 3.3: Plots of Intercept t-statistic

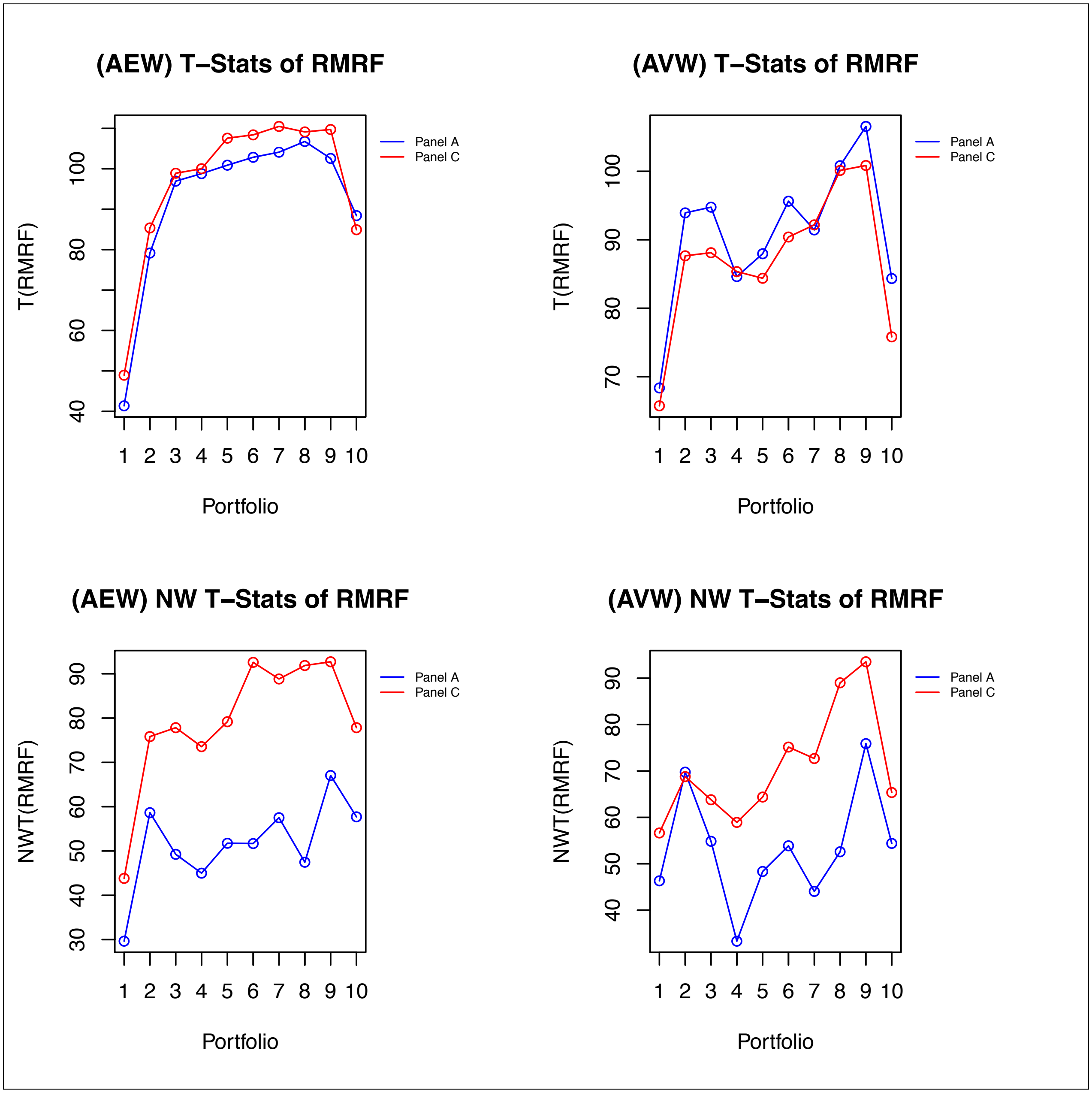


Figure 3.4: Plots of β_{RMRF} t-statistic

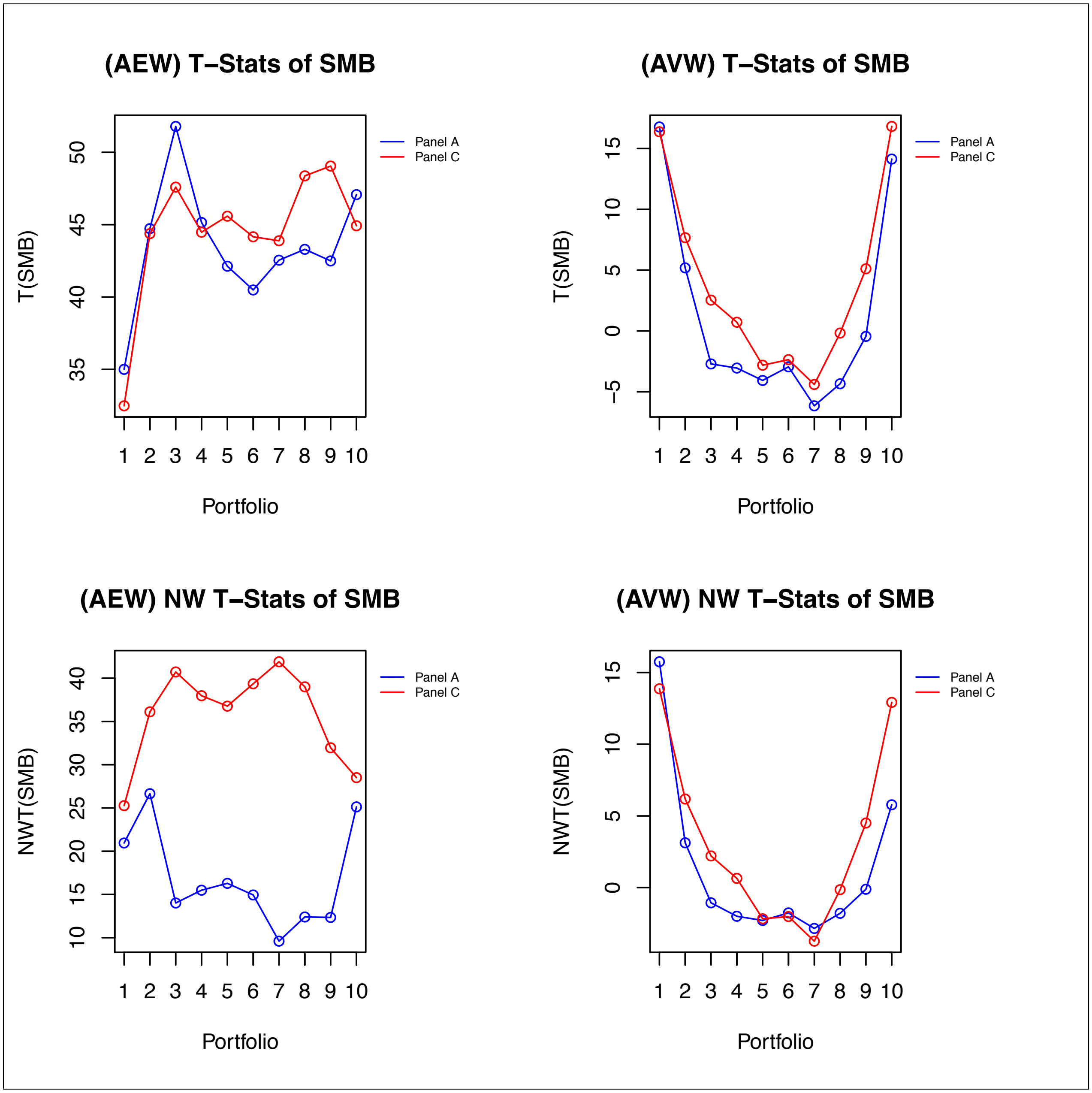


Figure 3.5: Plots of β_{SMB} t-statistic

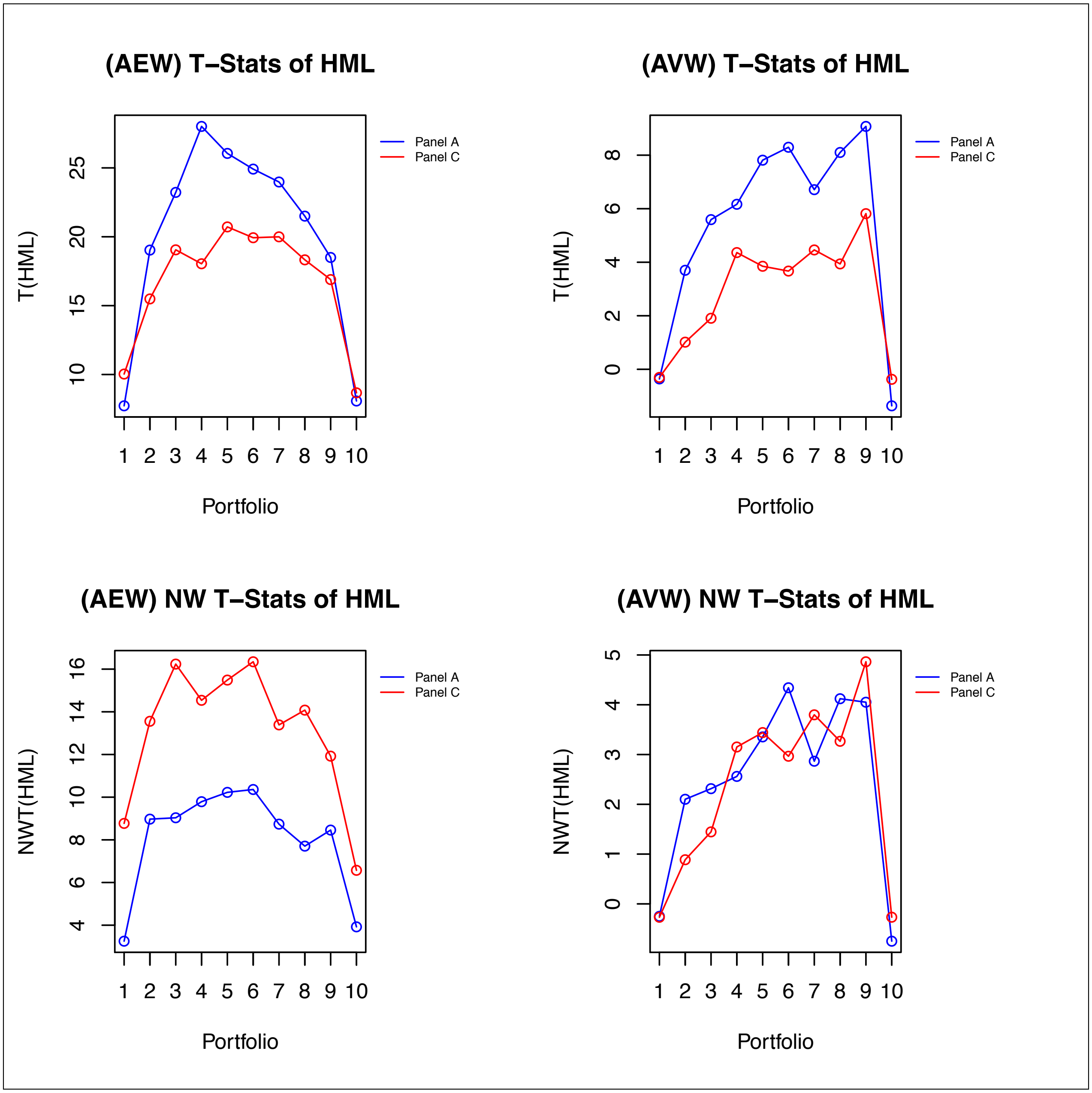


Figure 3.6: Plots of β_{HML} t-statistic

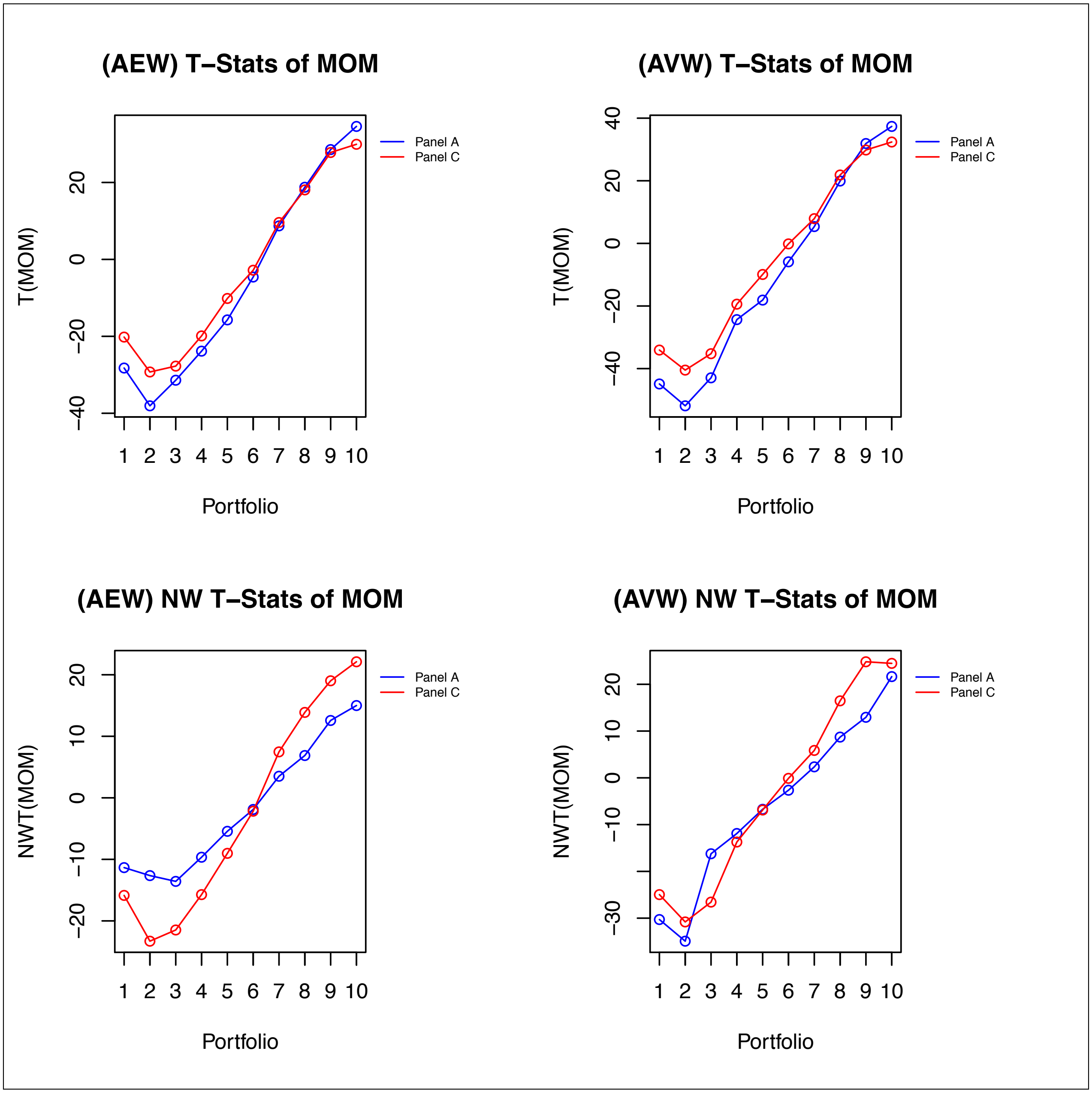


Figure 3.7: Plots of β_{MOM} t-statistic

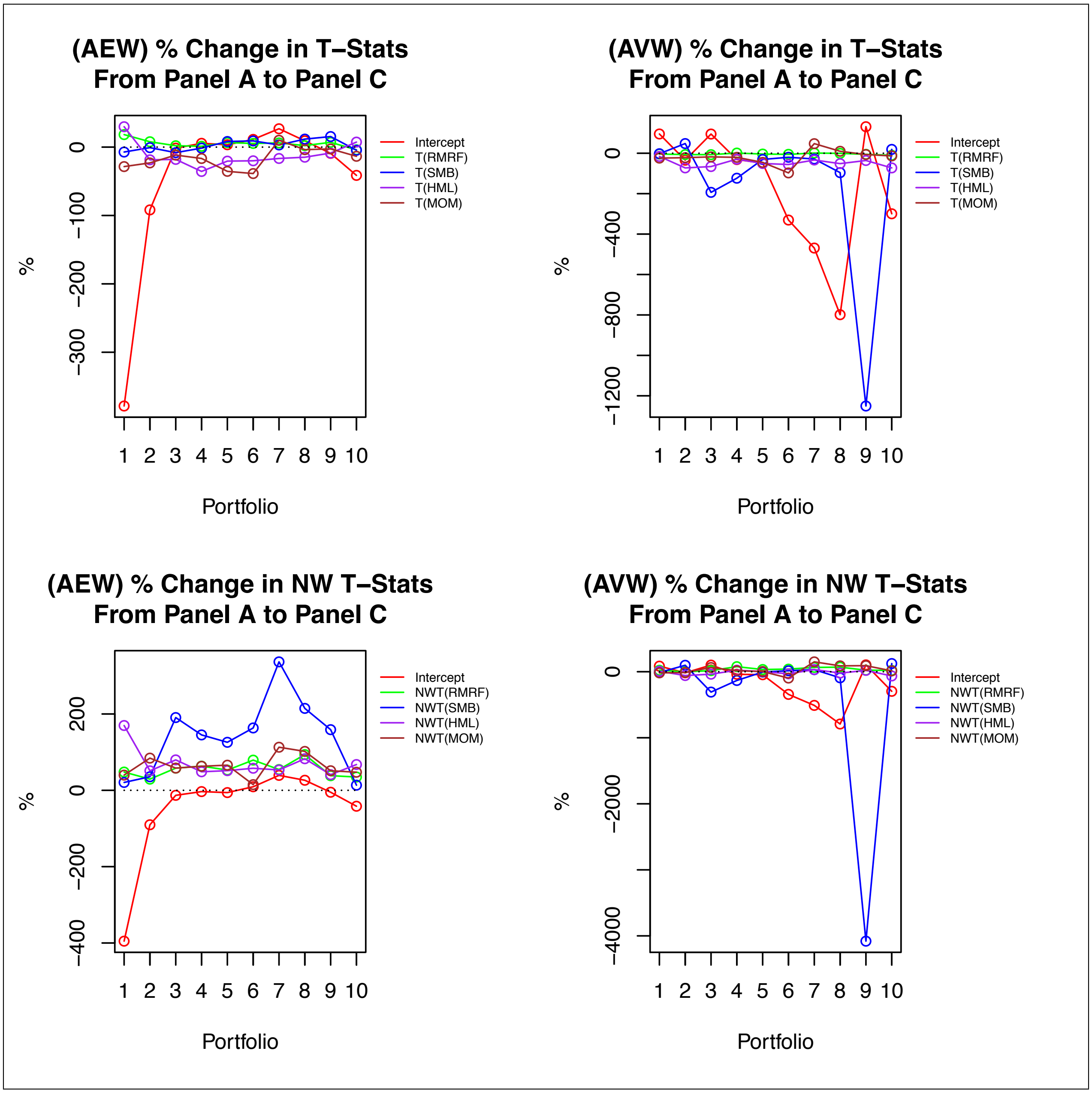


Figure 3.8: Plots of Percentage Change in t-statistic

3.3 Influence on the OLS Assumptions

In this section, we want to examine the impact of the influential observations on the OLS assumptions, in particular, normality and variance of residuals.

3.3.1 Lilliefors Test for Normality

We apply the Lilliefors test on panels B and C to test the null hypothesis that the residuals come from the Gaussian distribution. Tables 3.5 and 3.6 show the test results for panels B and C respectively. The Lilliefors test results for panel B remain the same as the ones for panel A. However, for panel C, the normality assumption seem to be valid for 3 and 8 out of 10 portfolios for the average equal weighted and average value weighted methods respectively.

Table 3.5: (Panel B) Lilliefors Test for Normality with 0.05 Alpha Level

portfolio	pvalAEW	pvalAVW	nullAEW	nullAVW
1	2.31e-40	2.59e-16	Reject	Reject
2	2.02e-26	4.58e-06	Reject	Reject
3	3.26e-22	3.28e-14	Reject	Reject
4	2.03e-15	2.70e-14	Reject	Reject
5	4.99e-18	8.70e-09	Reject	Reject
6	4.91e-17	3.46e-13	Reject	Reject
7	9.28e-11	2.30e-10	Reject	Reject
8	2.08e-08	2.61e-09	Reject	Reject
9	3.19e-17	3.47e-09	Reject	Reject
10	1.58e-13	1.79e-07	Reject	Reject

3.3.2 Non-constant Variance Score Test

We apply the non-constant variance score test on panels B and C to test the null hypothesis that the residuals are distributed with constant variance. Tables 3.7 and 3.8 show the test results for panels B and C respectively. For panel B, there is 1 additional portfolio seem to be distributed with constant variance for each weighting methods. Whereas for panel C, there are 7 and 5 additional portfolios seem to be distributed with constant variance for the average equal weighted and average value weighted methods respectively.

Table 3.6: (Panel C) Lilliefors Test for Normality with 0.05 Alpha Level

portfolio	pvalAEW	pvalAVW	nullAEW	nullAVW
1	3.83e-08	2.69e-02	Reject	Reject
2	6.46e-04	9.19e-01	Reject	Accept
3	3.48e-01	1.36e-02	Accept	Reject
4	1.18e-01	5.69e-02	Accept	Accept
5	1.99e-02	7.89e-01	Reject	Accept
6	2.53e-03	4.12e-01	Reject	Accept
7	8.22e-02	6.60e-01	Accept	Accept
8	4.53e-02	8.85e-01	Reject	Accept
9	3.34e-03	1.68e-01	Reject	Accept
10	5.10e-04	1.49e-02	Reject	Reject

Table 3.7: (Panel B) Non-constant Variance Score Test with 0.05 Alpha Level

portfolio	pvalAEW	pvalAVW	nullAEW	nullAVW
1	1.88e-55	3.77e-12	Reject	Reject
2	1.96e-19	5.33e-06	Reject	Reject
3	2.09e-10	2.07e-04	Reject	Reject
4	3.81e-16	1.58e-01	Reject	Accept
5	1.86e-17	4.63e-04	Reject	Reject
6	1.36e-14	1.34e-03	Reject	Reject
7	6.80e-06	8.59e-01	Reject	Accept
8	7.53e-01	1.35e-11	Accept	Reject
9	2.50e-19	1.49e-18	Reject	Reject
10	2.09e-06	4.90e-06	Reject	Reject

Table 3.8: (Panel C) Non-constant Variance Score Test with 0.05 Alpha Level

portfolio	pvalAEW	pvalAVW	nullAEW	nullAVW
1	1.15e-06	2.84e-03	Reject	Reject
2	2.08e-02	6.25e-01	Reject	Accept
3	3.45e-01	4.11e-02	Accept	Reject
4	2.73e-01	5.20e-01	Accept	Accept
5	5.26e-02	1.48e-01	Accept	Accept
6	6.97e-01	8.59e-01	Accept	Accept
7	6.70e-01	2.82e-02	Accept	Reject
8	1.97e-01	5.92e-01	Accept	Accept
9	1.95e-01	4.64e-01	Accept	Accept
10	6.85e-02	2.85e-01	Accept	Accept

Chapter 4

Portfolio Optimization

As a continuation from the last chapter, we want to examine the impact of the influence observations on the expected monthly return and the standard deviation of the monthly return by comparing their results among panels A, B, and C. Then, with the two different weighting methods for consideration, our logical next step is to compare their investment performances by looking at their mean-variance optimal portfolios.

4.1 Mean and SD of Monthly Portfolio Returns

Figure 4.1 shows the plots of the expected monthly portfolio returns, their standard deviations, and the percentage change from panel A to panels B and C against the portfolio rankings for both weighting methods. In sum, for both weighting methods,

- The expected monthly portfolio return increases as the portfolio ranking increases.
- The standard deviations of monthly portfolio returns are convex on the portfolio ranking.
- The percentage changes for the expected monthly portfolio returns and their standard deviations are negative from panel A to panels B and C, except for the expected monthly portfolio returns for portfolios 9 and 10 with the average value weighted method in panel C.
- The absolute percentage changes from panel A to panels B and C for the two estimates (mean and SD) are diminishing on the portfolio rankings at large.

To go one step further, we want to look into the relationship between the expected monthly portfolio returns and their standard deviations for each of the weighting methods and panels. As shown in the top two plots in figure 4.2, for both weighting methods, the risk and return curve shifts to the left when we change from panel A to panel B. Similarly, for both weighting methods, the risk and return curve shifts to the left when we change from either panel A or panel B to panel C. These results are what we have expected because the influential observations have abnormal high monthly portfolio returns and therefore their removal would reduce the risk and return. The bottom two plots show that the risk and return curve shifts to the left when we change from the average equal weighted method to the average value weighted method in all panels. The explanation will be given in the latter section *Optimal Portfolio Weights*.

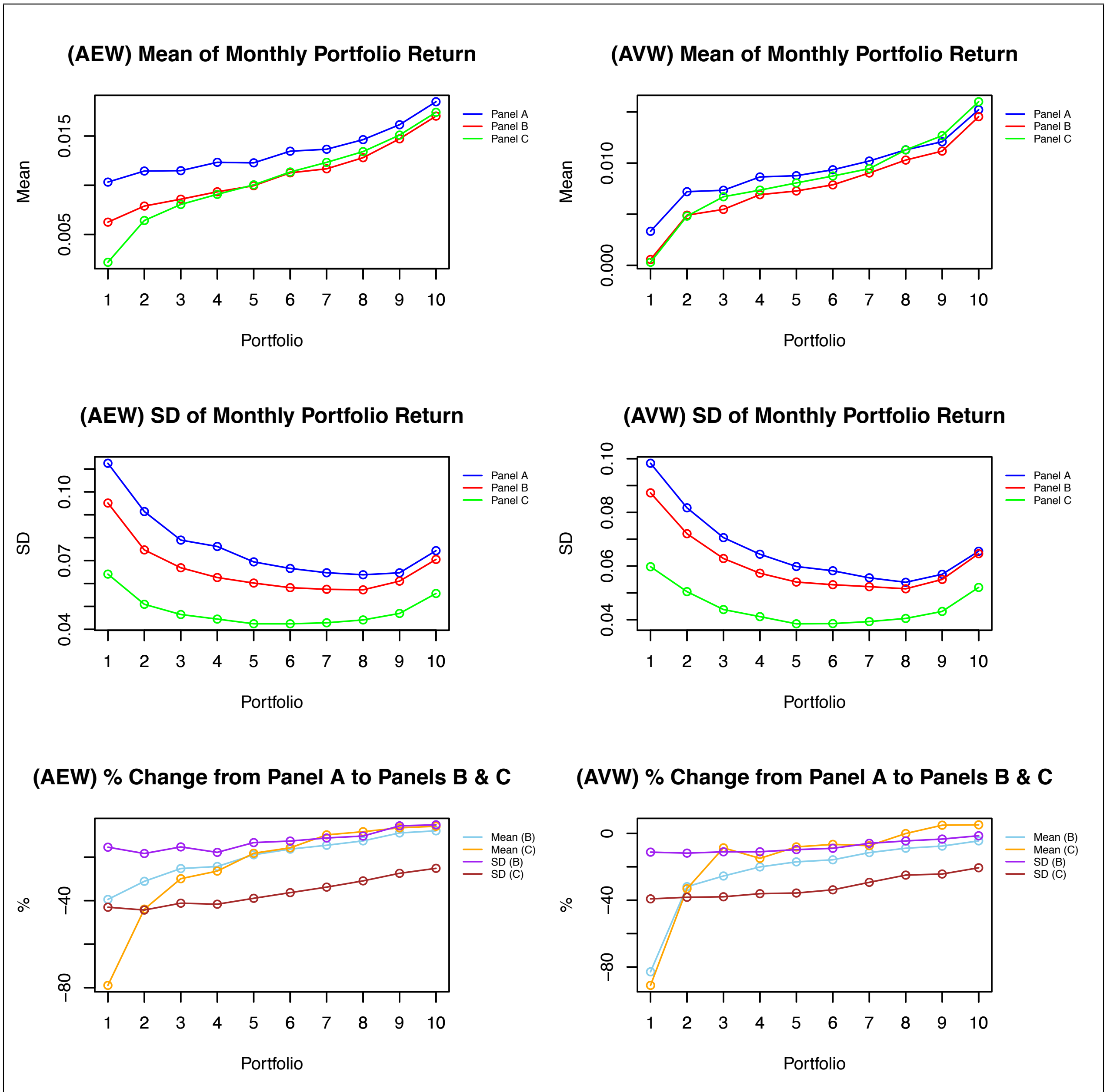


Figure 4.1: Plots of Mean and SD of Monthly Portfolio Returns

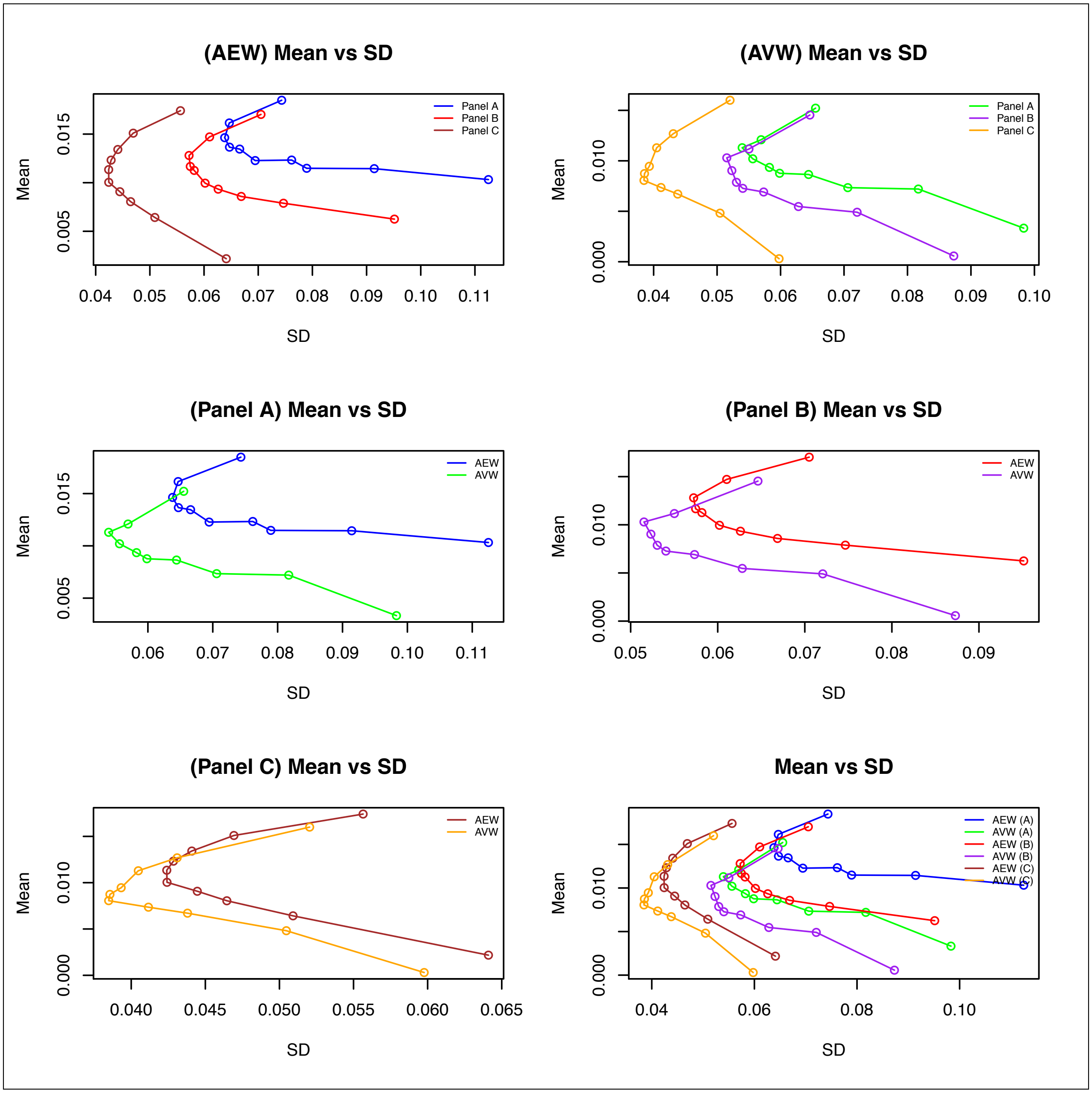


Figure 4.2: Plots of Mean versus SD of Monthly Portfolio Returns

4.2 Mean-Variance Optimal Portfolio

In this section, we want to compare the investment performances of two mean-variance optimal portfolios, in which one portfolio is comprised of the ten momentum portfolios formed with the average equal weighted method and the other portfolio is comprised of the ten momentum portfolios formed with the average value weighted method.

To find a mean-variance optimal portfolio with ten assets [13], i.e. the ten momentum portfolios, first, we compute the mean rates of return $\bar{r}_1, \bar{r}_2, \ldots, \bar{r}_{10}$ and the covariances σ_{ij}, $i, j = 1, 2, \ldots, 10$ for the ten momentum portfolios, using all the months in our dataset. Our portfolio is defined by a set of ten weights w_i, $i = 1, 2, \ldots, 10$, that sum to 1 (Negative weight corresponds to short selling). Then, we fix the mean value at some arbitrary value $\bar{r}$ and find the feasible portfolio of minimum variance that has this mean. The mathematical problem of solving for the mean-variance optimal portfolio as known as the Markowitz problem is equivalent to the following problem:

$$\textit{minimize} \ \tfrac{1}{2} \textstyle\sum_{i,j=1}^{10} w_i w_j \sigma_{ij}$$

$$\textit{subject to} \ \textstyle\sum_{i=1}^{10} w_i \bar{r}_i = \bar{r}$$

$$\textstyle\sum_{i=1}^{10} w_i = 1$$

To find the solutions for the Markowitz problem, we form the *Lagrangian L* with the *Lagrange multipliers* λ and μ.

$$L = \frac{1}{2} \sum_{i,j=1}^{10} w_i w_j \sigma_{ij} - \lambda \left(\sum_{i=1}^{10} w_i \bar{r}_i - \bar{r} \right) - \mu \left(\sum_{i=1}^{10} w_i - 1 \right) \tag{4.1}$$

After setting the first derivatives of the *Lagrangian L* with respect to λ, μ, and the 10 portfolio weights w_i ($i = 1, 2, \ldots, 10$) equal to zero, we obtain

$$\sum_{j=1}^{10} \sigma_{ij} w_j - \lambda \bar{r}_i - \mu = 0 \ \textit{for} \ i = 1, 2, \ldots, 10 \tag{4.2}$$

$$\sum_{i=1}^{10} w_i \bar{r}_i = \bar{r} \tag{4.3}$$

$$\sum_{i=1}^{10} w_i = 1 \tag{4.4}$$

With equations (4.2), (4.3), and (4.4), we can generate the mean-variance optimal set of portfolios as shown in figure 4.3. The top two plots compares the mean-variance optimal sets with selling short allowed and going long only, in which the plot on the top refers to the average equal weighted method and the plot in the middle refers to the average value weighted method. Both plots show that the mean-variance optimal set shifts to the left when selling short is allowed, which is what we have expected because the feasible solution set for going long only is the subset of the feasible solution set for selling short allowed.

Absent risk-free borrowing, the efficient frontier is the upper arc of the parabola (the mean-variance optimal set) because for any portfolio on the lower arc you can always find a portfolio on the upper arc with the same standard deviation and higher expected return. Once a risk-free rate is introduced, the efficient frontier is a line that is tangent to the upper arc of the parabola. [13].

With the assumption of selling short allowed, the plot at the bottom compares the mean-variance optimal sets for both weighting method. The plot shows that the mean-variance optimal set shifts to the left when we change from the average equal weighted method to the average value weighted method, but with the intersection near the expected monthly return of 0.018 and its standard deviation of 0.060. Therefore, if our risk appetite (or standard deviation) is lower than 0.060, we should hold the optimal portfolio formed with the average value weighted method, otherwise, we should hold the optimal portfolio formed with the average equal weighted method.

The result that the mean-variance optimal set shifts to the left when we change from the average equal weighted method to the average value weighted method can be explained by Banz's finding [2] that smaller firms have had higher risk adjusted returns, on average, than larger firms. The average equal weighted method put much more weight on the smaller firms than the larger firms because we have numerous of smaller firms in the market. Therefore, the lowest level of risk that is achievable with the average equal weighted method is higher than the one that is achievable with the average value weighted method. However, with the effect of diversification and selling short allowed, we can achieve higher expected monthly return with risk or standard deviation greater than 0.060 using the average equal weighted method.

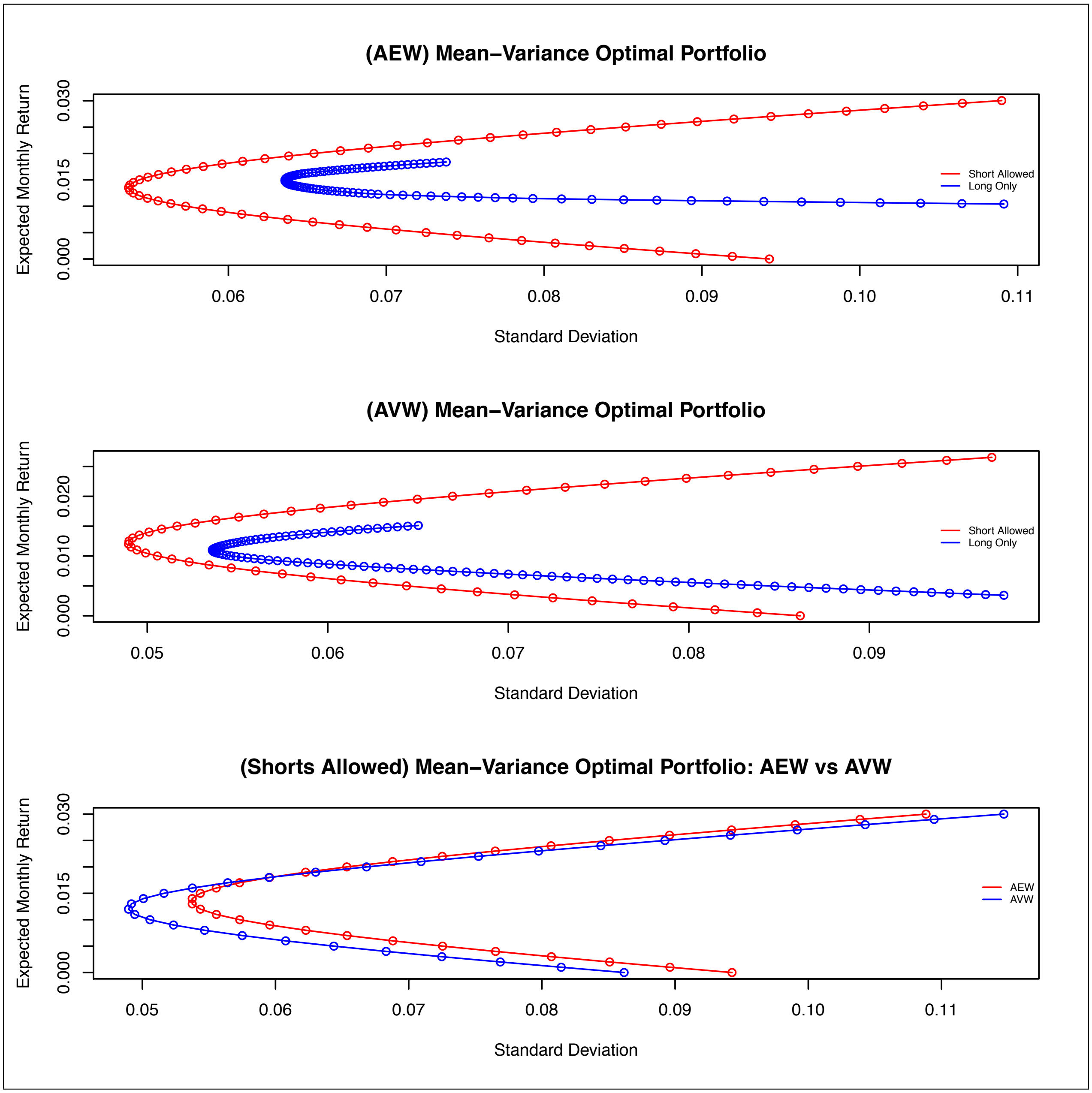


Figure 4.3: Plots of Mean-Variance Optimal Portfolio

4.3 Optimal Portfolio Weights

Tables 4.1 and 4.2 contain the solutions for the mean-variance optimal portfolio for the average equal weighted method and the average value weighted method respectively. It is easier to see the relationships among the minimum portfolio set and the corresponding optimal portfolio weights by looking at their correlations. The numerical results for the average equal weighted method and the average value weighted method are shown in tables 4.3 and 4.4 respectively; whereas the graphic results are shown in figures 4.4 and 4.5 respectively.

We find that for the average equal weighted method, the optimal weights for portfolios 2, 4, 6, 9, and 10 are positively correlated with the expected month return and risk; whereas for the average value weighted method, the optimal weights for portfolios 2, 4, and 10 are positively correlated with the expected month return and risk. Therefore, the average equal weighted method includes two additional portfolio (9 and 10) for the positive correlation.

Table 4.1: (AEW) Mean-Variance Optimal Portfolio: Solution

Mean	SD	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
0.000	0.094	0.40	-2.06	1.59	-1.39	3.06	-0.80	1.63	1.38	-0.45	-2.36
0.001	0.090	0.37	-1.97	1.47	-1.30	2.90	-0.71	1.54	1.32	-0.38	-2.23
0.002	0.085	0.33	-1.88	1.35	-1.21	2.74	-0.62	1.44	1.25	-0.31	-2.10
0.003	0.081	0.30	-1.79	1.24	-1.12	2.58	-0.53	1.35	1.19	-0.24	-1.97
0.004	0.077	0.26	-1.69	1.12	-1.04	2.42	-0.44	1.25	1.12	-0.17	-1.84
0.005	0.073	0.23	-1.60	1.00	-0.95	2.26	-0.34	1.16	1.05	-0.10	-1.71
0.006	0.069	0.20	-1.51	0.88	-0.86	2.10	-0.25	1.06	0.99	-0.03	-1.58
0.007	0.065	0.16	-1.41	0.76	-0.78	1.94	-0.16	0.97	0.92	0.04	-1.44
0.008	0.062	0.13	-1.32	0.64	-0.69	1.78	-0.07	0.87	0.86	0.11	-1.31
0.009	0.060	0.09	-1.23	0.53	-0.60	1.62	0.02	0.78	0.79	0.19	-1.18
0.010	0.057	0.06	-1.14	0.41	-0.51	1.46	0.12	0.68	0.72	0.26	-1.05
0.011	0.056	0.02	-1.04	0.29	-0.43	1.30	0.21	0.59	0.66	0.33	-0.92
0.012	0.054	-0.01	-0.95	0.17	-0.34	1.14	0.30	0.49	0.59	0.40	-0.79
0.013	0.054	-0.04	-0.86	0.05	-0.25	0.98	0.39	0.40	0.53	0.47	-0.66
0.014	0.054	-0.08	-0.77	-0.06	-0.16	0.82	0.49	0.30	0.46	0.54	-0.53
0.015	0.054	-0.11	-0.67	-0.18	-0.08	0.66	0.58	0.21	0.39	0.61	-0.39
0.016	0.056	-0.15	-0.58	-0.30	0.01	0.50	0.67	0.11	0.33	0.68	-0.26
0.017	0.057	-0.18	-0.49	-0.42	0.10	0.33	0.76	0.01	0.26	0.75	-0.13
0.018	0.060	-0.22	-0.39	-0.54	0.18	0.17	0.85	-0.08	0.19	0.82	-0.00
0.019	0.062	-0.25	-0.30	-0.65	0.27	0.01	0.95	-0.18	0.13	0.89	0.13
0.020	0.065	-0.29	-0.21	-0.77	0.36	-0.15	1.04	-0.27	0.06	0.96	0.26
0.021	0.069	-0.32	-0.12	-0.89	0.45	-0.31	1.13	-0.37	-0.00	1.03	0.39
0.022	0.073	-0.35	-0.02	-1.01	0.53	-0.47	1.22	-0.46	-0.07	1.11	0.52
0.023	0.076	-0.39	0.07	-1.13	0.62	-0.63	1.31	-0.56	-0.14	1.18	0.66
0.024	0.081	-0.42	0.16	-1.25	0.71	-0.79	1.41	-0.65	-0.20	1.25	0.79
0.025	0.085	-0.46	0.26	-1.36	0.79	-0.95	1.50	-0.75	-0.27	1.32	0.92
0.026	0.090	-0.49	0.35	-1.48	0.88	-1.11	1.59	-0.84	-0.33	1.39	1.05
0.027	0.094	-0.53	0.44	-1.60	0.97	-1.27	1.68	-0.94	-0.40	1.46	1.18
0.028	0.099	-0.56	0.53	-1.72	1.06	-1.43	1.77	-1.03	-0.47	1.53	1.31
0.029	0.104	-0.59	0.63	-1.84	1.14	-1.59	1.87	-1.13	-0.53	1.60	1.44
0.030	0.109	-0.63	0.72	-1.95	1.23	-1.75	1.96	-1.22	-0.60	1.67	1.57

Table 4.2: (AVW) Mean-Variance Optimal Portfolio: Solution

Mean	SD	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
0.000	0.086	0.82	-1.29	0.30	-0.33	0.72	0.89	0.55	0.66	0.13	-1.45
0.001	0.081	0.72	-1.20	0.28	-0.28	0.70	0.82	0.52	0.64	0.12	-1.33
0.002	0.077	0.63	-1.12	0.26	-0.24	0.69	0.76	0.49	0.63	0.12	-1.22
0.003	0.072	0.54	-1.04	0.24	-0.19	0.67	0.70	0.46	0.61	0.11	-1.10
0.004	0.068	0.45	-0.95	0.22	-0.14	0.66	0.64	0.43	0.59	0.10	-0.99
0.005	0.064	0.35	-0.87	0.20	-0.10	0.64	0.58	0.40	0.58	0.09	-0.87
0.006	0.061	0.26	-0.79	0.18	-0.05	0.63	0.52	0.37	0.56	0.09	-0.76
0.007	0.058	0.17	-0.70	0.15	-0.01	0.61	0.46	0.34	0.54	0.08	-0.64
0.008	0.055	0.07	-0.62	0.13	0.04	0.59	0.39	0.31	0.52	0.07	-0.52
0.009	0.052	-0.02	-0.53	0.11	0.08	0.58	0.33	0.28	0.51	0.06	-0.41
0.010	0.051	-0.11	-0.45	0.09	0.13	0.56	0.27	0.25	0.49	0.05	-0.29
0.011	0.049	-0.20	-0.37	0.07	0.17	0.55	0.21	0.22	0.47	0.05	-0.18
0.012	0.049	-0.30	-0.28	0.05	0.22	0.53	0.15	0.19	0.46	0.04	-0.06
0.013	0.049	-0.39	-0.20	0.03	0.26	0.52	0.09	0.16	0.44	0.03	0.06
0.014	0.050	-0.48	-0.12	0.01	0.31	0.50	0.03	0.13	0.42	0.02	0.17
0.015	0.052	-0.58	-0.03	-0.02	0.35	0.49	-0.04	0.10	0.41	0.02	0.29
0.016	0.054	-0.67	0.05	-0.04	0.40	0.47	-0.10	0.07	0.39	0.01	0.40
0.017	0.056	-0.76	0.13	-0.06	0.45	0.46	-0.16	0.04	0.37	0.00	0.52
0.018	0.060	-0.85	0.22	-0.08	0.49	0.44	-0.22	0.01	0.36	-0.01	0.64
0.019	0.063	-0.95	0.30	-0.10	0.54	0.43	-0.28	-0.02	0.34	-0.01	0.75
0.020	0.067	-1.04	0.39	-0.12	0.58	0.41	-0.34	-0.05	0.32	-0.02	0.87
0.021	0.071	-1.13	0.47	-0.14	0.63	0.40	-0.40	-0.08	0.31	-0.03	0.98
0.022	0.075	-1.23	0.55	-0.16	0.67	0.38	-0.47	-0.11	0.29	-0.04	1.10
0.023	0.080	-1.32	0.64	-0.19	0.72	0.37	-0.53	-0.14	0.27	-0.04	1.21
0.024	0.084	-1.41	0.72	-0.21	0.76	0.35	-0.59	-0.17	0.26	-0.05	1.33
0.025	0.089	-1.50	0.80	-0.23	0.81	0.34	-0.65	-0.19	0.24	-0.06	1.45
0.026	0.094	-1.60	0.89	-0.25	0.85	0.32	-0.71	-0.22	0.22	-0.07	1.56
0.027	0.099	-1.69	0.97	-0.27	0.90	0.31	-0.77	-0.25	0.21	-0.08	1.68
0.028	0.104	-1.78	1.05	-0.29	0.95	0.29	-0.83	-0.28	0.19	-0.08	1.79
0.029	0.109	-1.88	1.14	-0.31	0.99	0.28	-0.90	-0.31	0.17	-0.09	1.91
0.030	0.115	-1.97	1.22	-0.33	1.04	0.26	-0.96	-0.34	0.16	-0.10	2.03

Table 4.3: (AEW) Mean-Variance Optimal Portfolio: Correlation

	Mean	SD	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Mean	1.0	0.3	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0	1.0
SD	0.3	1.0	-0.3	0.3	-0.3	0.3	-0.3	0.3	-0.3	-0.3	0.3	0.3
W1	-1.0	-0.3	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	1.0	-1.0	-1.0
W2	1.0	0.3	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0	1.0
W3	-1.0	-0.3	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	1.0	-1.0	-1.0
W4	1.0	0.3	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0	1.0
W5	-1.0	-0.3	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	1.0	-1.0	-1.0
W6	1.0	0.3	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0	1.0
W7	-1.0	-0.3	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	1.0	-1.0	-1.0
W8	-1.0	-0.3	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	1.0	-1.0	-1.0
W9	1.0	0.3	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0	1.0
W10	1.0	0.3	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0	1.0

Table 4.4: (AVW) Mean-Variance Optimal Portfolio: Correlation

	Mean	SD	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Mean	1.0	0.5	-1.0	1.0	-1.0	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	1.0
SD	0.5	1.0	-0.5	0.5	-0.5	0.5	-0.5	-0.5	-0.5	-0.5	-0.5	0.5
W1	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W2	1.0	0.5	-1.0	1.0	-1.0	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	1.0
W3	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W4	1.0	0.5	-1.0	1.0	-1.0	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	1.0
W5	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W6	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W7	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W8	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W9	-1.0	-0.5	1.0	-1.0	1.0	-1.0	1.0	1.0	1.0	1.0	1.0	-1.0
W10	1.0	0.5	-1.0	1.0	-1.0	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	1.0

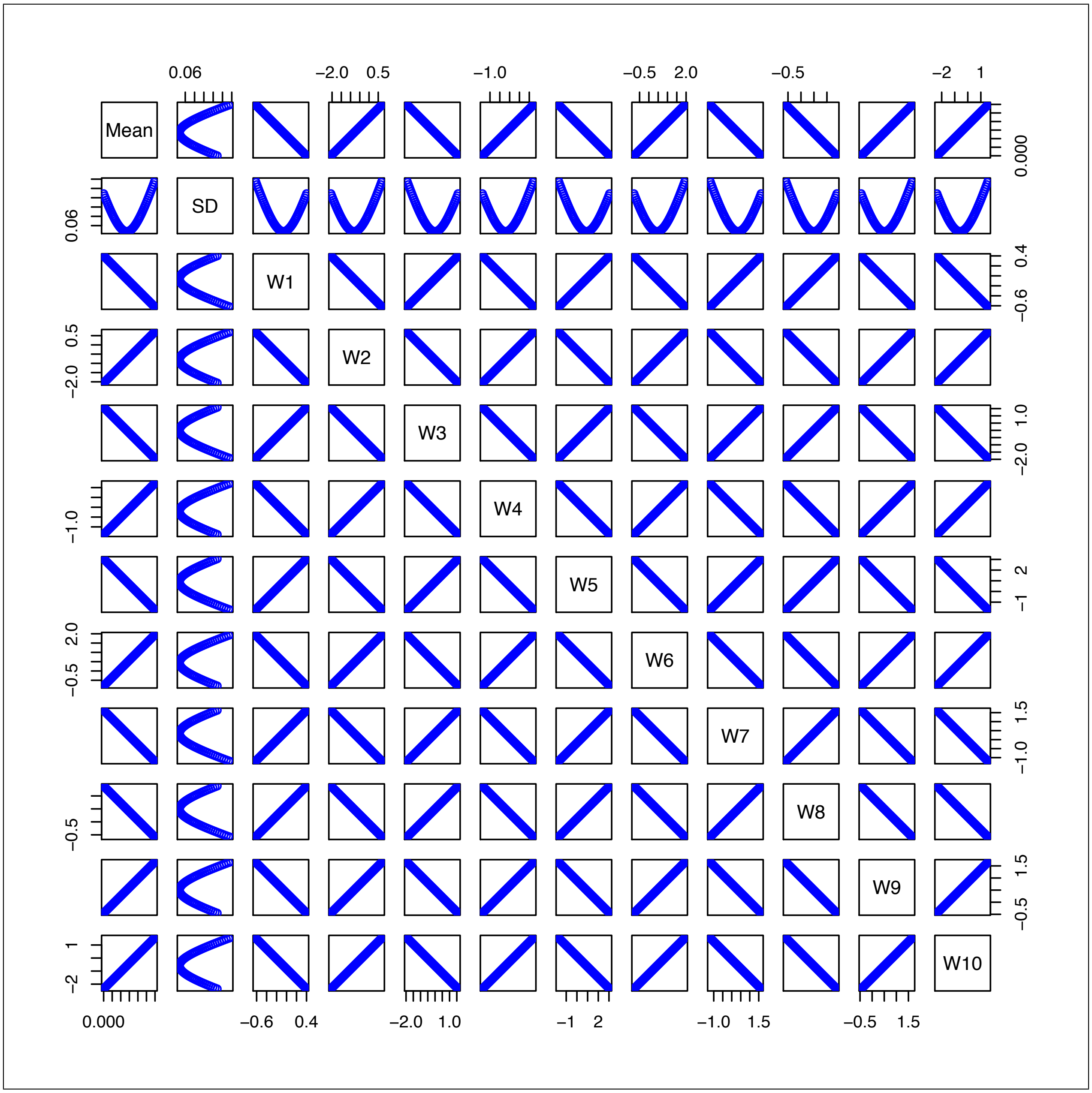


Figure 4.4: (AEW) Scatterplot of the Portfolio's Mean, SD, and Weight

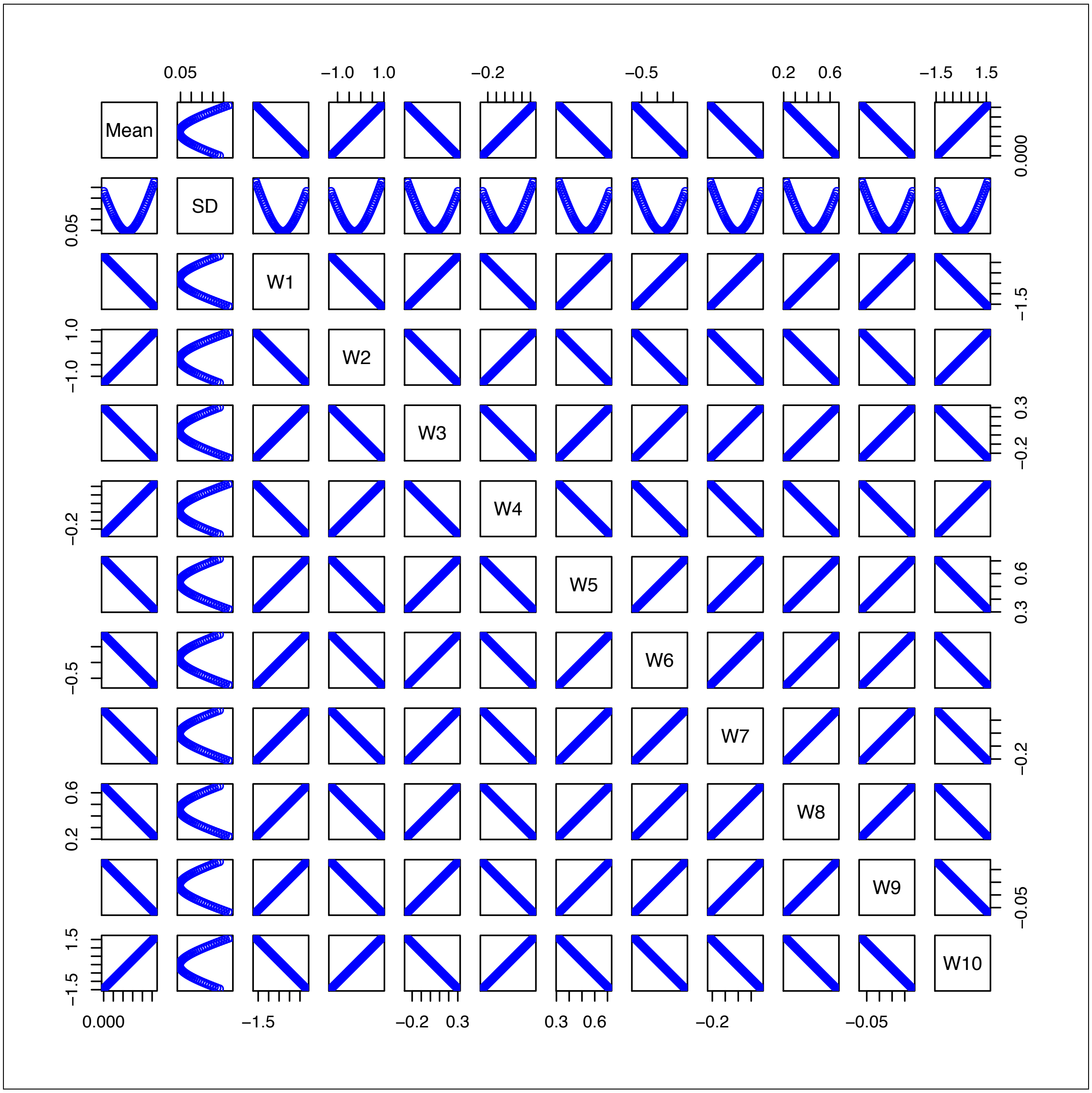


Figure 4.5: (AVW) Scatterplot of the Portfolio's Mean, SD, and Weight

Chapter 5

Conclusion

Based on the results of Lilliefors test for normality, with 5% α level, the random errors are not Gaussian distributed, therefore the OLS estimates are not equivalent to the maximum-likelihood estimates. For OLS, the random errors do not have to be Gaussian distributed.

Through our regression diagnostic, the random errors appear to be distributed with mean zero. In addition, the random errors appear to be independent of the observed data of the Fama French Carhart four factors. However, based on the times series of residuals, the residuals seem not to be independent and identically distributed because they have larger fluctuations before 1940 and after 1980. The time series plots also suggest that the homoscedasticity (constant variance) assumption is violated, which are confirmed by the results of the non-constant variance score test with 5% alpha level. Our failure of meeting some of the OLS assumptions suggests that our dataset constains influential observations.

Covariance ratio identifies more influential observations than Cook's distance. Out of 1,039 monthly observations, for the average equal weighted method, Cook's distance and covariance ratio identify 5 and 187 influential observations respectively. For the average value weighted method, Cook's distance and covariance ratio identify 4 and 232 influential observations respectively.

We use Cook's distance to examine influence on betas estimates. After excluding the influential observations identified by Cook's distance from the original data set, for the average equal weighted method, the β_{RMRF} and β_{SMB} estimates are more convex on portfolio rankings and β_{HML} estimates are more concave on portfolio rankings. We have also found that all the influential observations identified by Cook's Distance are connected with major historical events.

We use covariance ratio to examine influence on t-statistics. After excluding the influential observations identified by covariance ratio from the original data set, there are substantial percentage changes for both the Newey-West t-statistics and the standard t-statistics. The Newey-West t-statistics appear to be more sensitive to the elimination of influential observations than the ordinary t-statistics.

We apply the Lilliefors test on panels B and C to test the null hypothesis that the residuals come from the Gaussian distribution. For panel B, the results of Lilliefors test for normality remain the same as the ones for panel A. However, for panel C, the normality assumption seem to be valid for 3 and 8 out of 10 portfolios for the average equal weighted and average value weighted methods respectively.

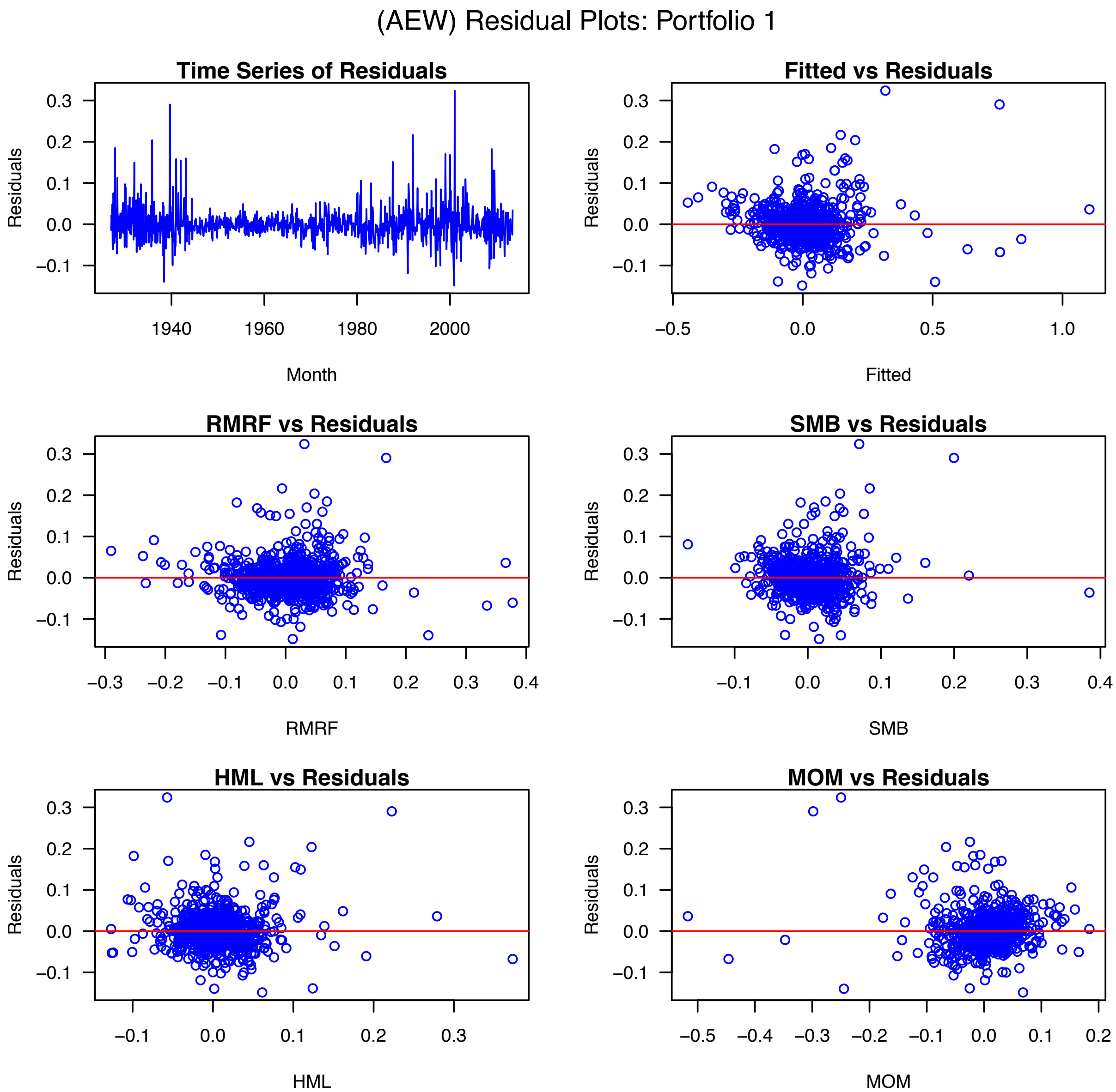
We also apply the non-constant variance score test on panels B and C to test the null hypothesis that the residuals are distributed with constant variance. For panel B, there is 1 additional portfolio seem to be distributed with constant variance for each weighting methods. Whereas for panel C, there are 7 and 5 additional portfolios seem to be distributed with constant variance for the average equal weighted and average value weighted methods respectively.

By comparing the two mean-variance optimal portfolios, in which the portfolios are both comprised of the 10 portfolios formed on momentum but with two different weighted methods, we have found that the mean-variance optimal set shifts to the left when we change from the average equal weighted method to the average value weighted method, but with the intersection near the expected monthly return of 0.018 and its standard deviation of 0.060. To increase the expected monthly return and therefore the associated risk of an efficient portfolio, the optimal portfolio weights for portfolios 2, 4, and 10 have to be increased for both weighted methods, in addtion to increasing the optimal portfolio weights for portfolios 6 and 9 for average equal weighted method.

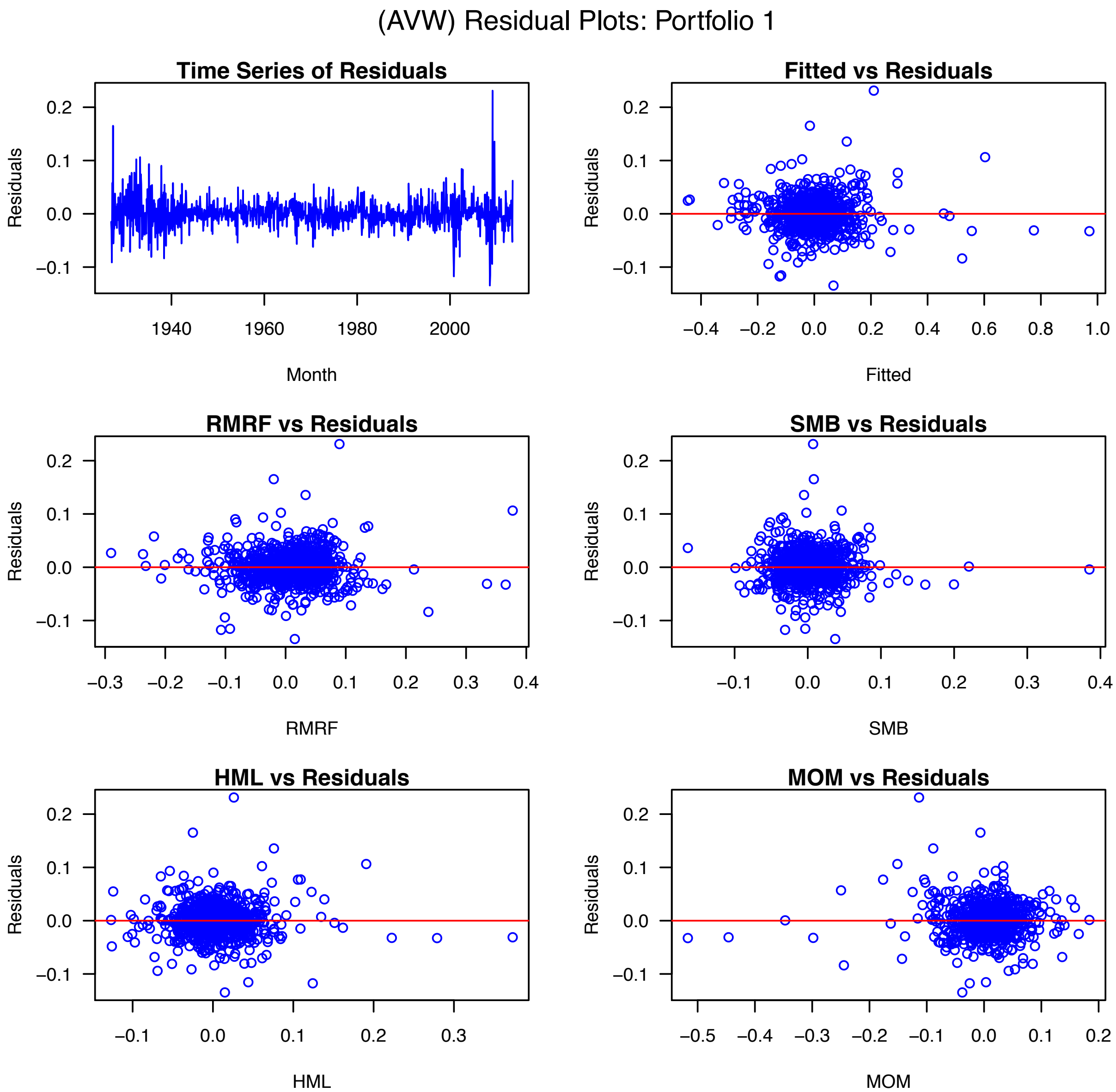
Appendix A

Residual Plots

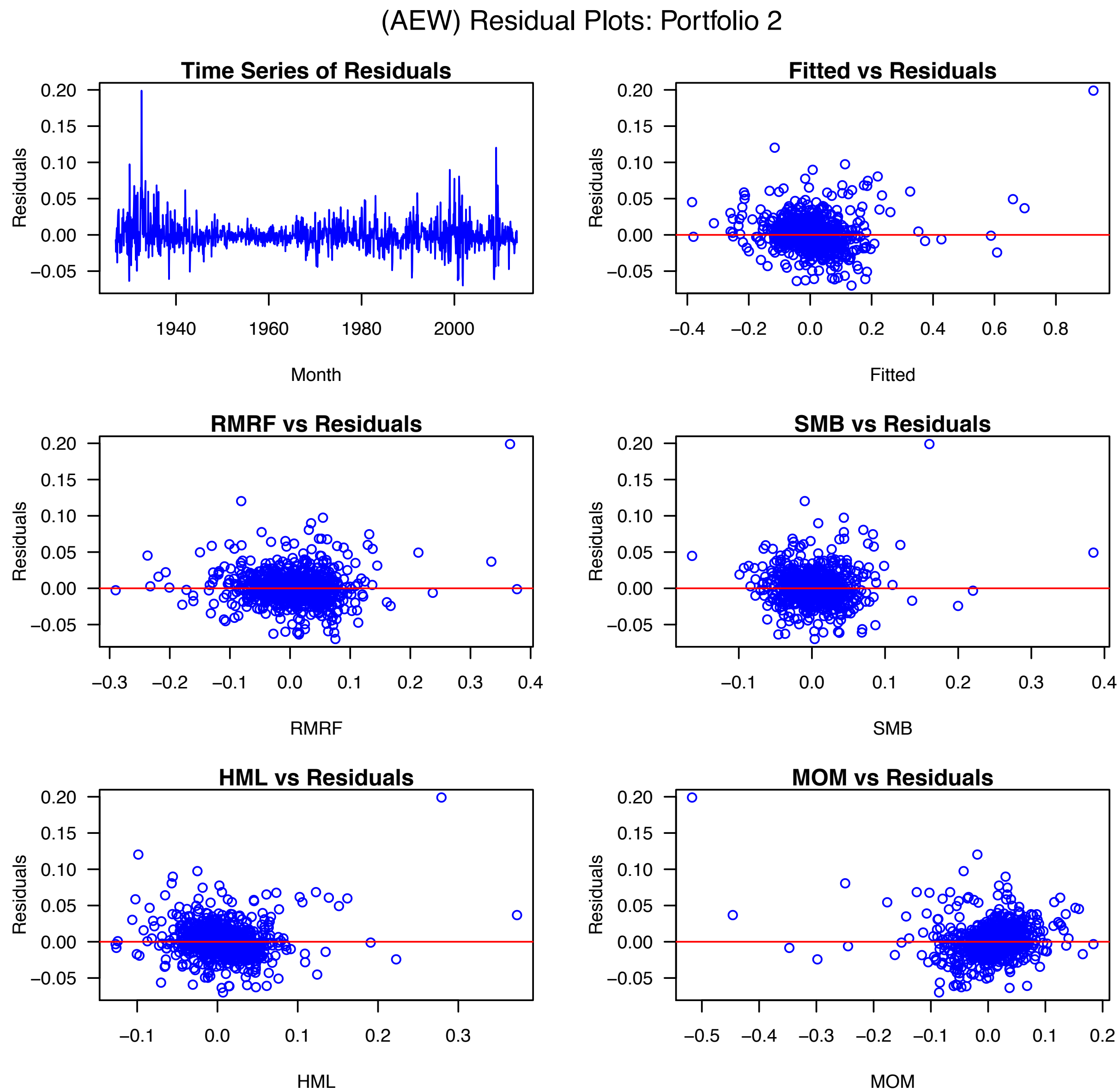
A.1 (AEW) Portfolio 1



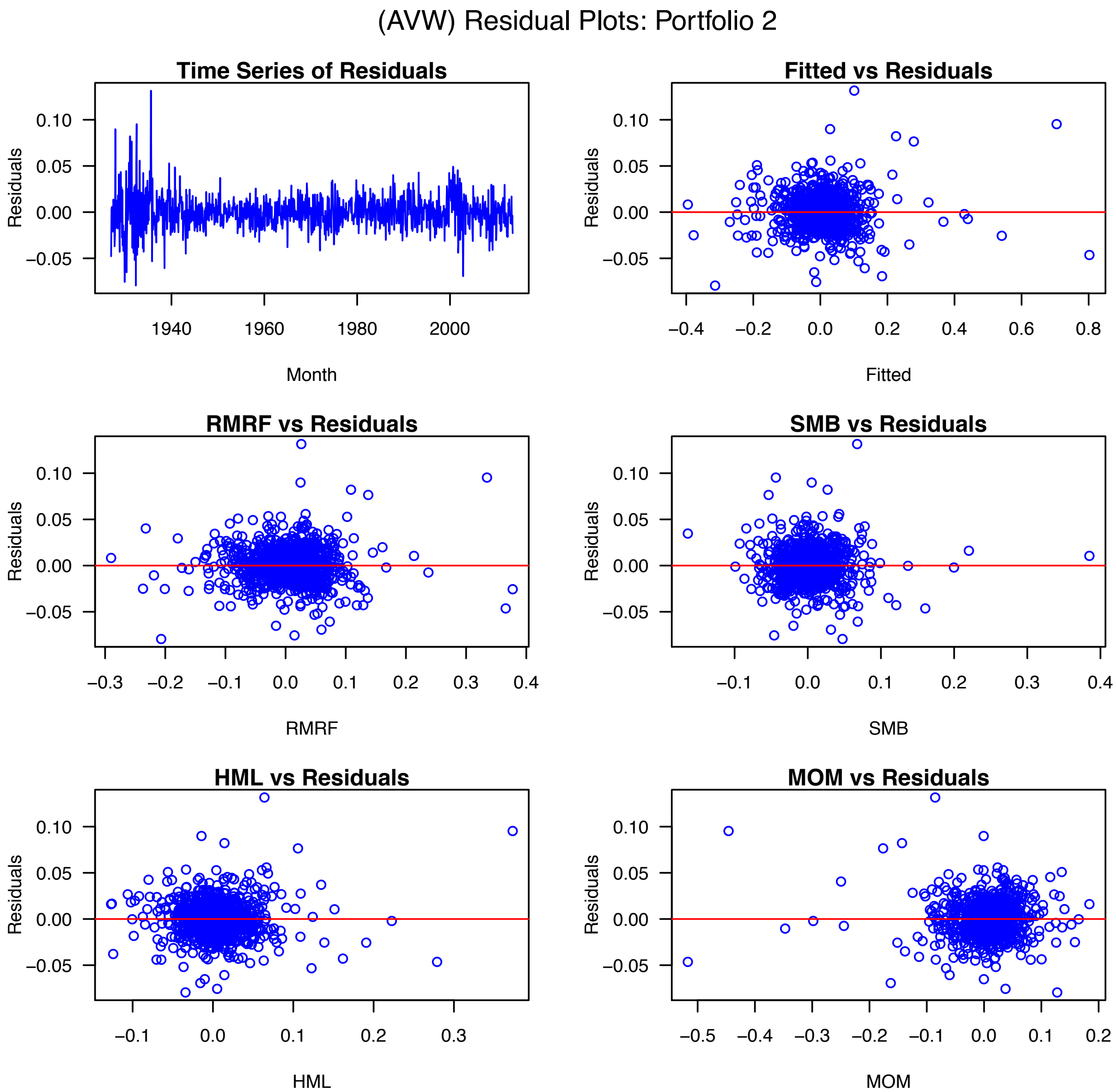
A.2 (AVW) Portfolio 1



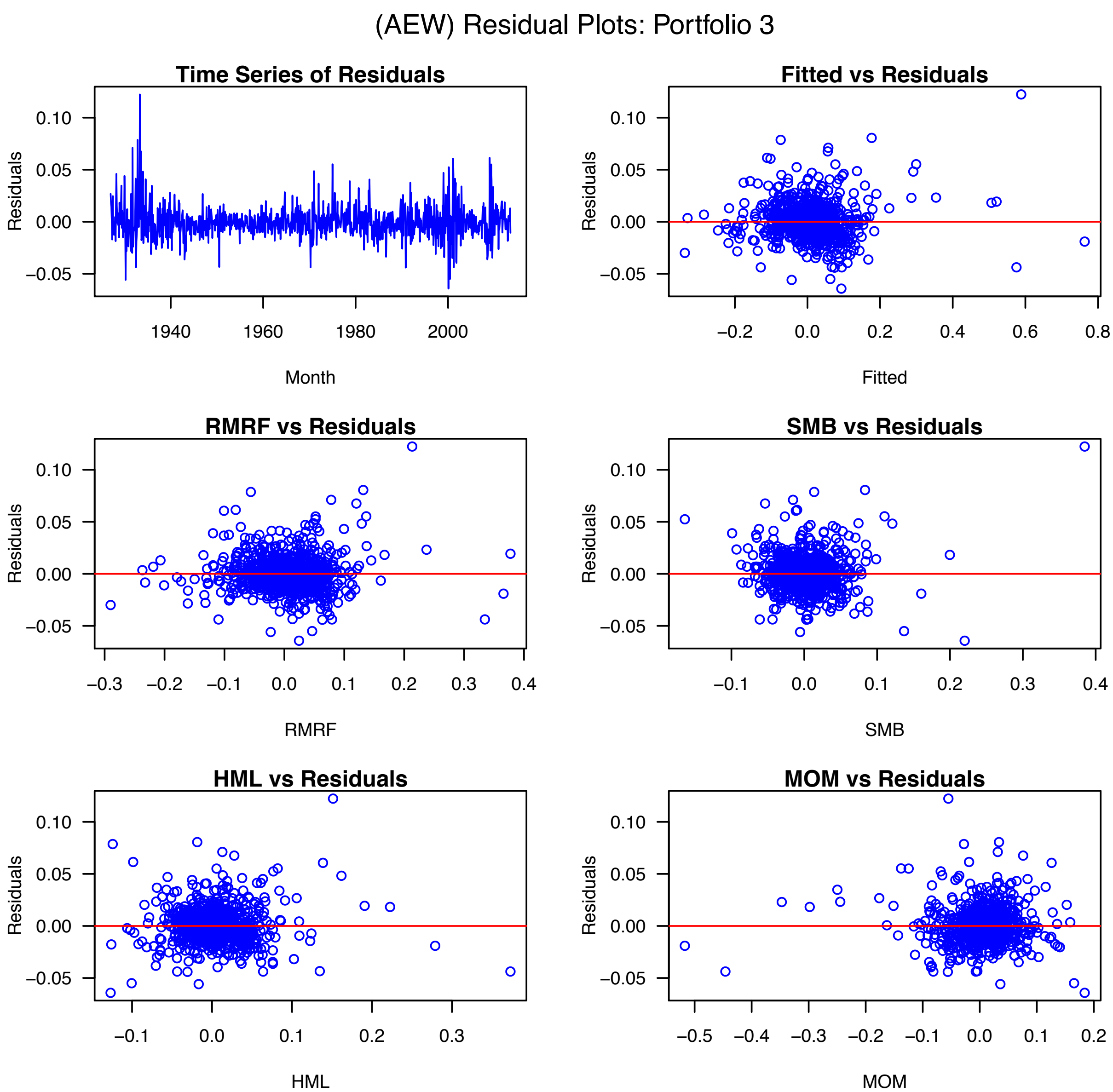
A.3 (AEW) Portfolio 2



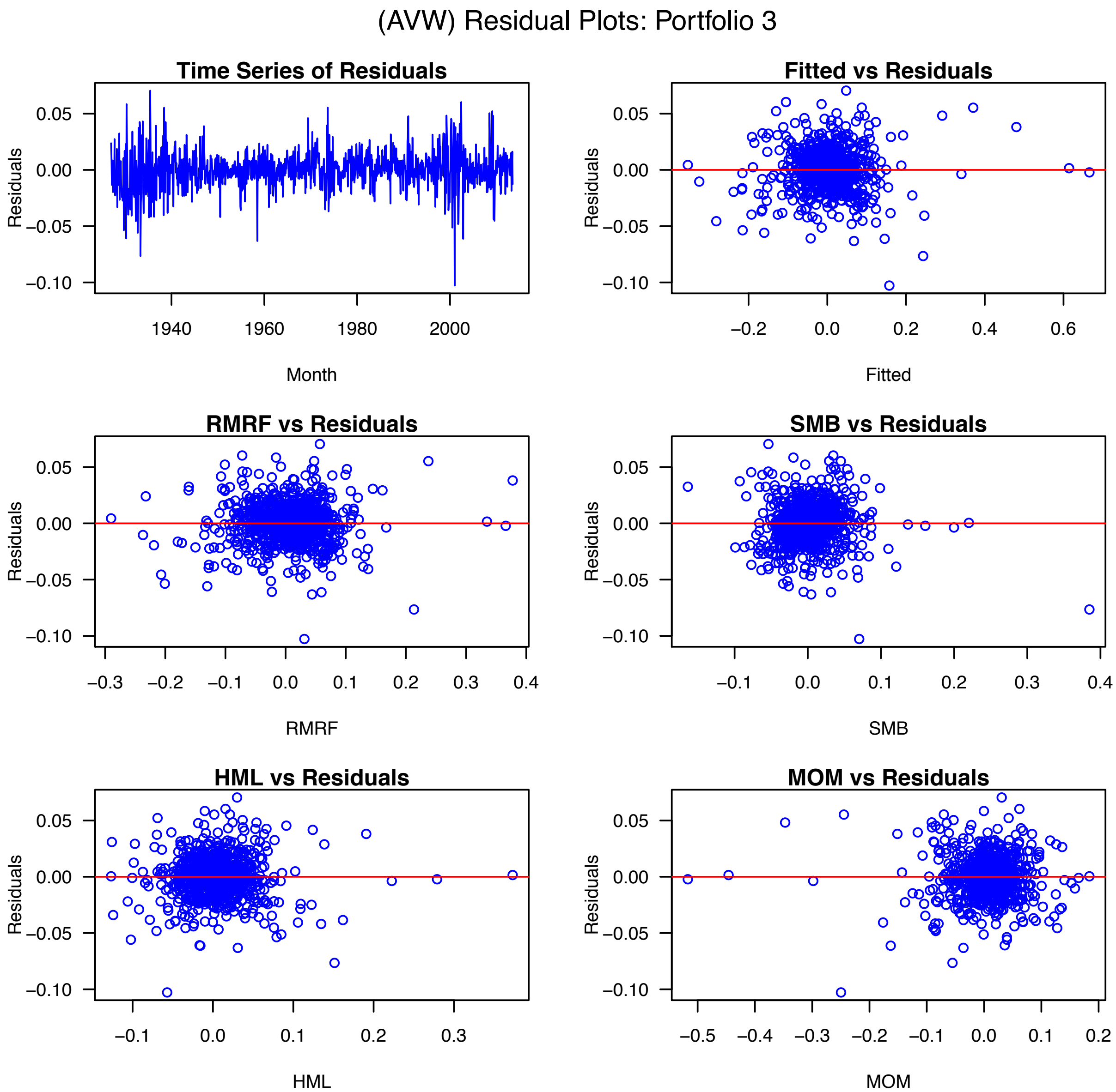
A.4 (AVW) Portfolio 2



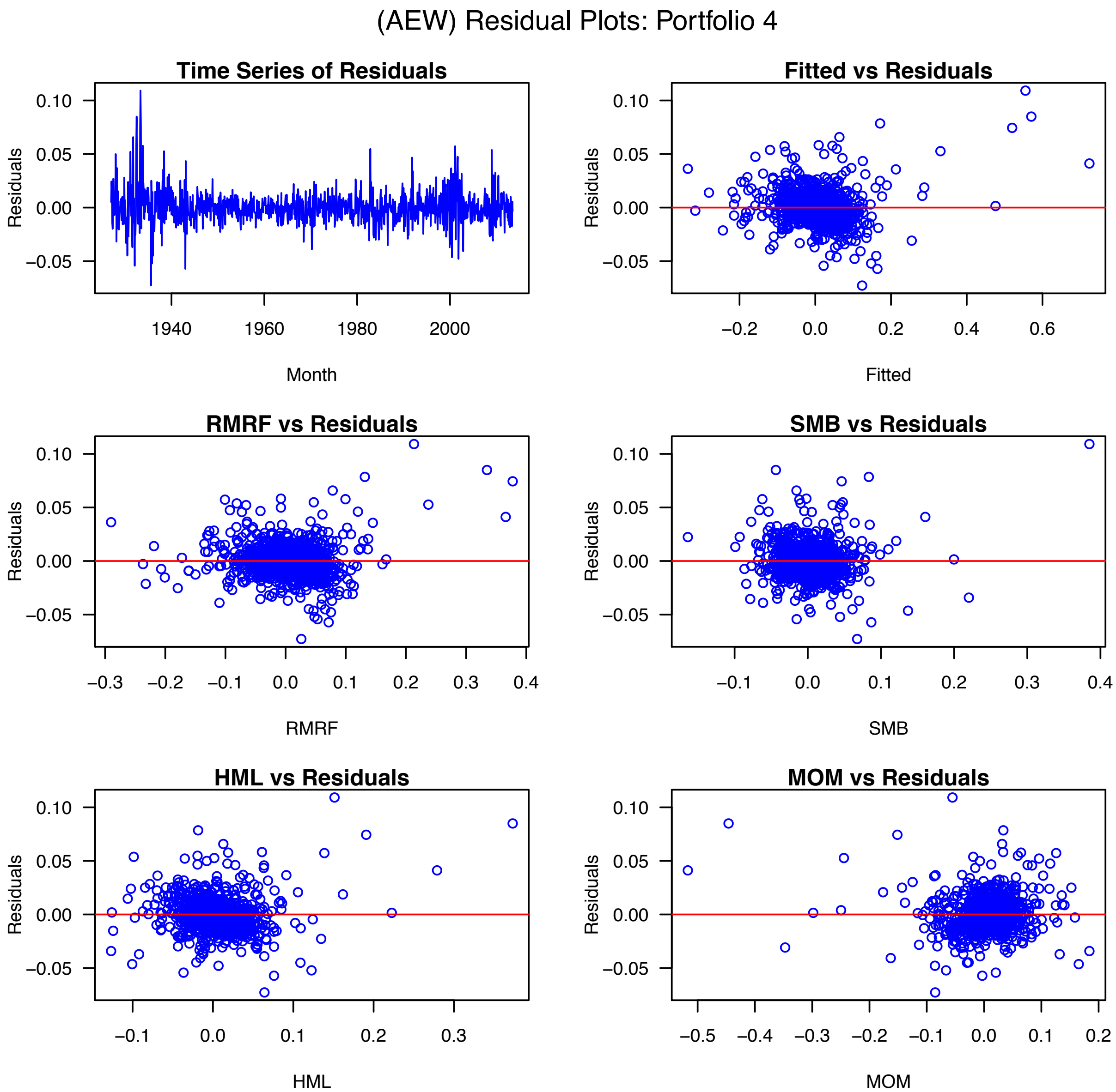
A.5 (AEW) Portfolio 3



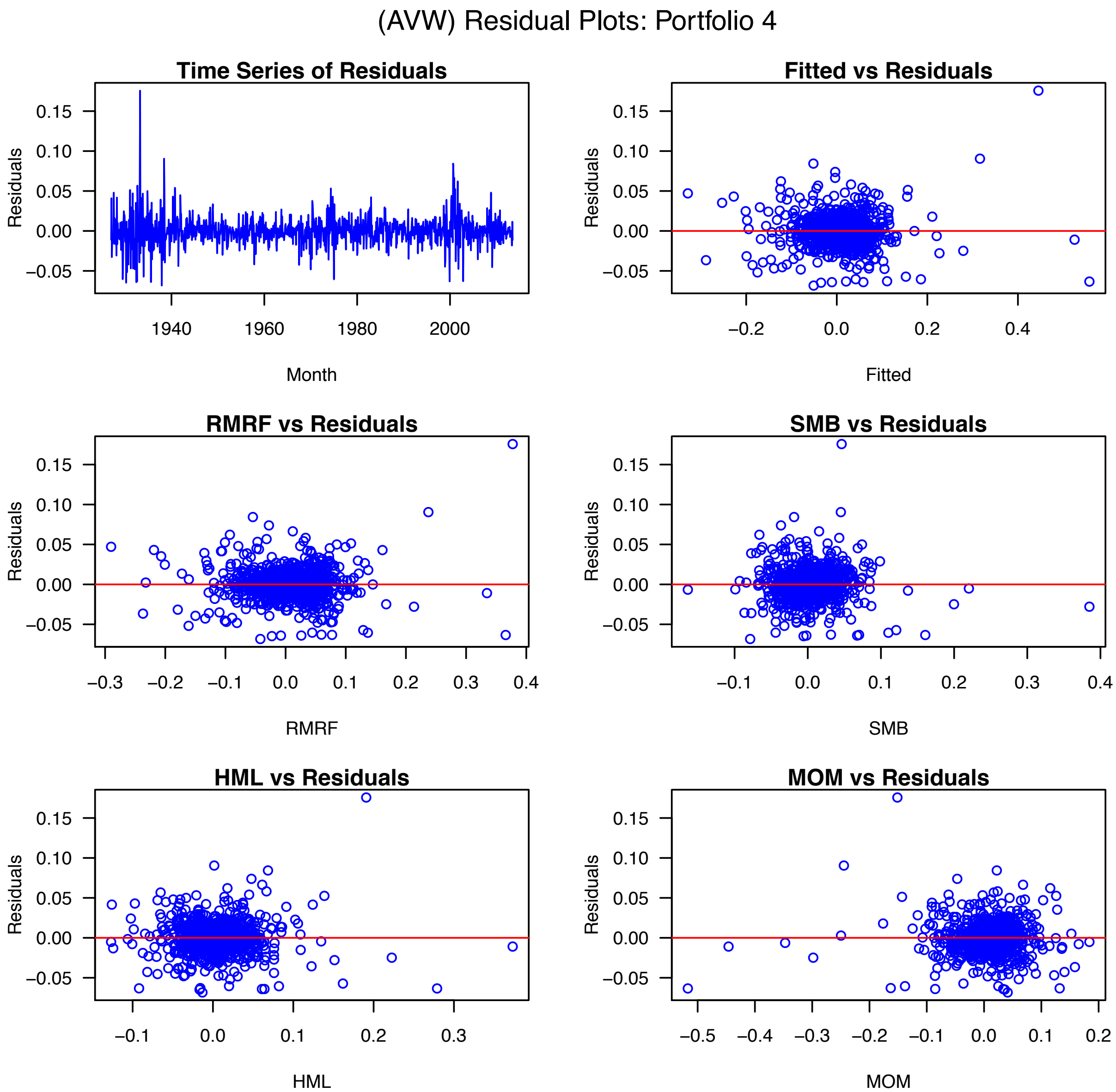
A.6 (AVW) Portfolio 3



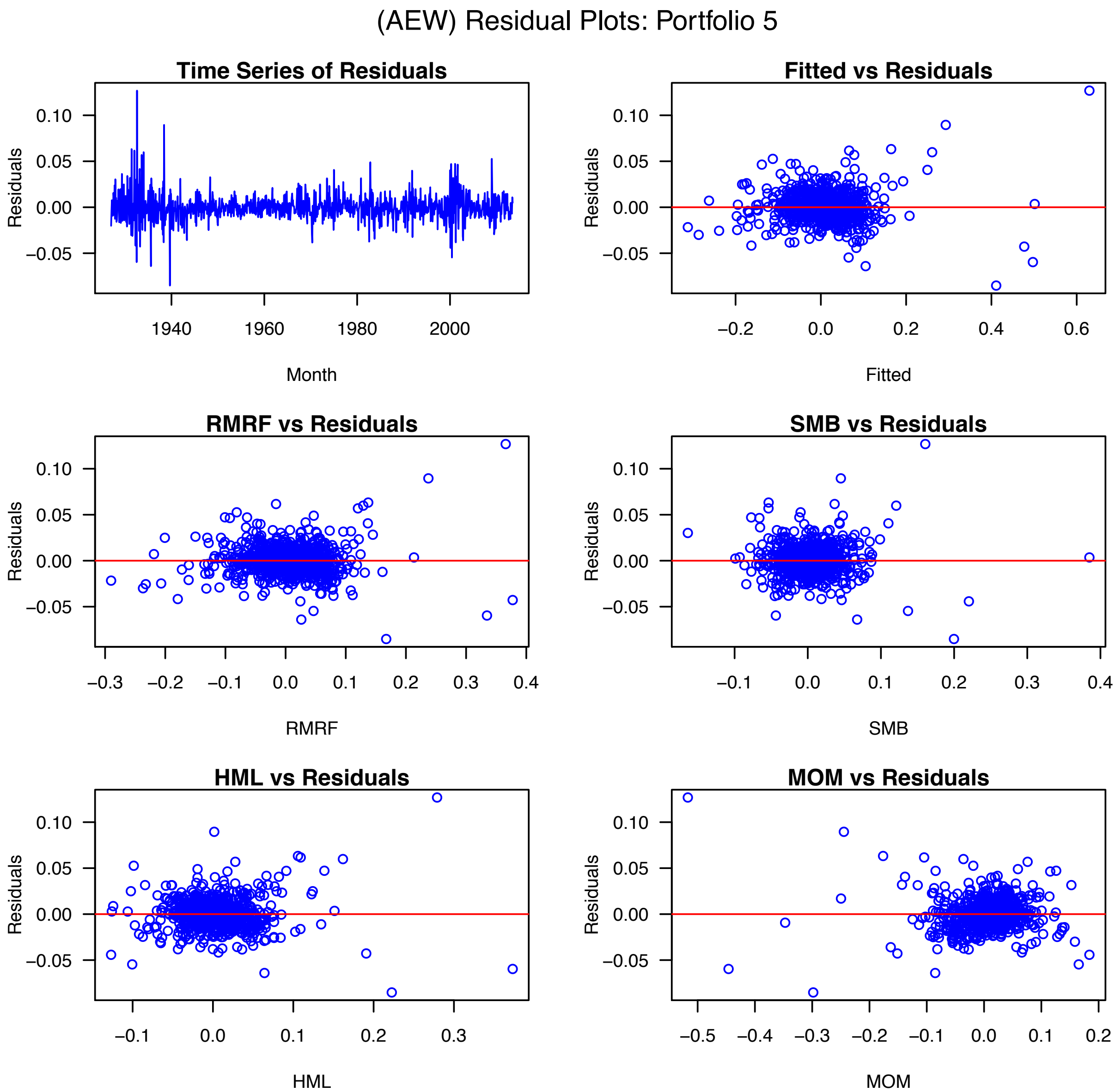
A.7 (AEW) Portfolio 4



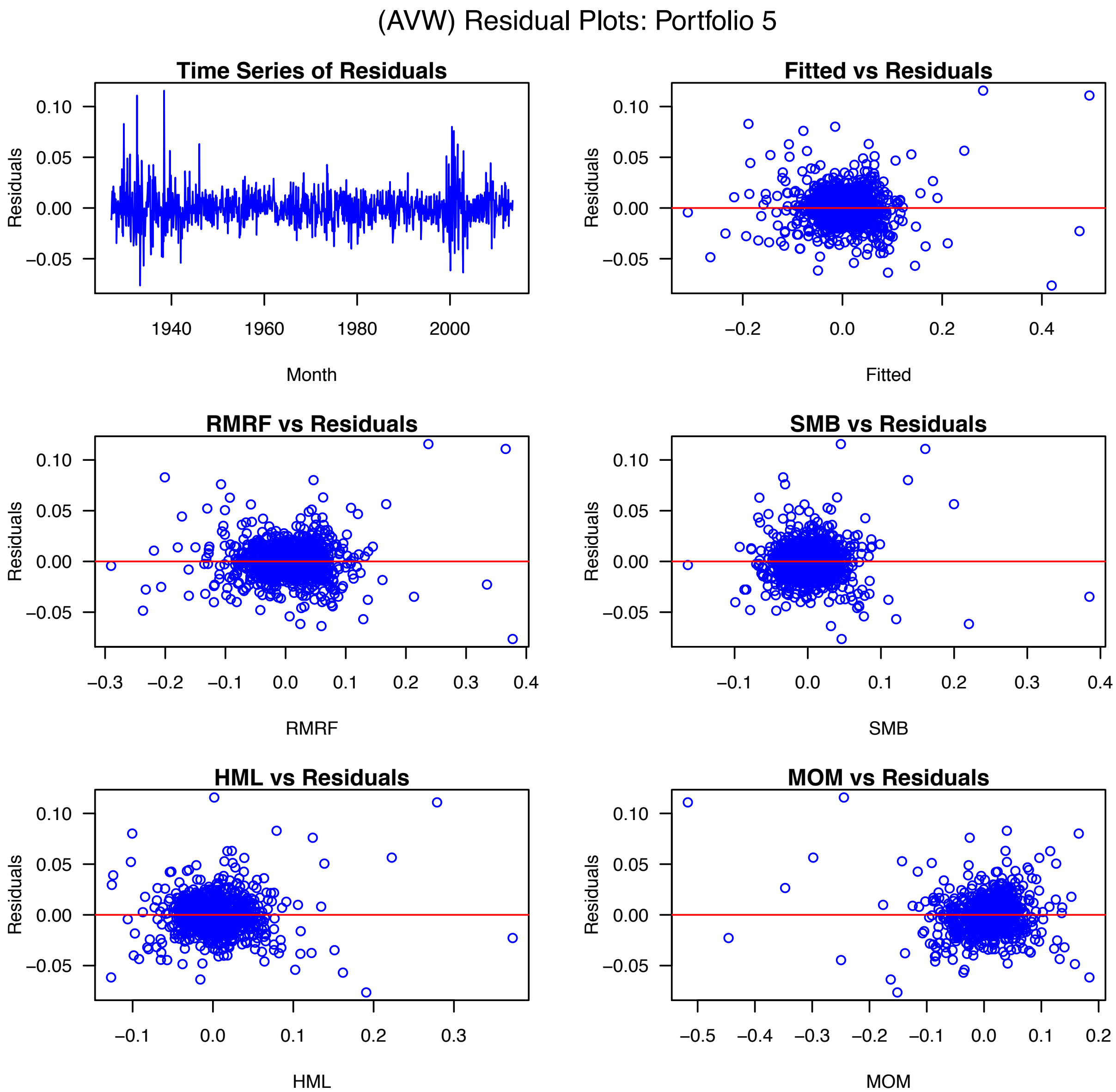
A.8 (AVW) Portfolio 4



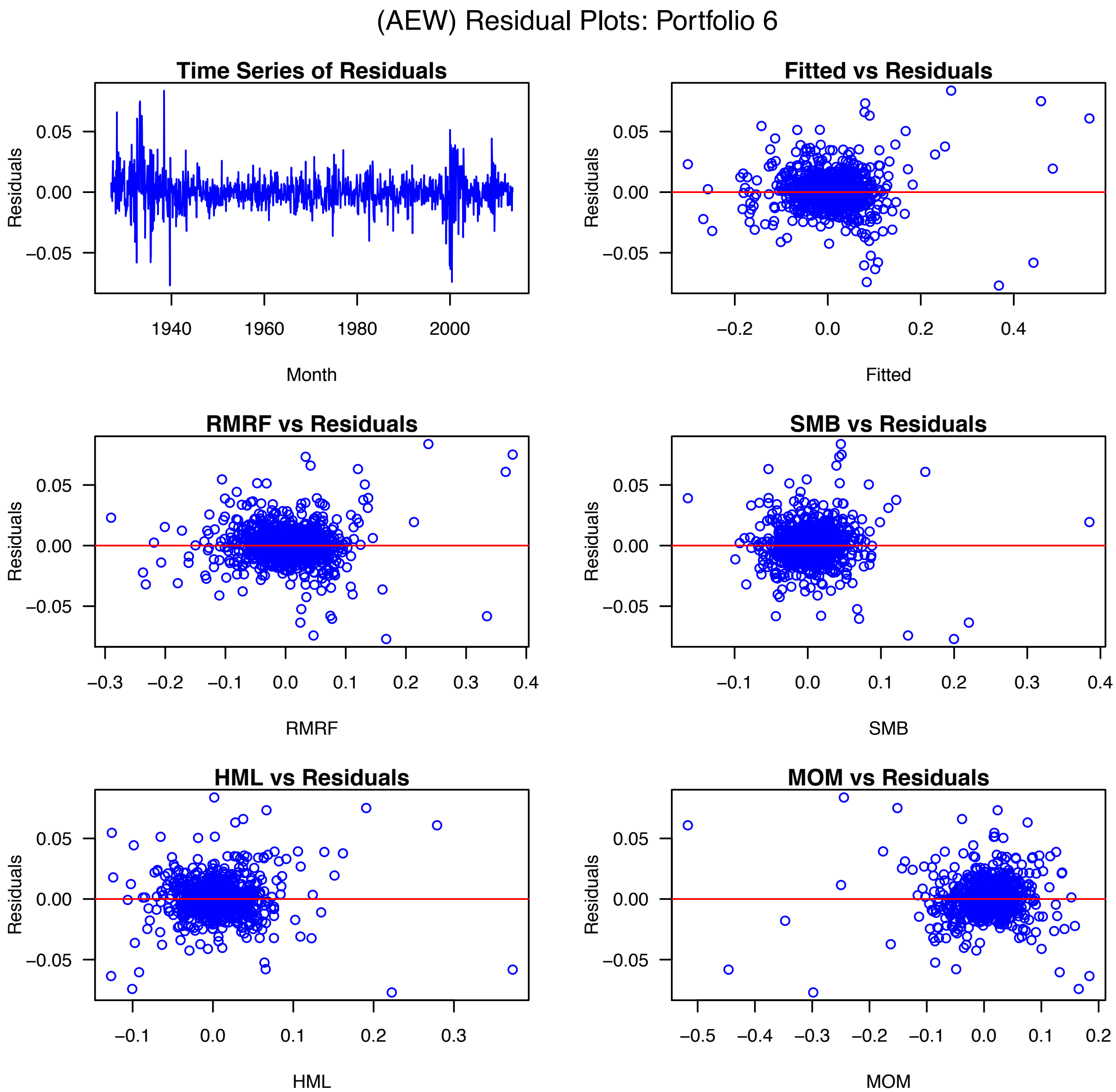
A.9 (AEW) Portfolio 5



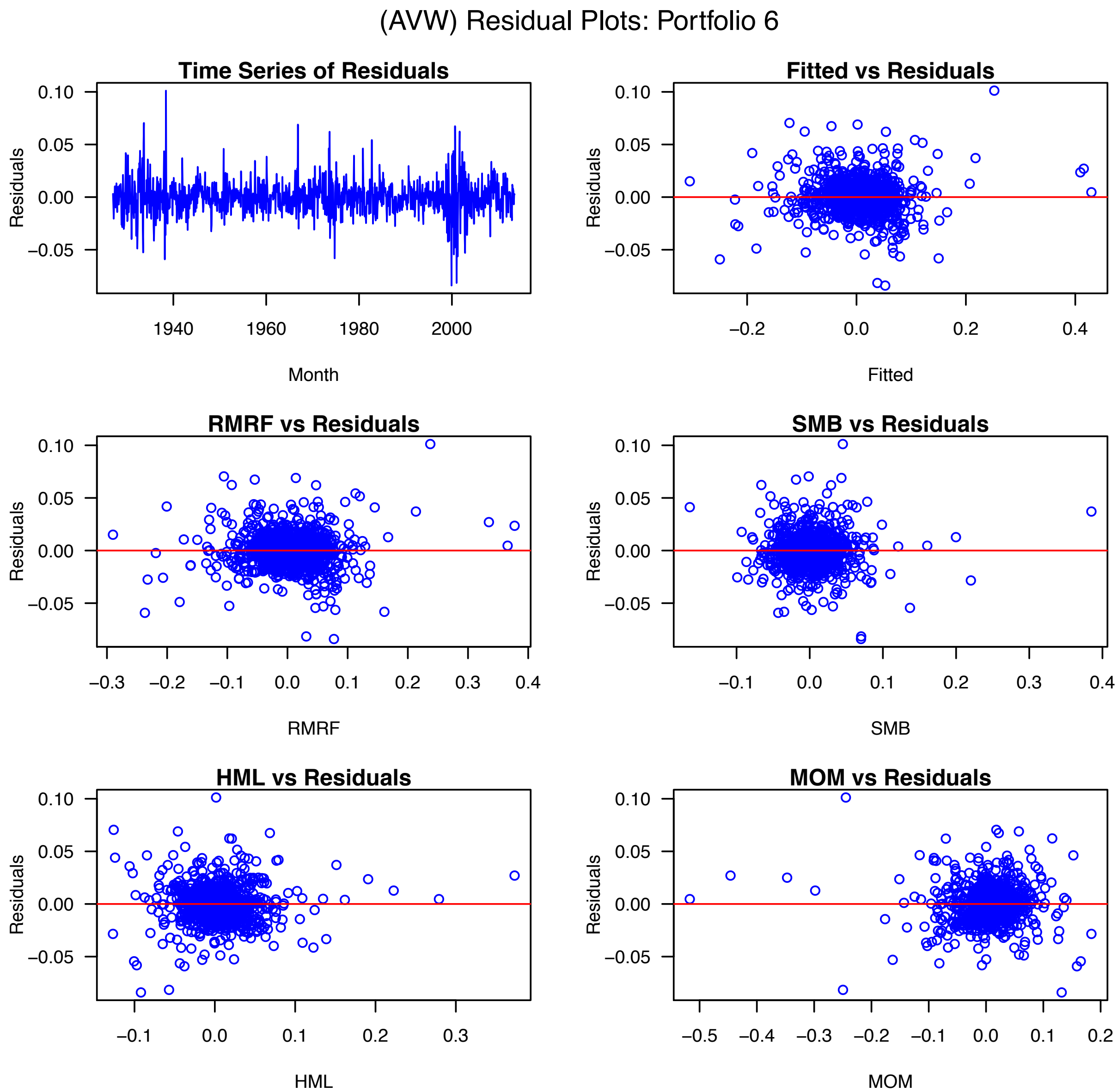
A.10 (AVW) Portfolio 5



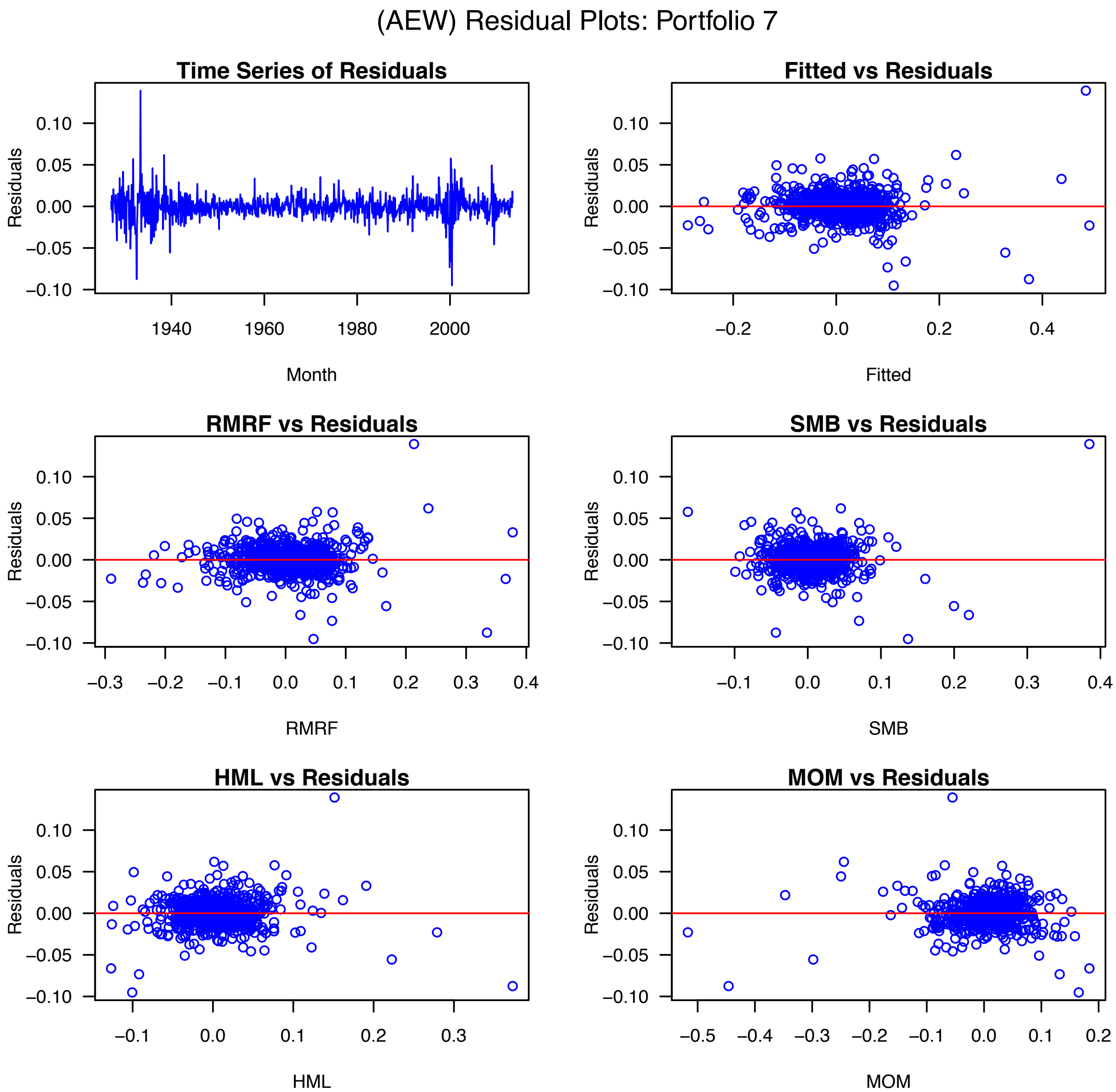
A.11 (AEW) Portfolio 6



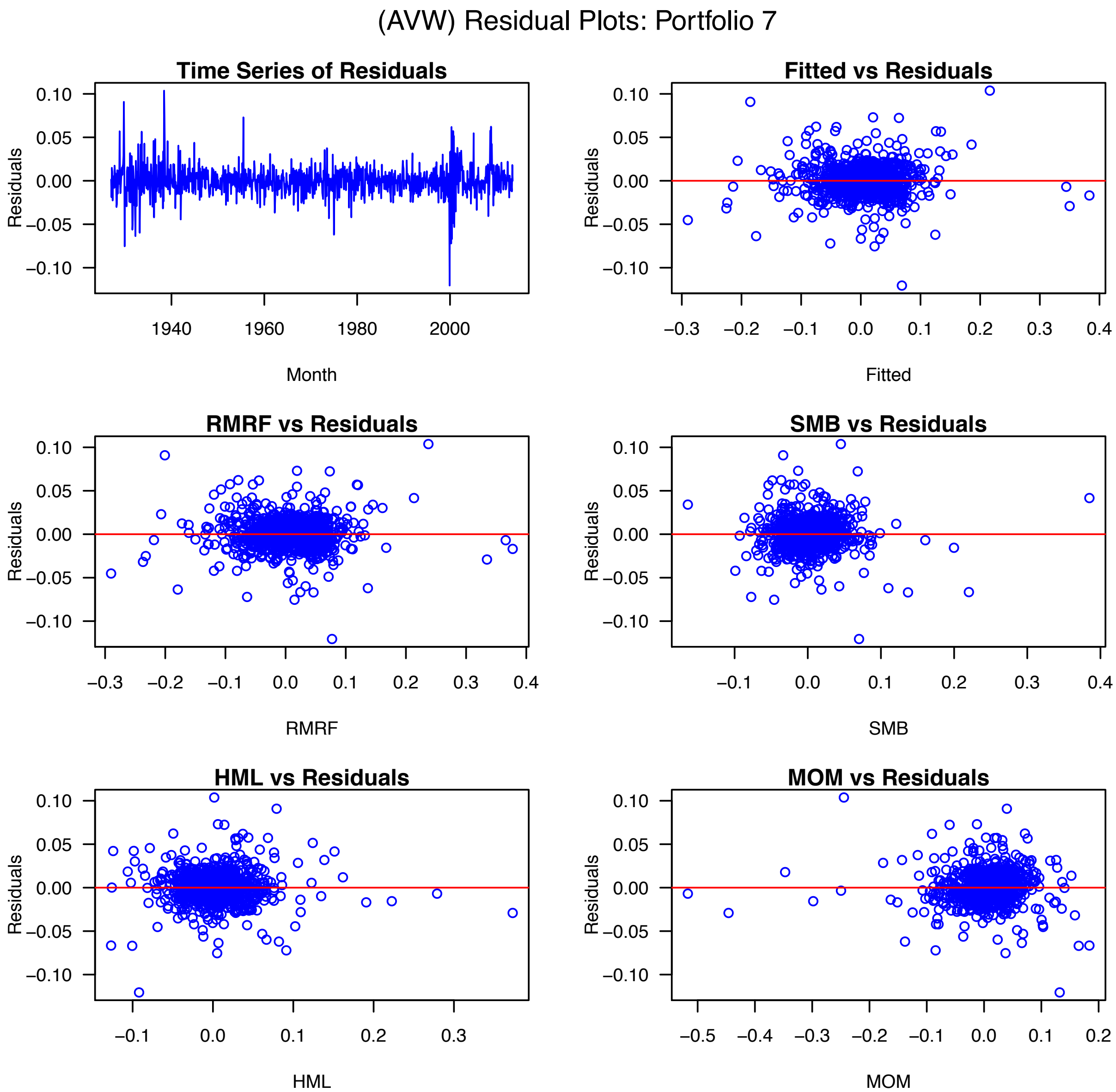
A.12 (AVW) Portfolio 6



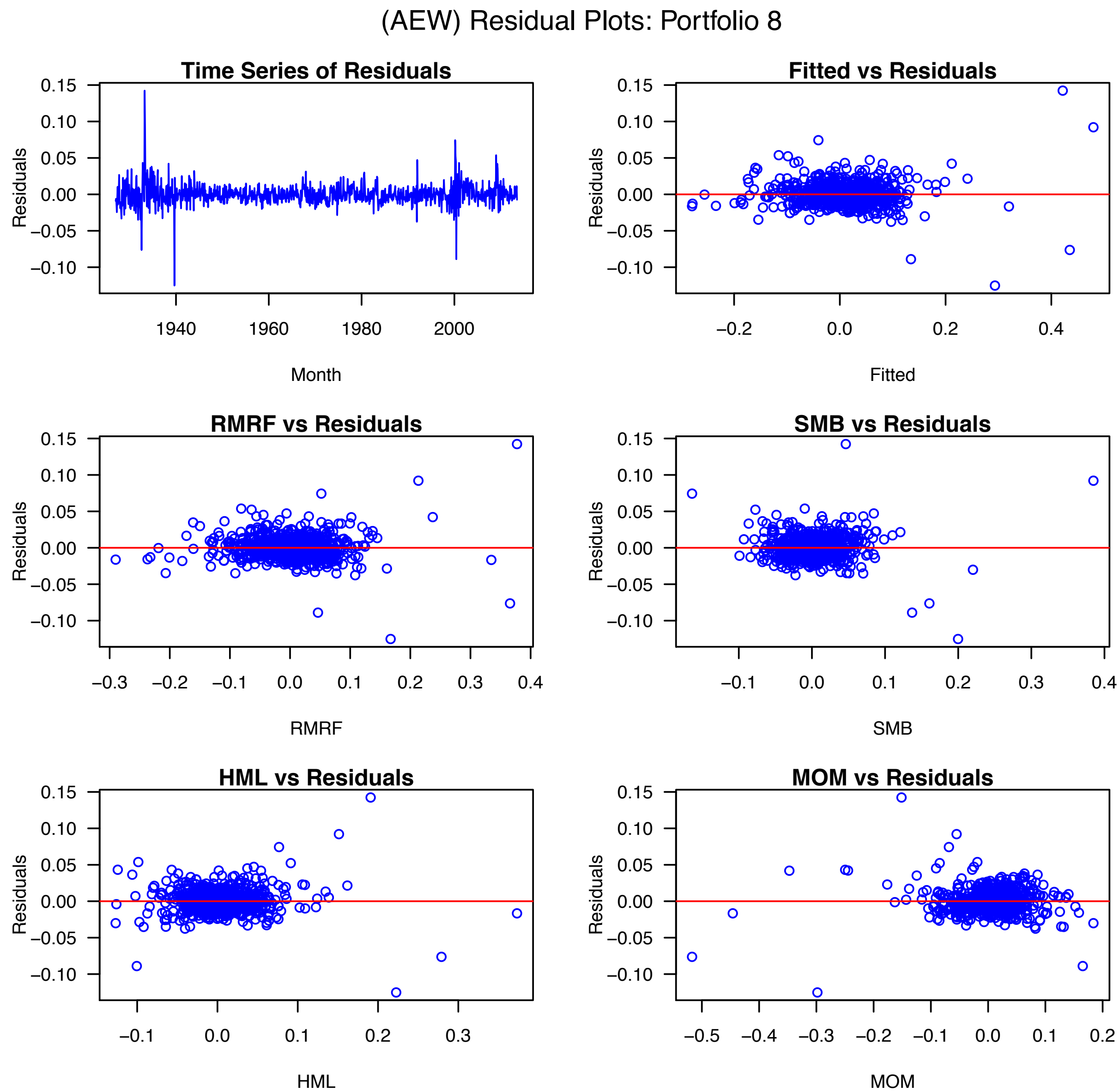
A.13 (AEW) Portfolio 7



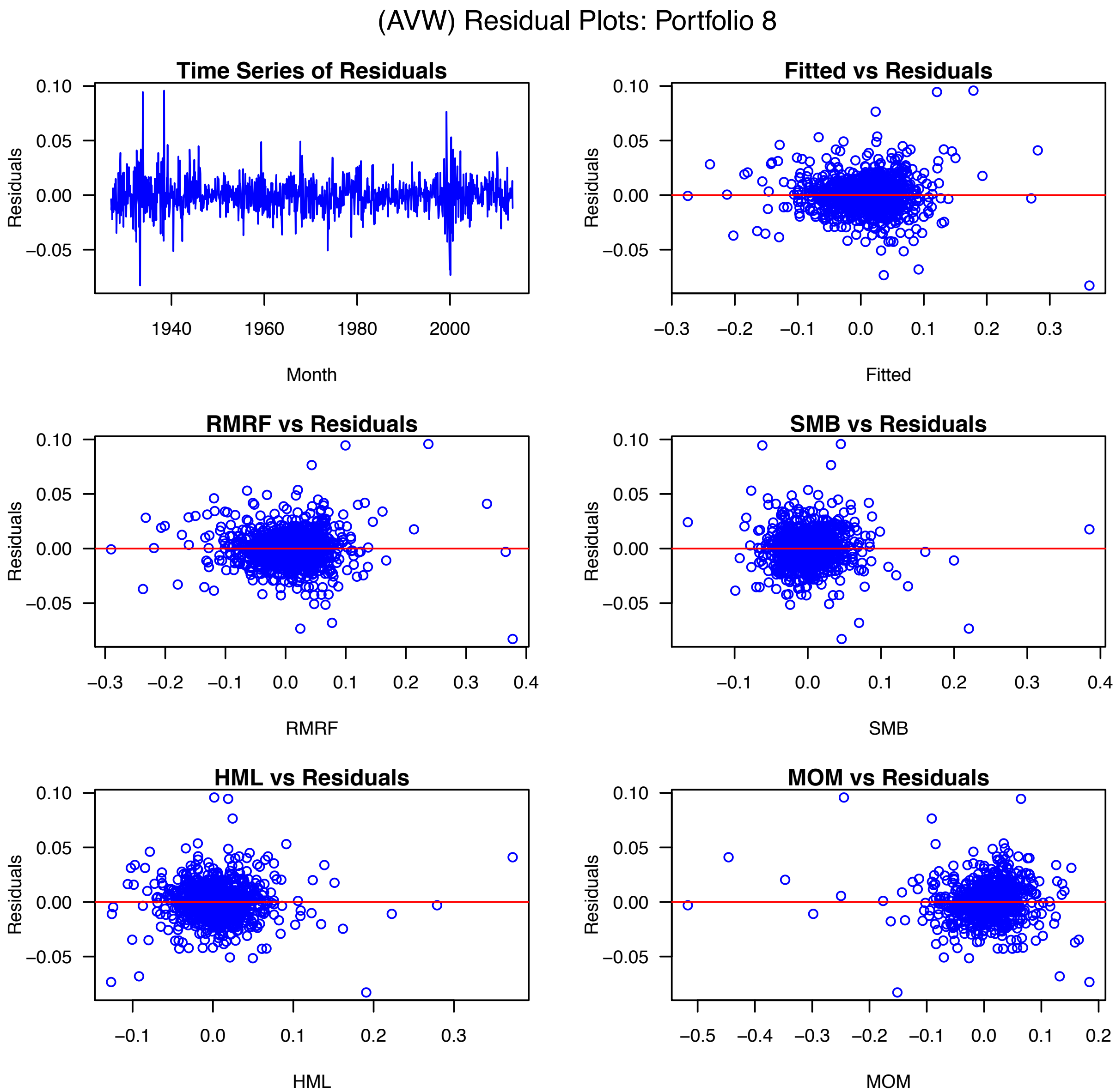
A.14 (AVW) Portfolio 7



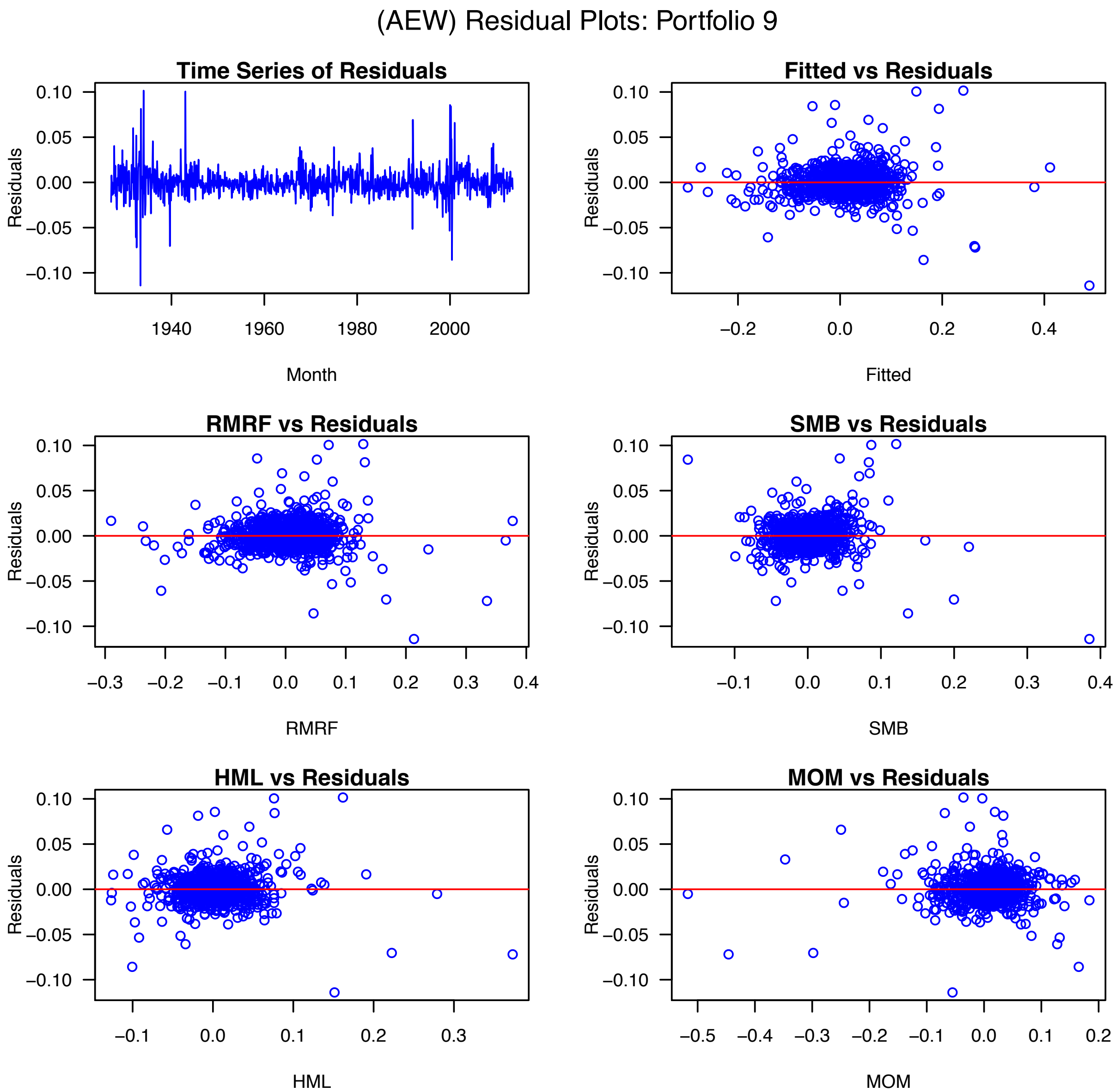
A.15 (AEW) Portfolio 8



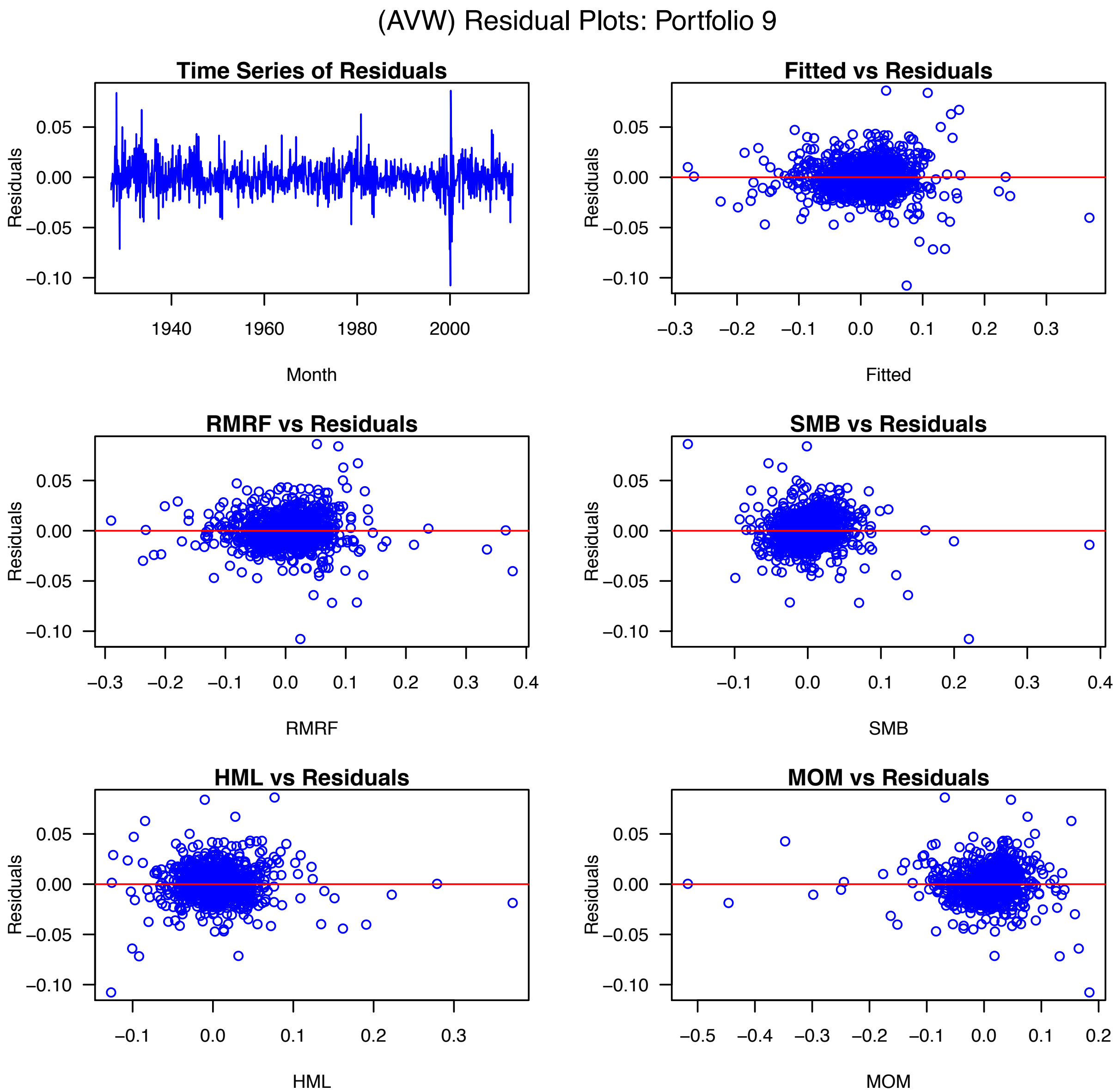
A.16 (AVW) Portfolio 8



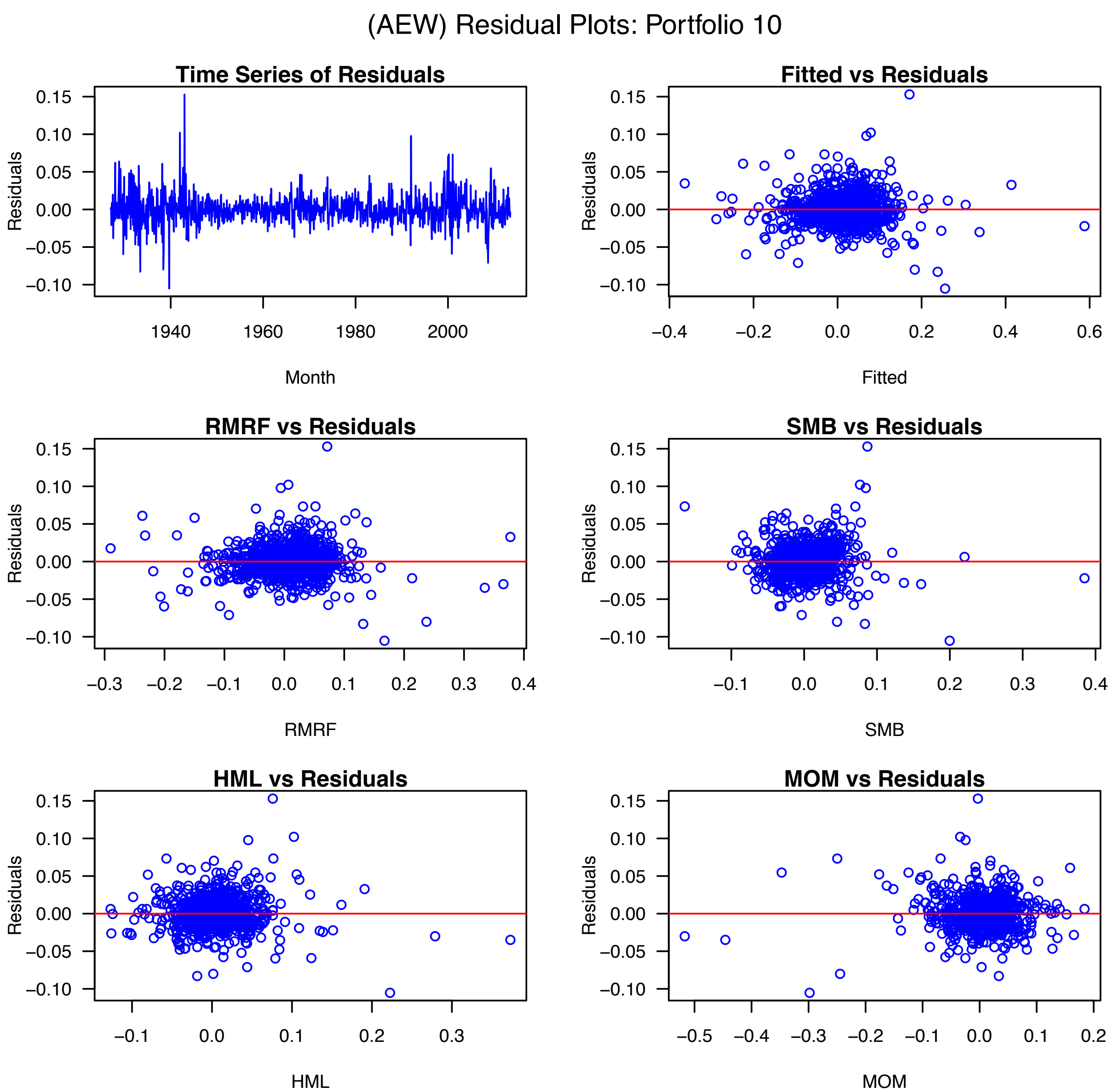
A.17 (AEW) Portfolio 9



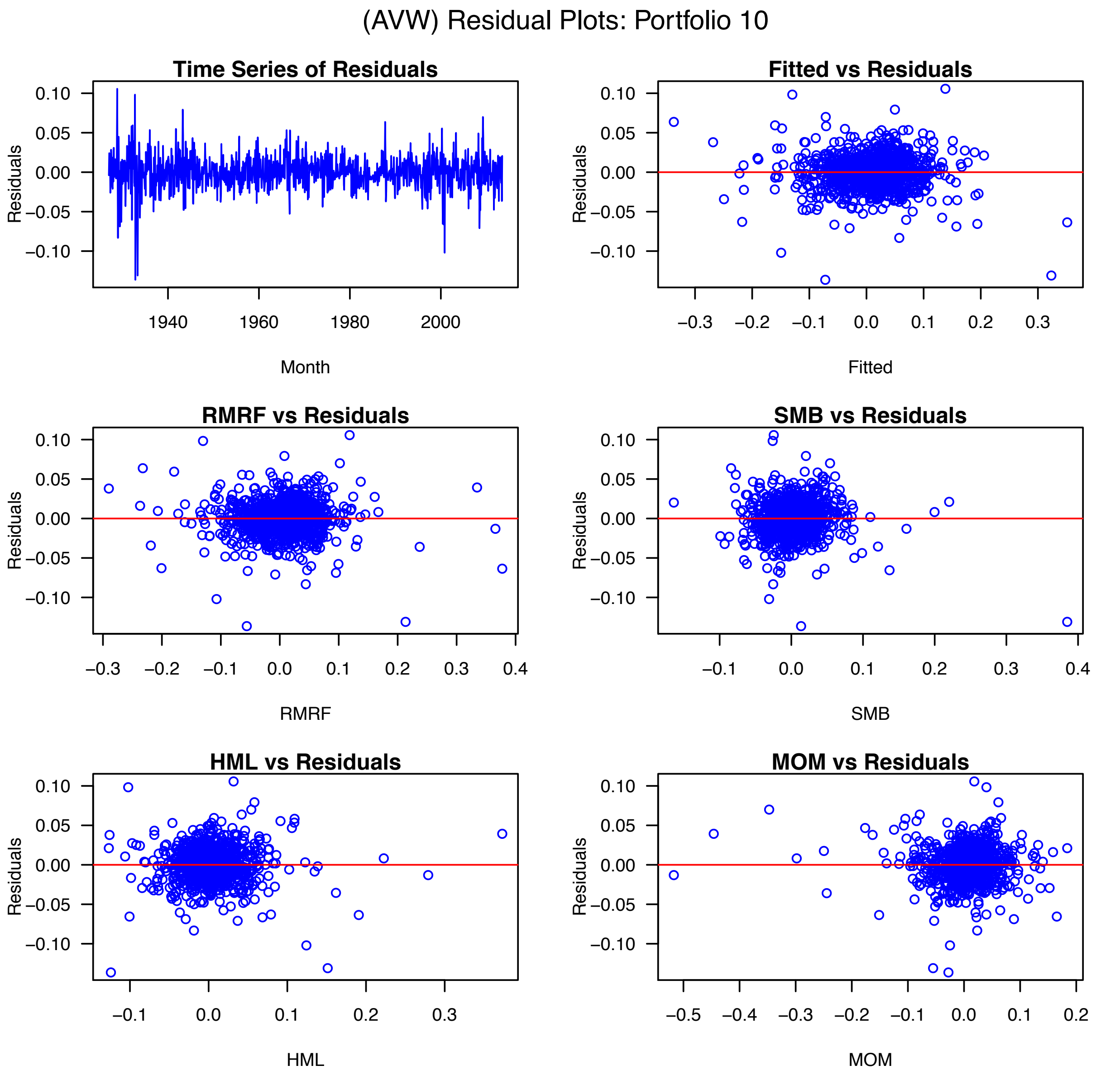
A.18 (AVW) Portfolio 9



A.19 (AEW) Portfolio 10



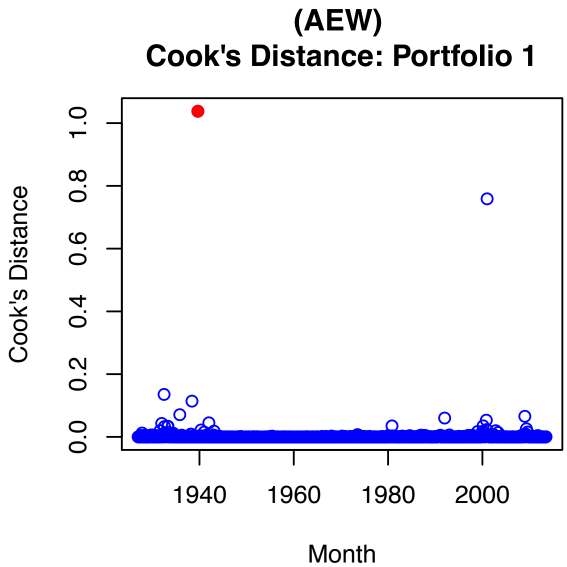
A.20 (AVW) Portfolio 10

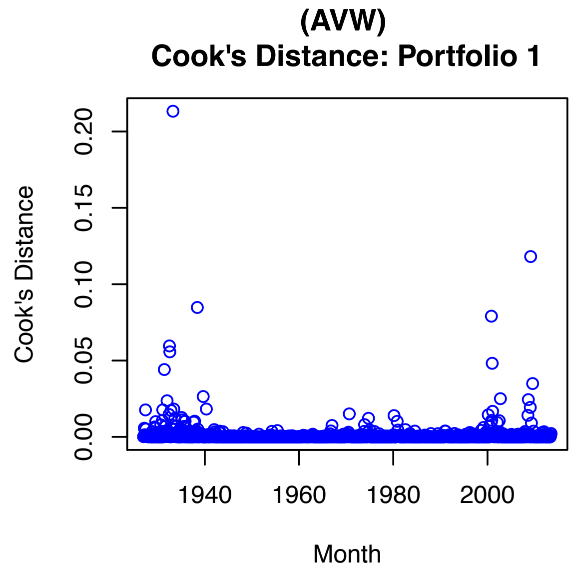


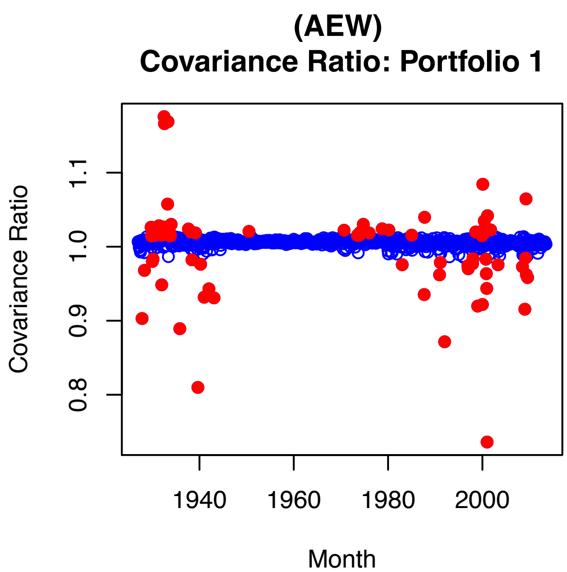
Appendix B

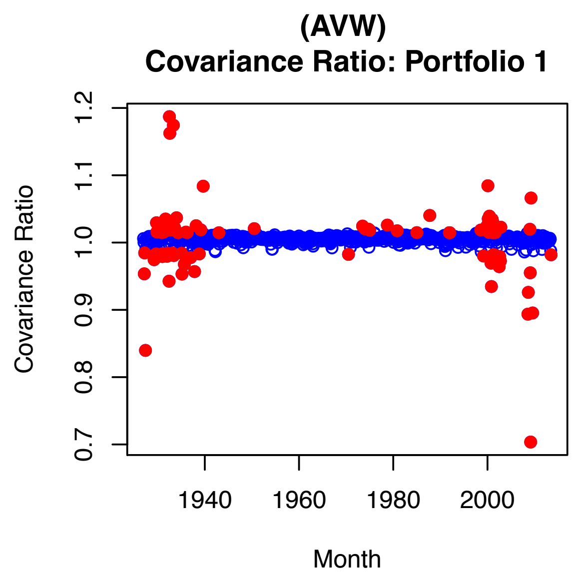
Plot of Cook’s Distance and Covariance ratio

B.1 Portfolio 1

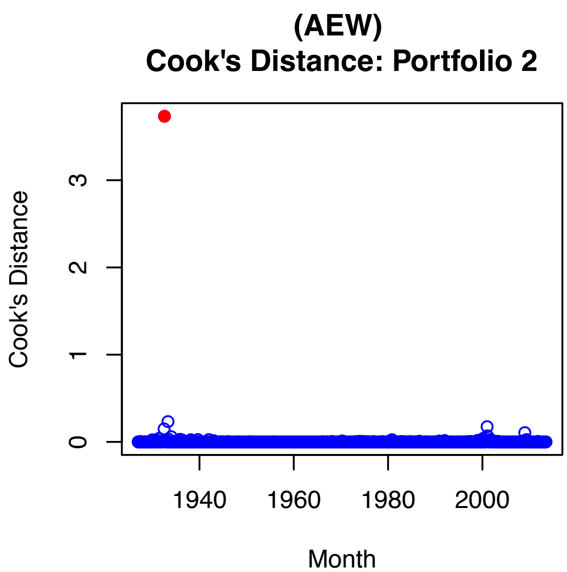


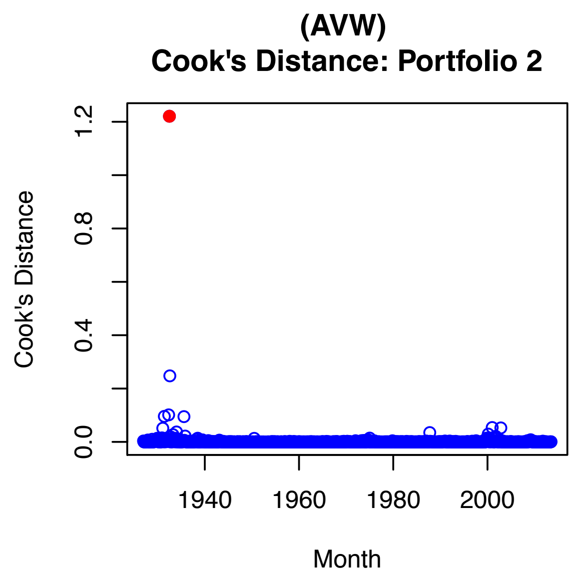


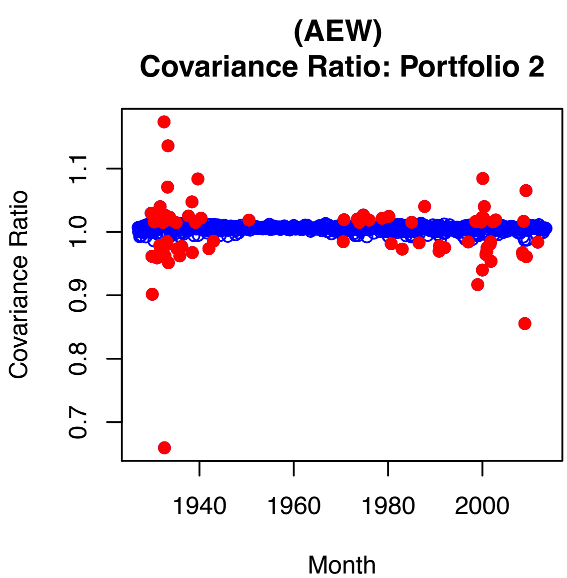


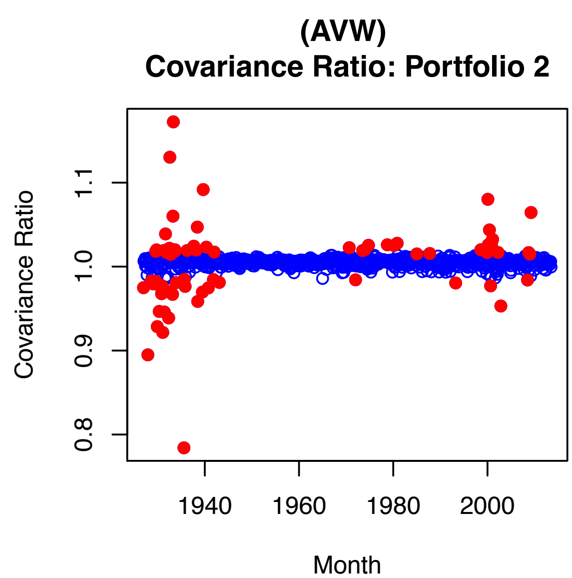


B.2 Portfolio 2

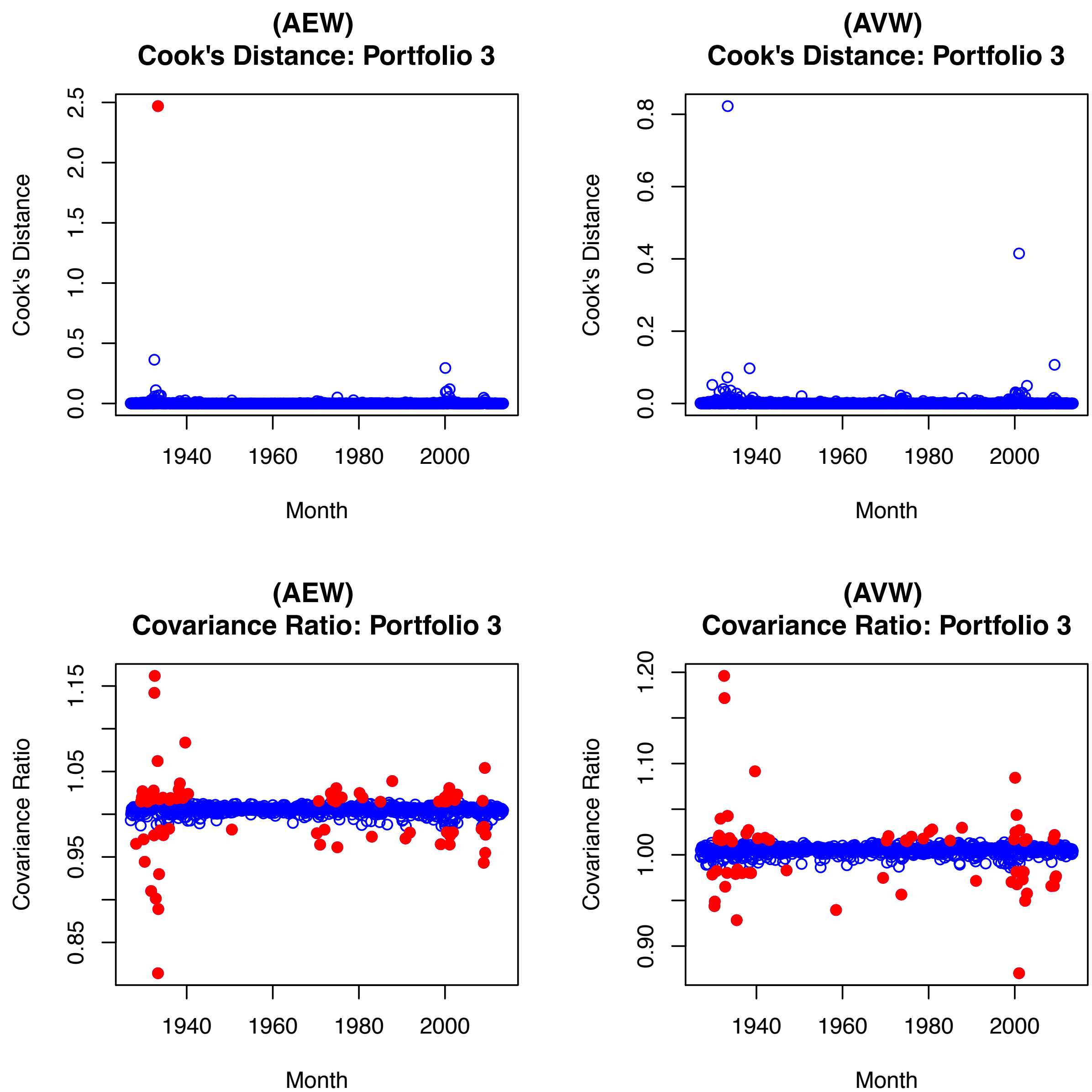




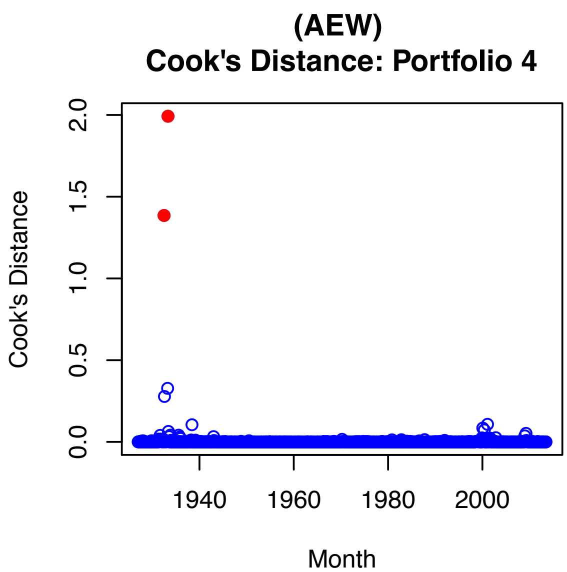


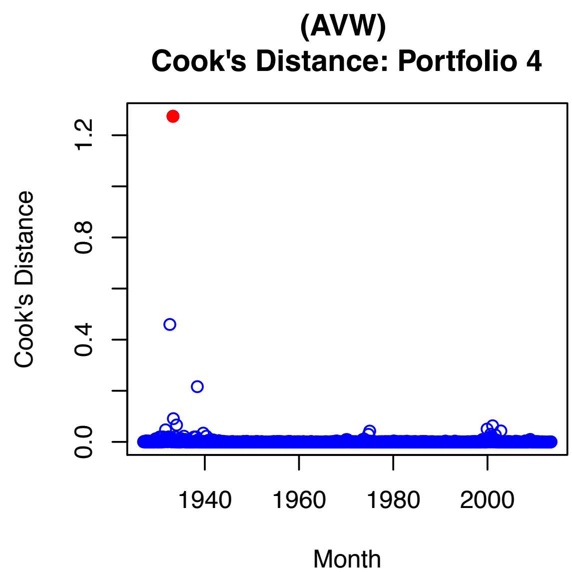


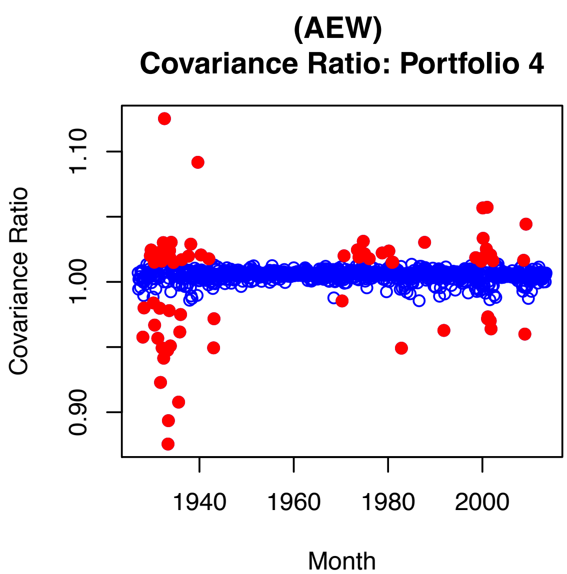
B.3 Portfolio 3

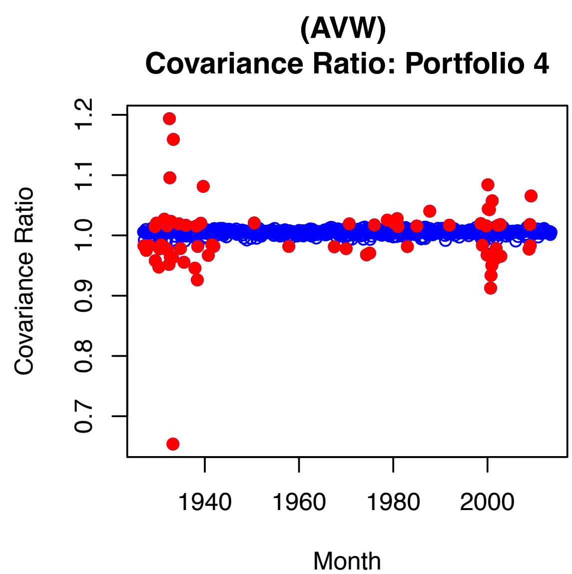


B.4 Portfolio 4

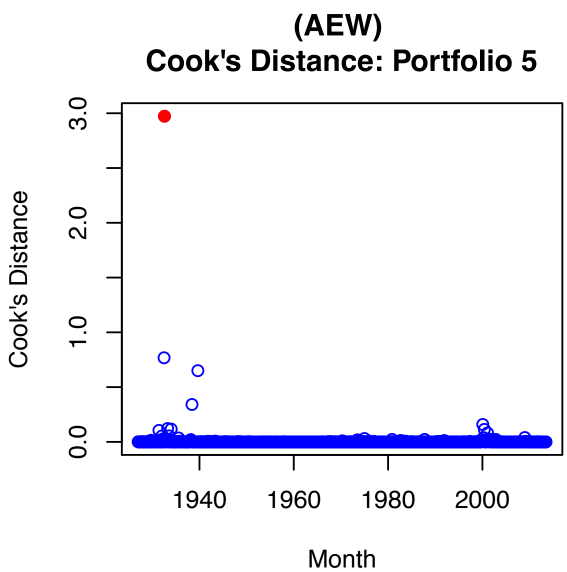


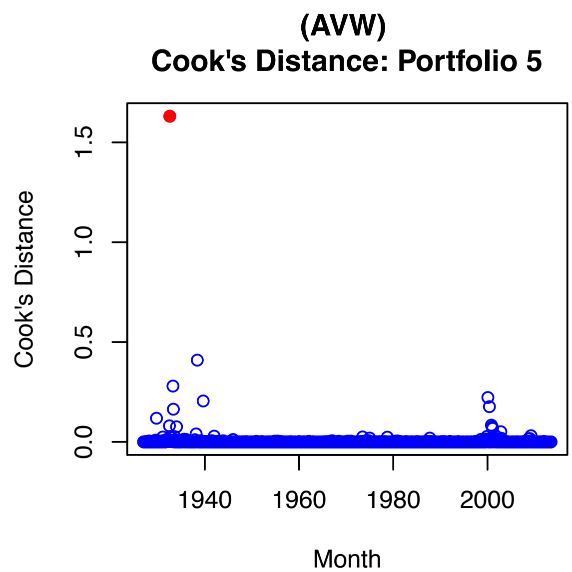


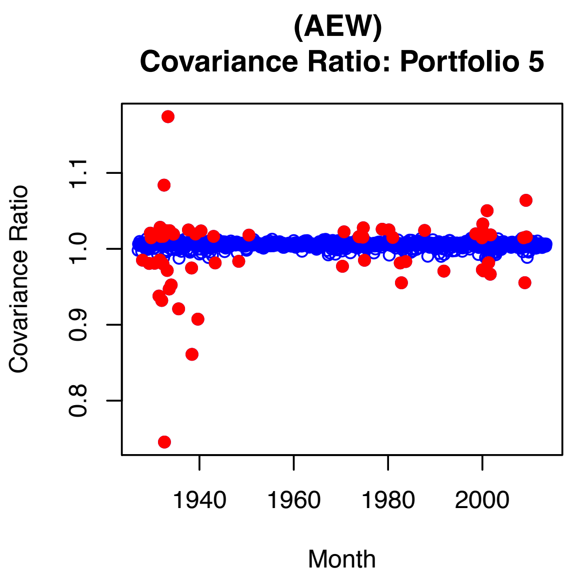


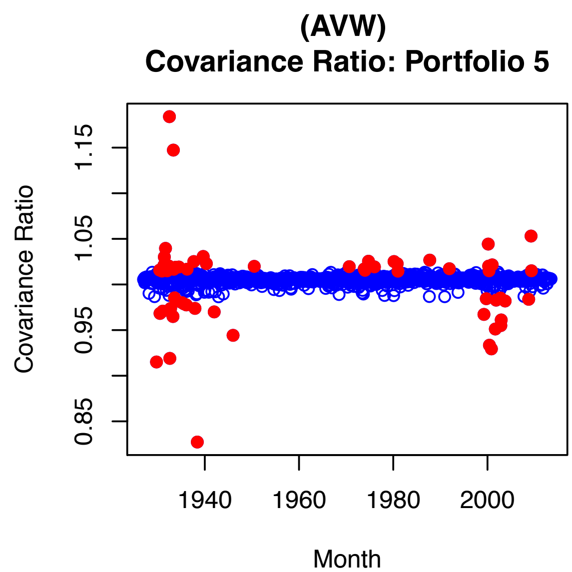


B.5 Portfolio 5

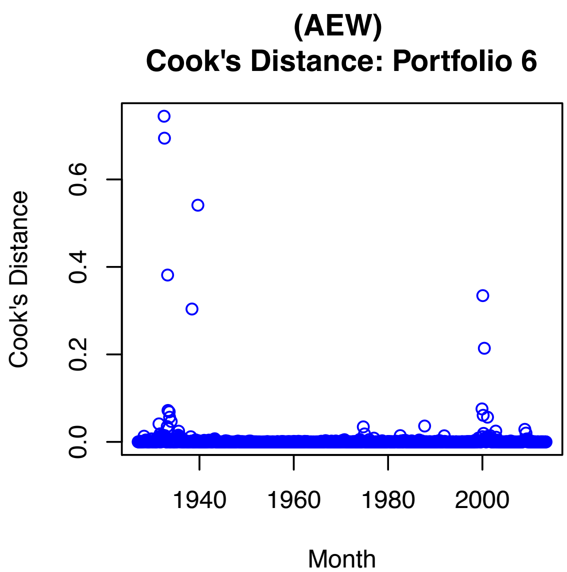


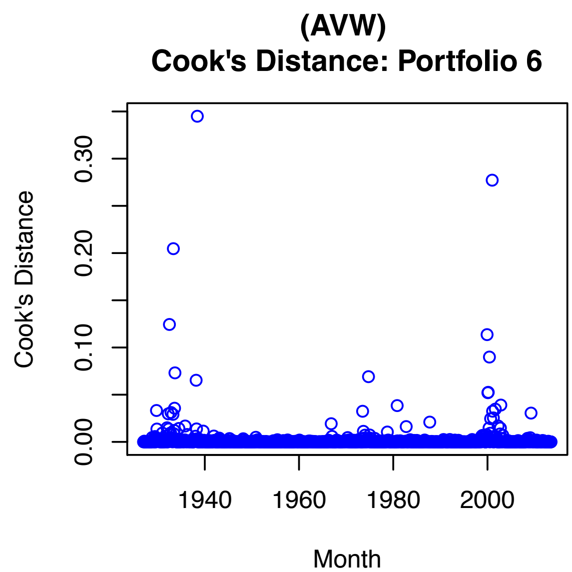


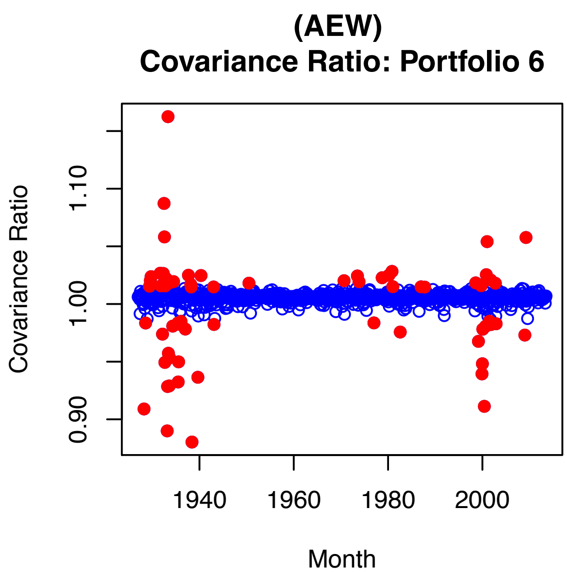


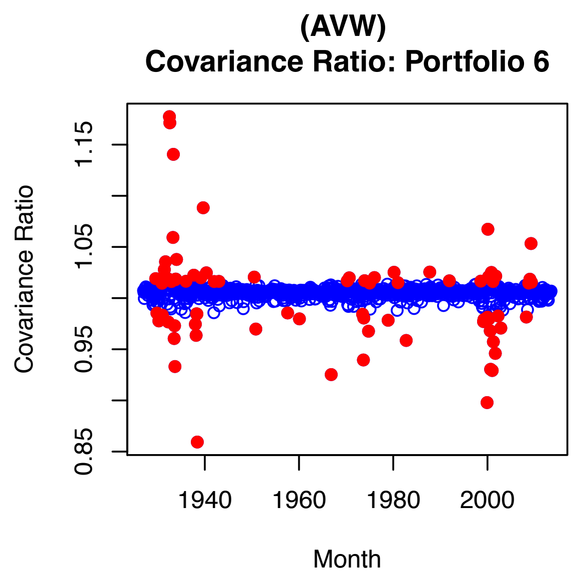


B.6 Portfolio 6

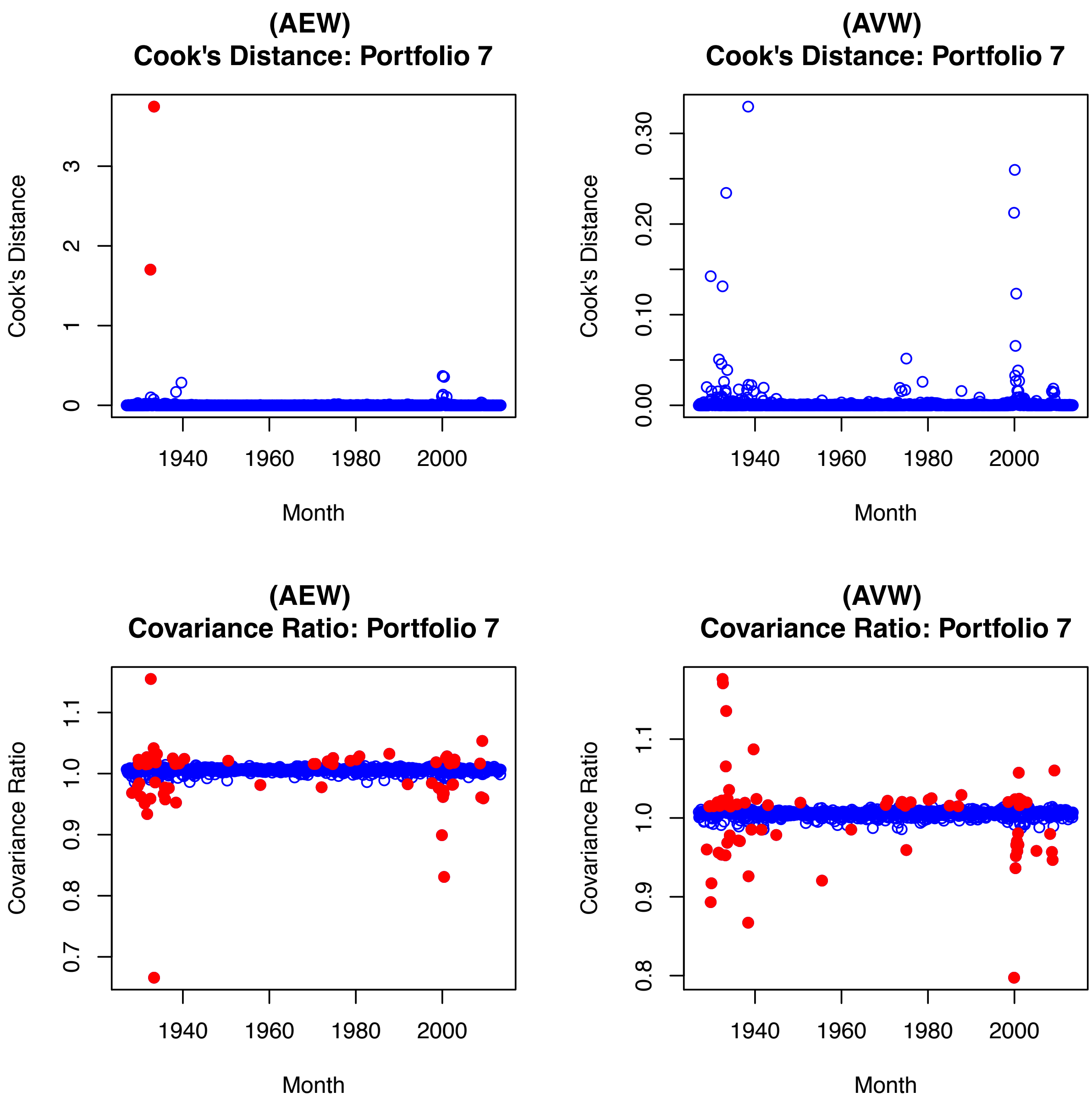




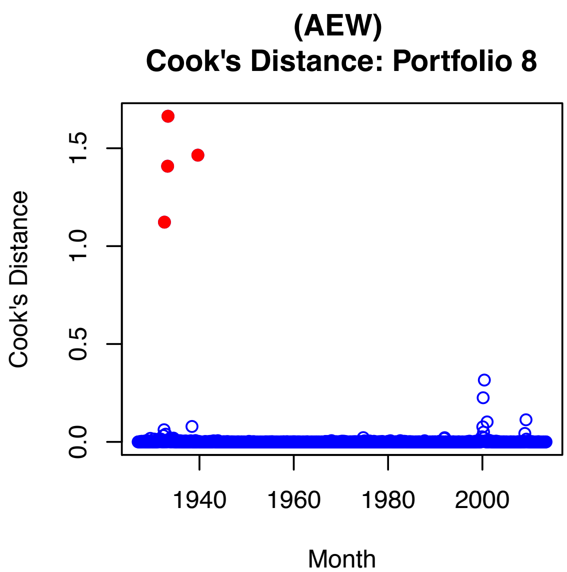


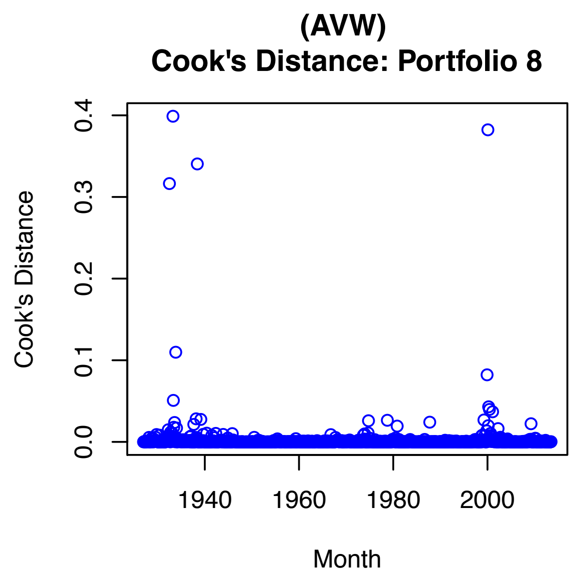


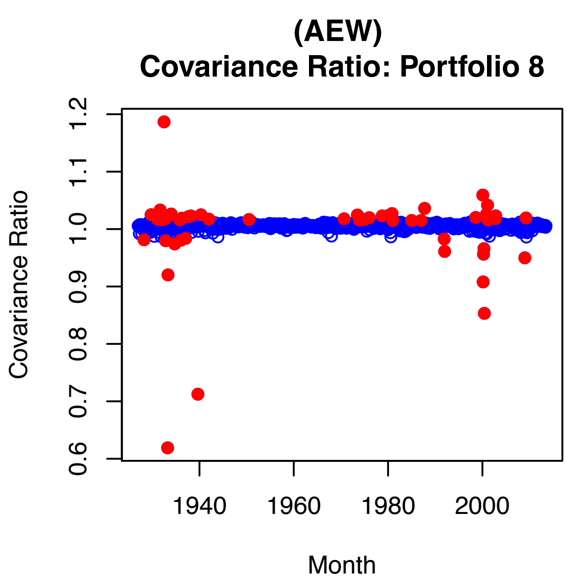
B.7 Portfolio 7

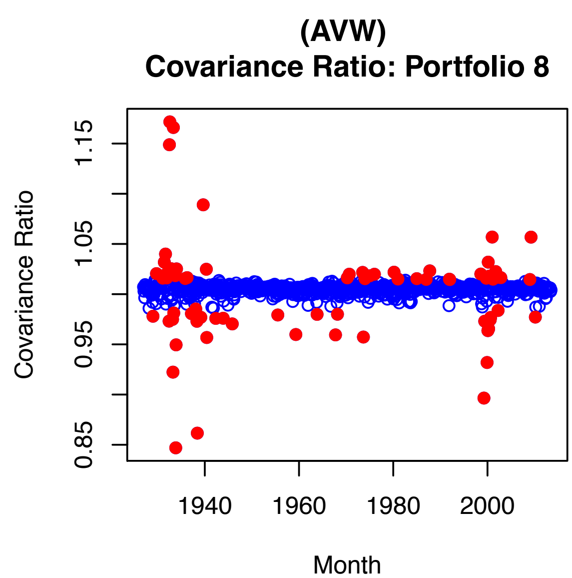


B.8 Portfolio 8

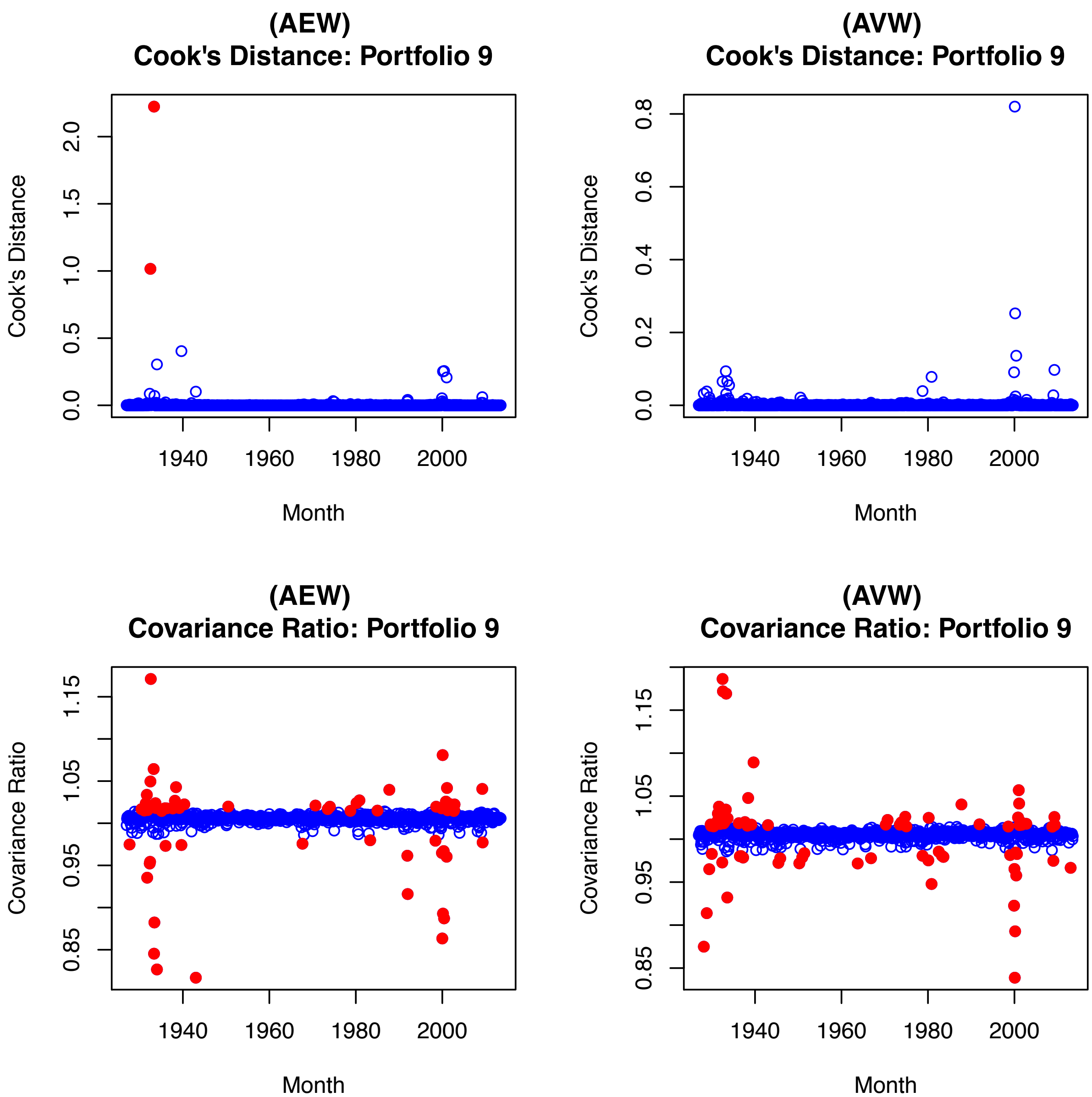




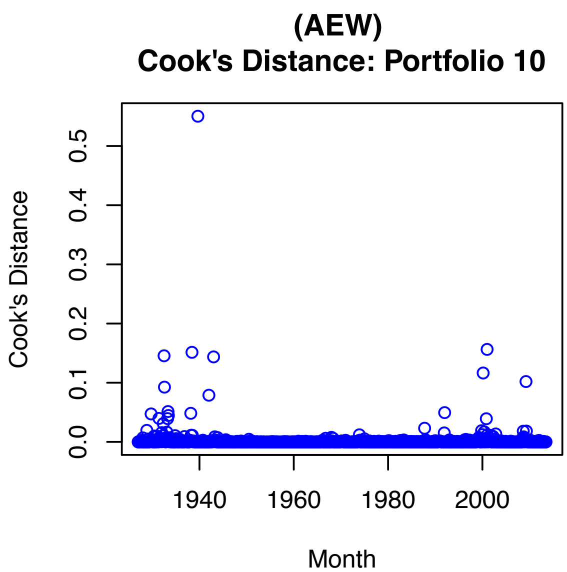


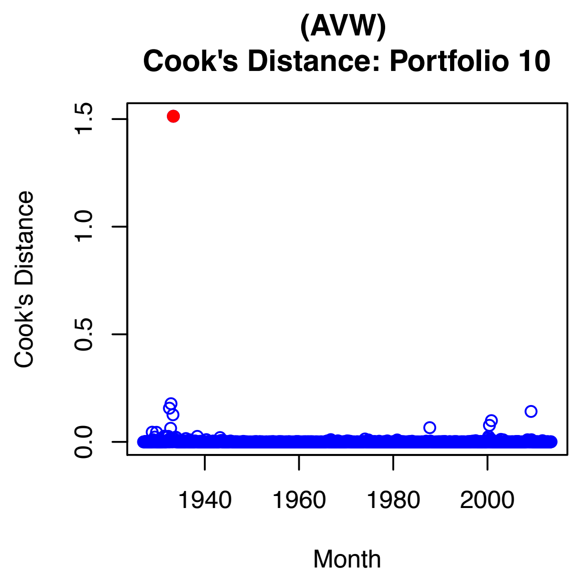


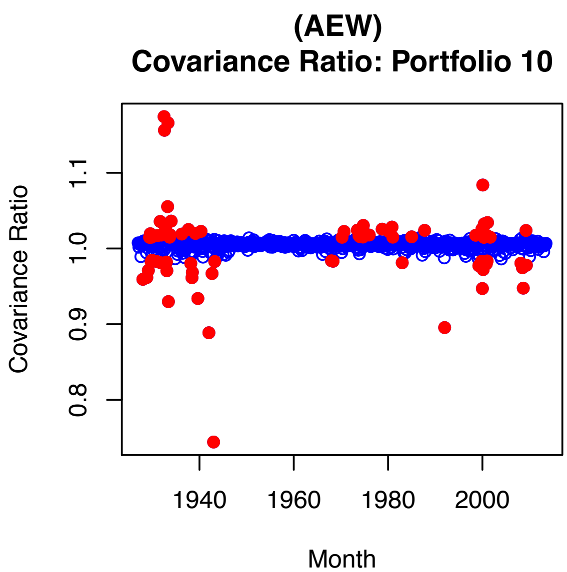
B.9 Portfolio 9

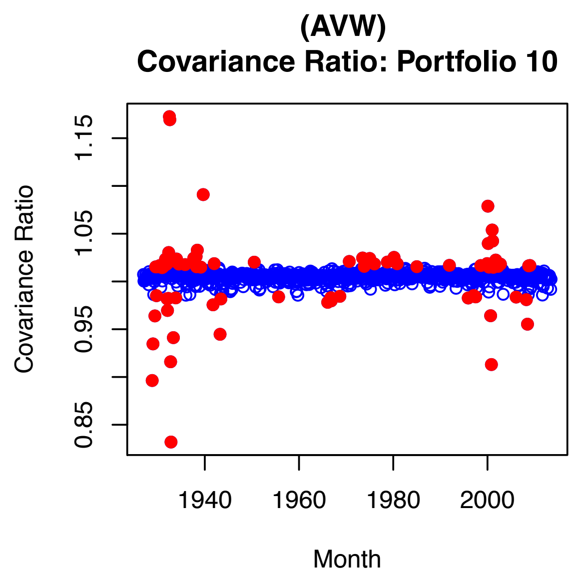


B.10 Portfolio 10





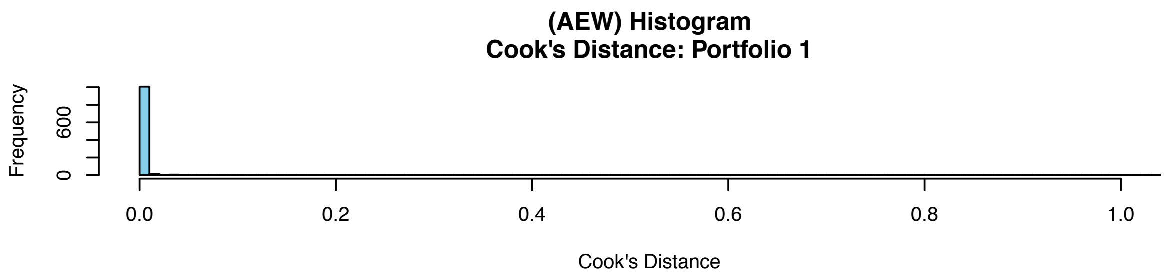


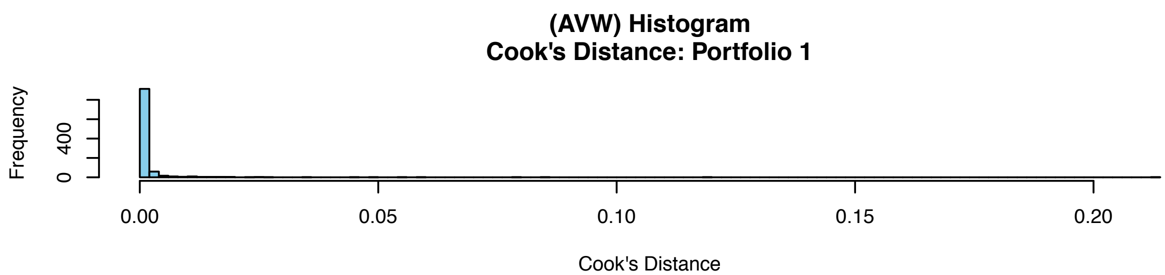


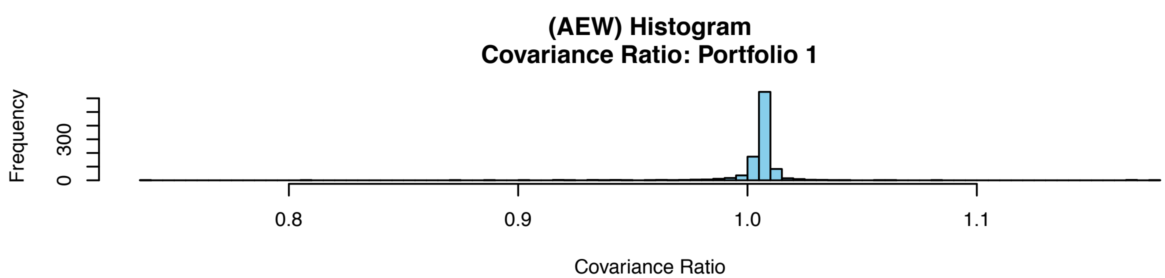
Appendix C

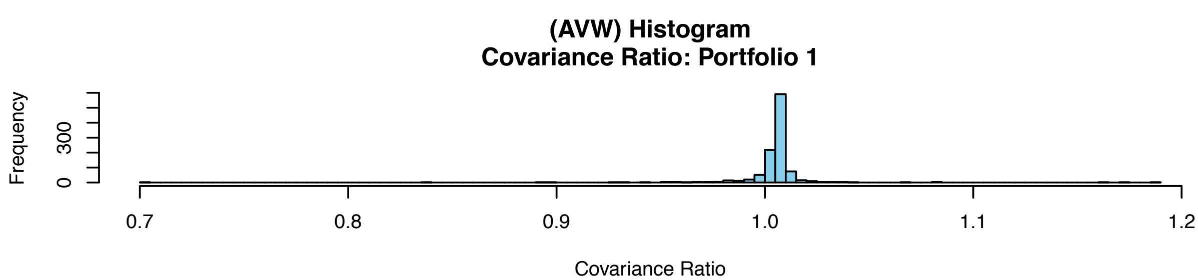
Histogram of Cook's Distance and Covariance ratio

C.1 Portfolio 1

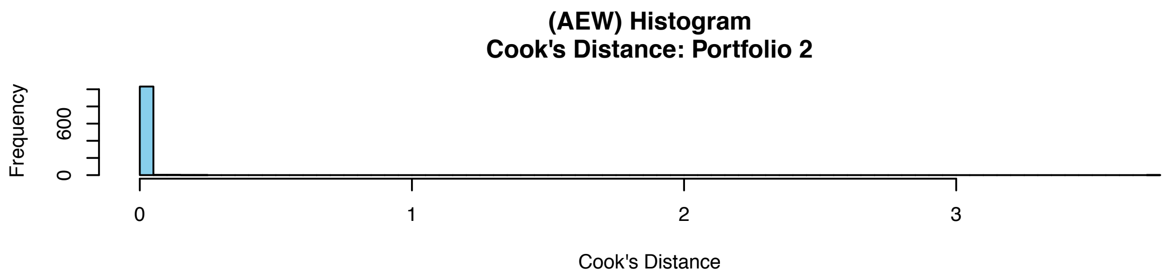


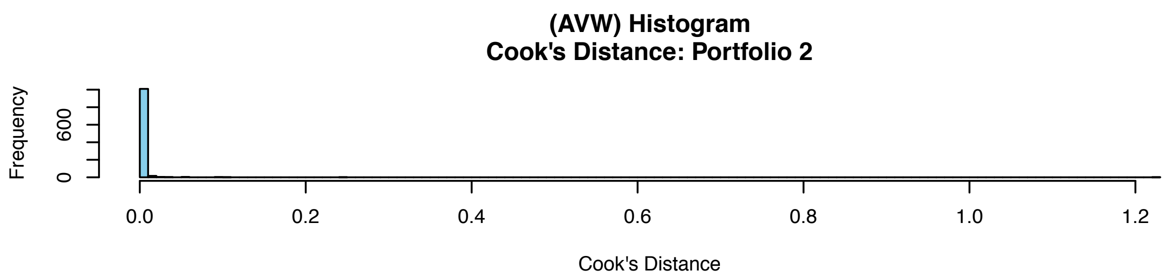


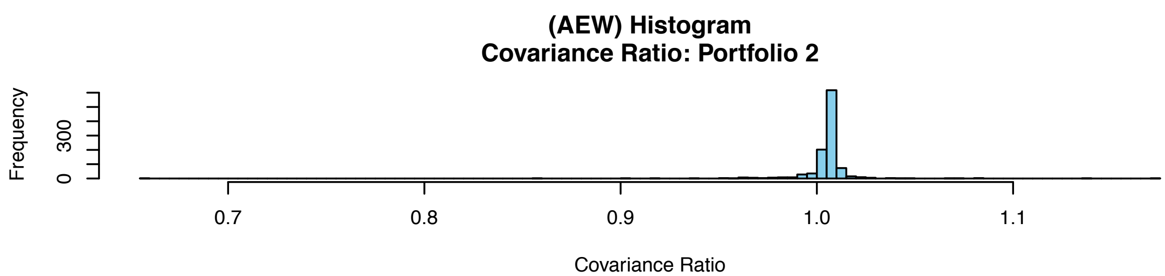


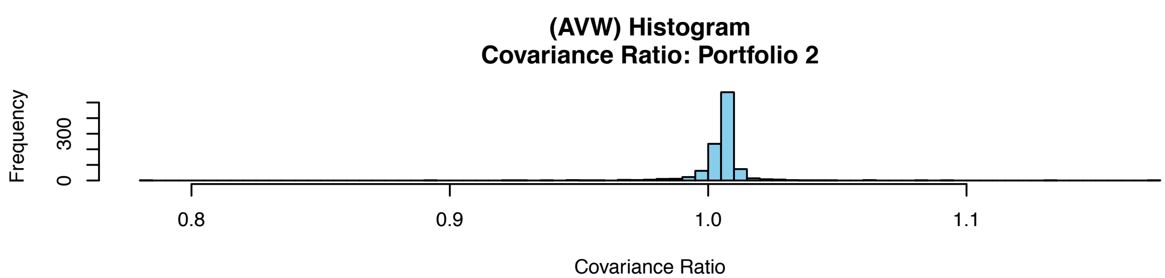


C.2 Portfolio 2

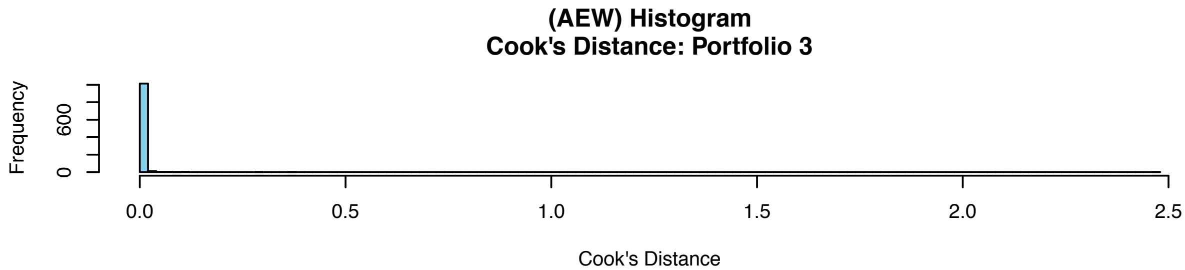


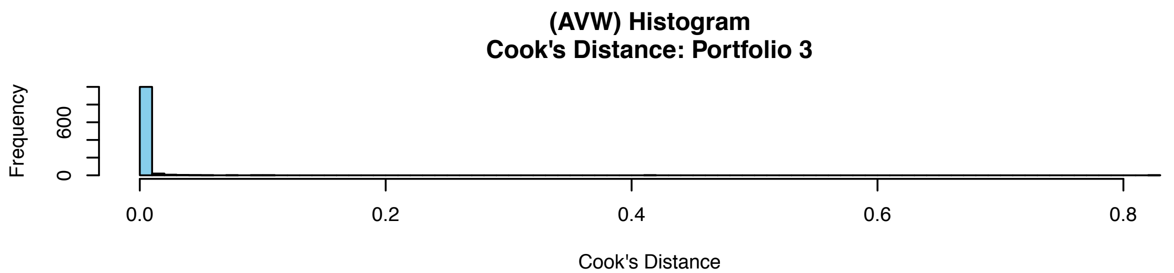


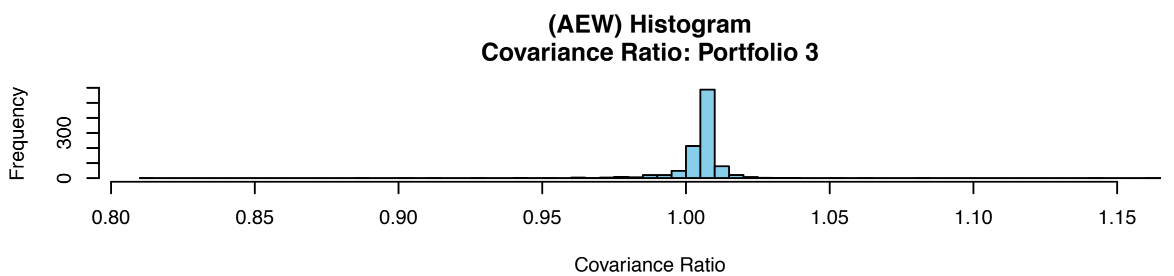


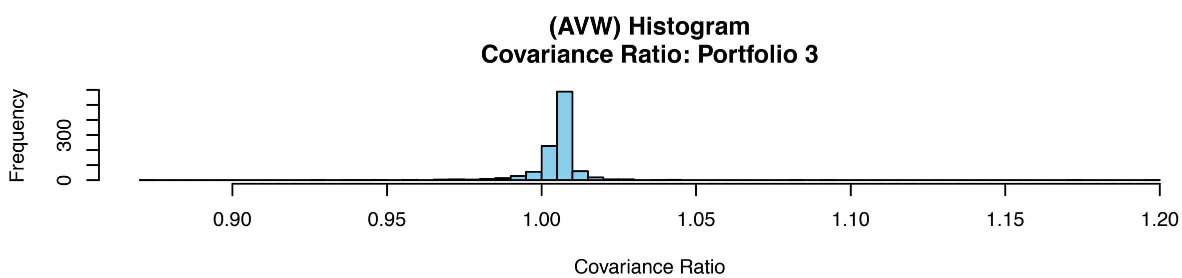


C.3 Portfolio 3

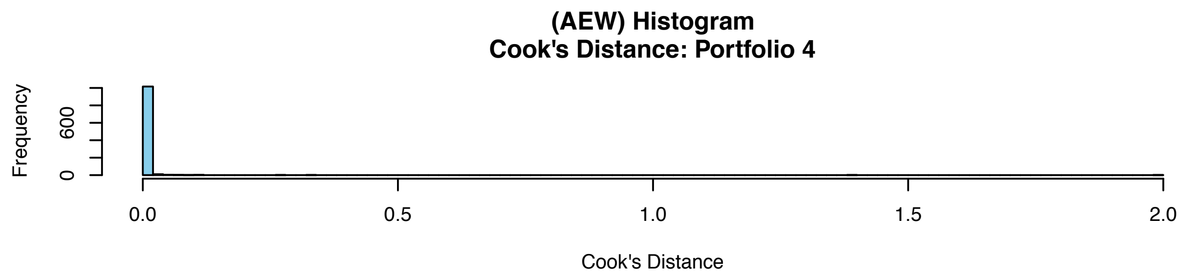


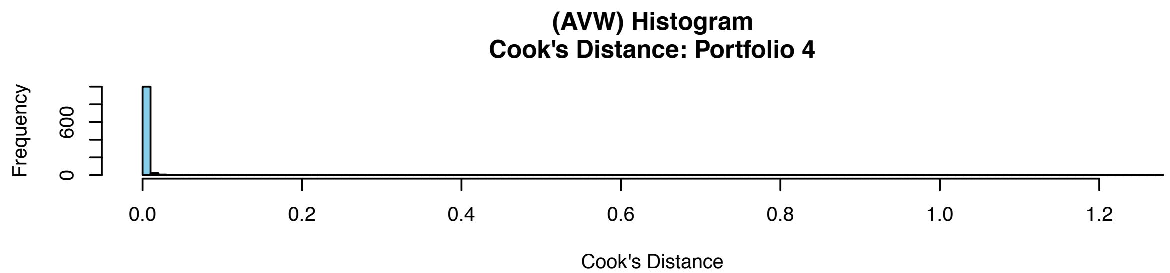


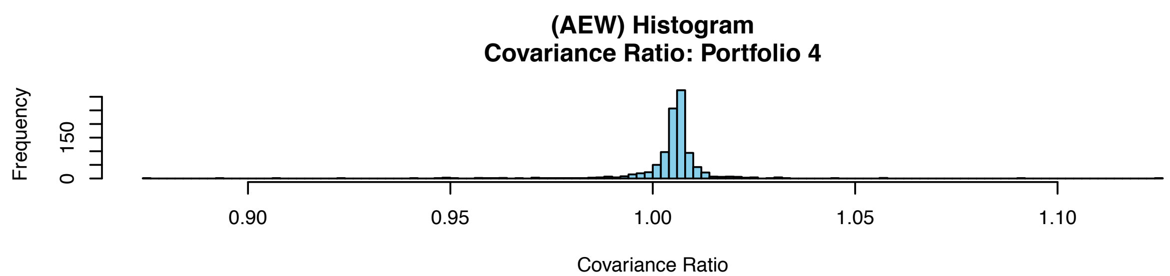


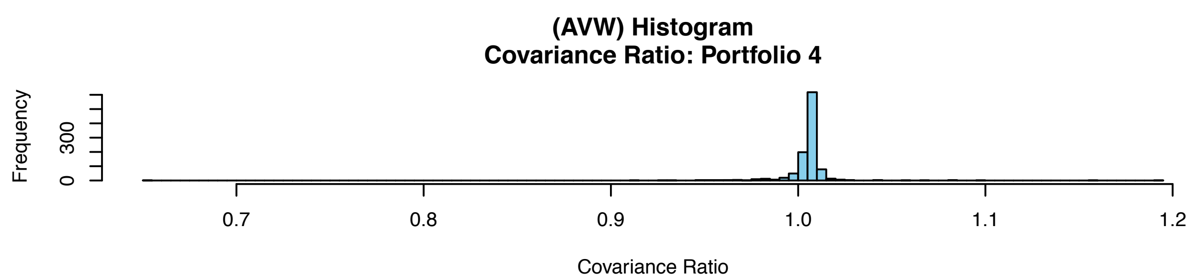


C.4 Portfolio 4

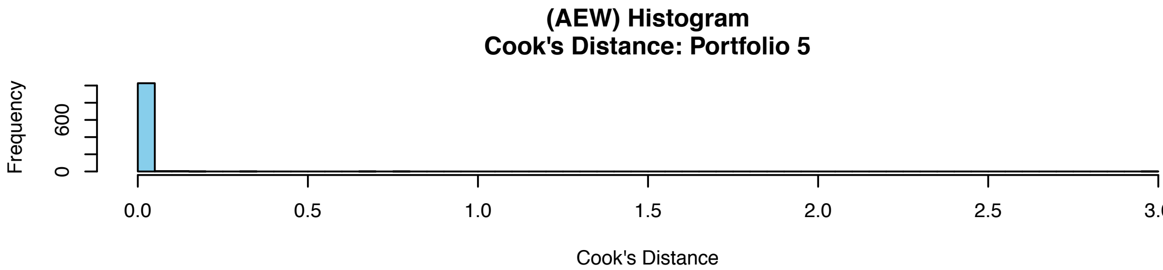


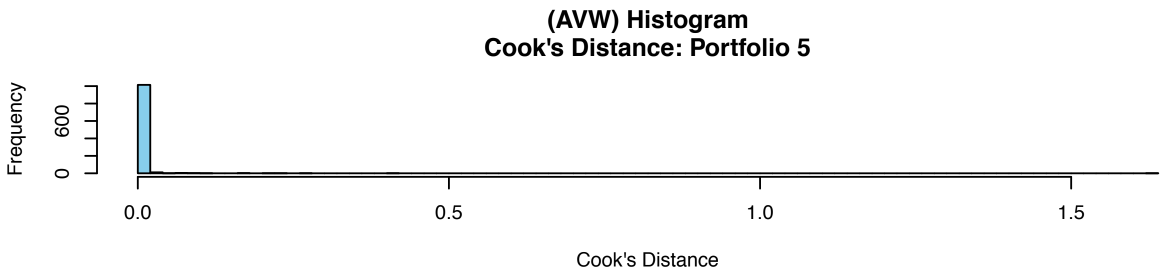


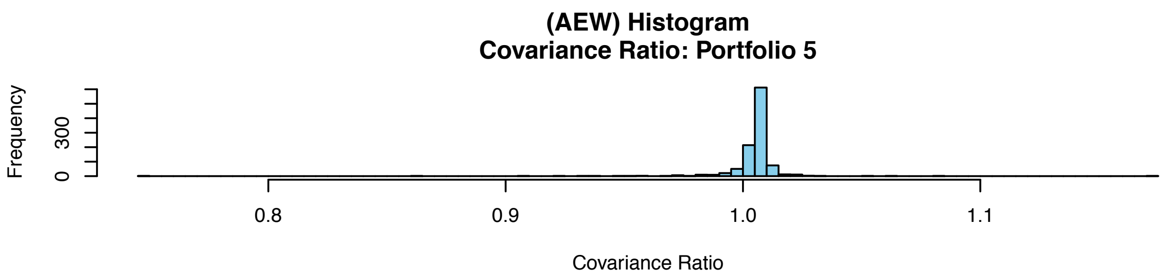


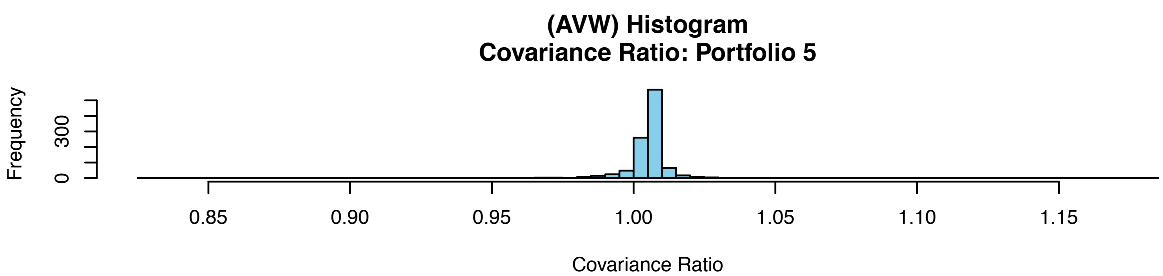


C.5 Portfolio 5

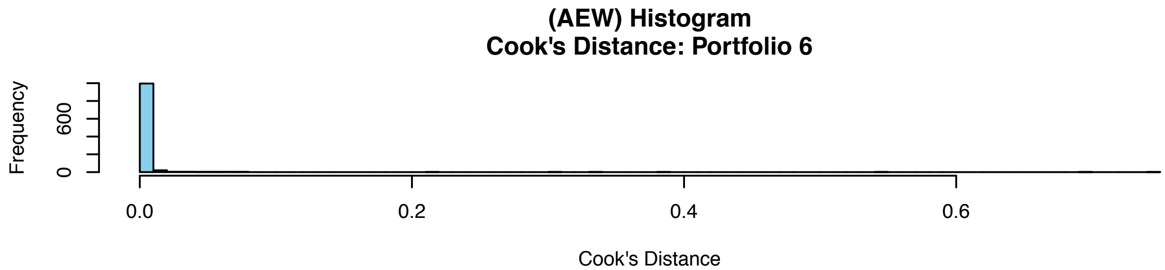


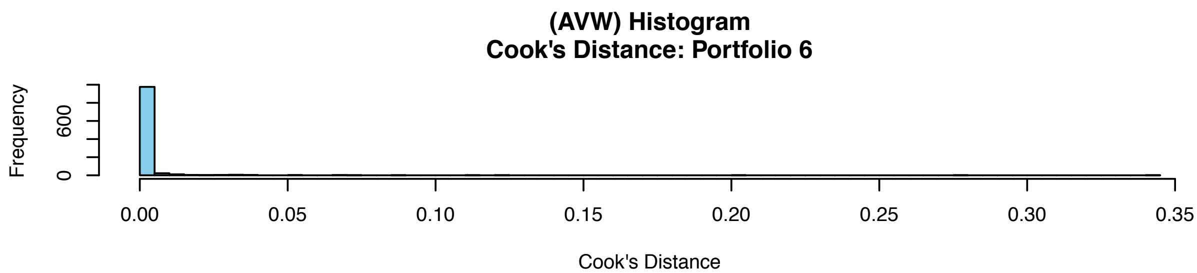


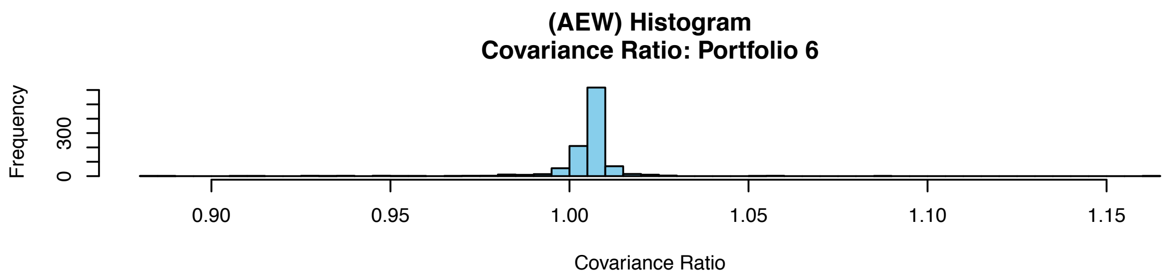


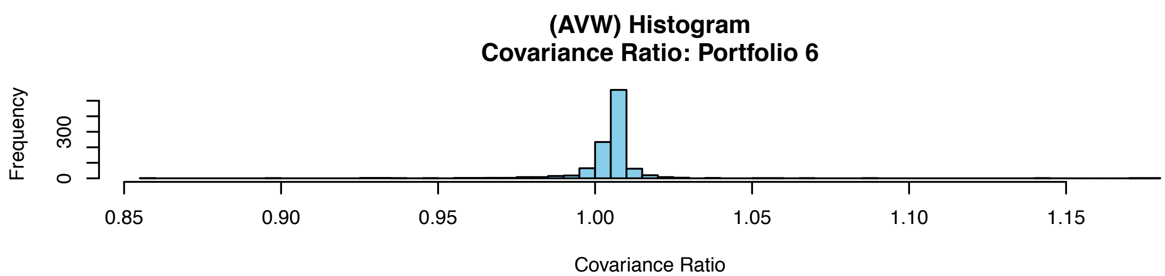


C.6 Portfolio 6

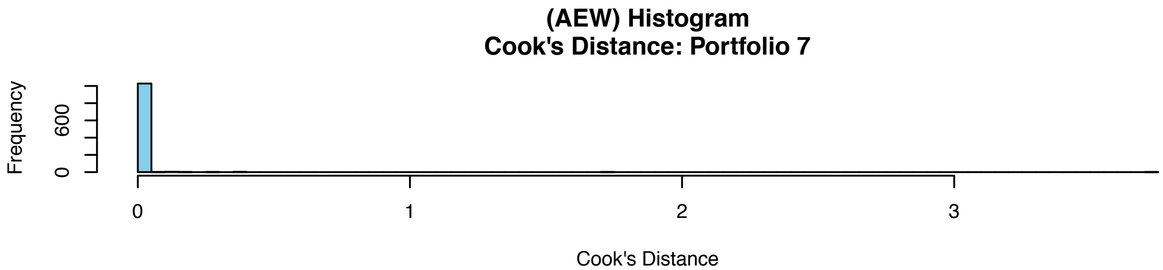


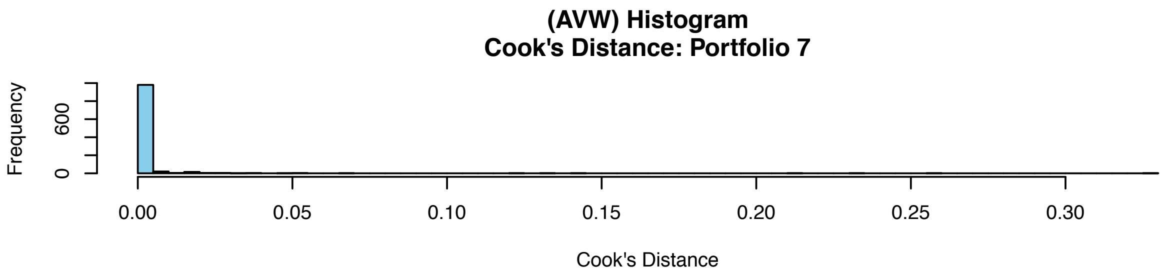


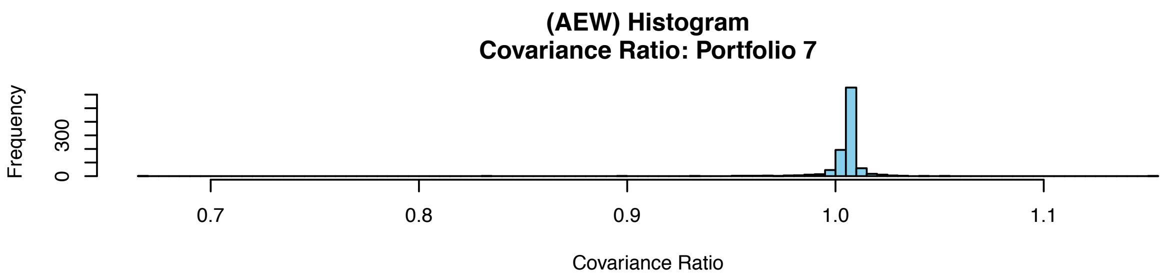


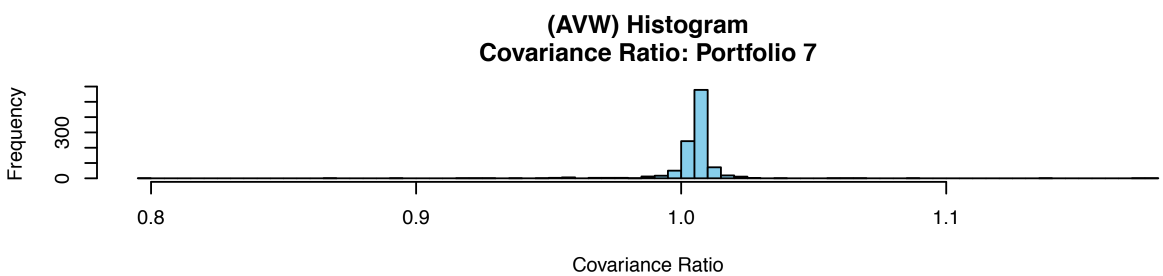


C.7 Portfolio 7

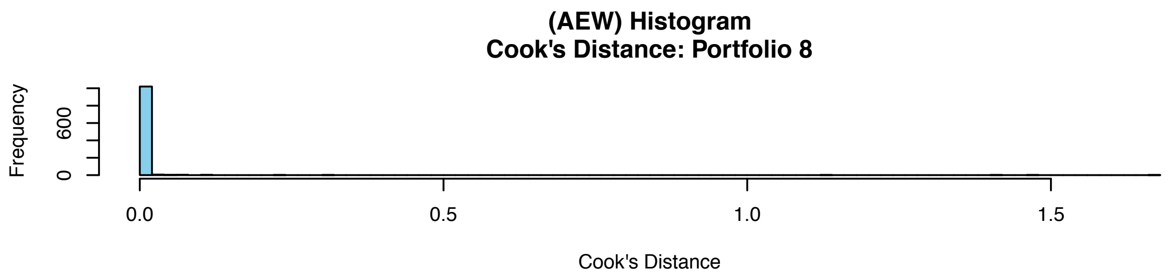


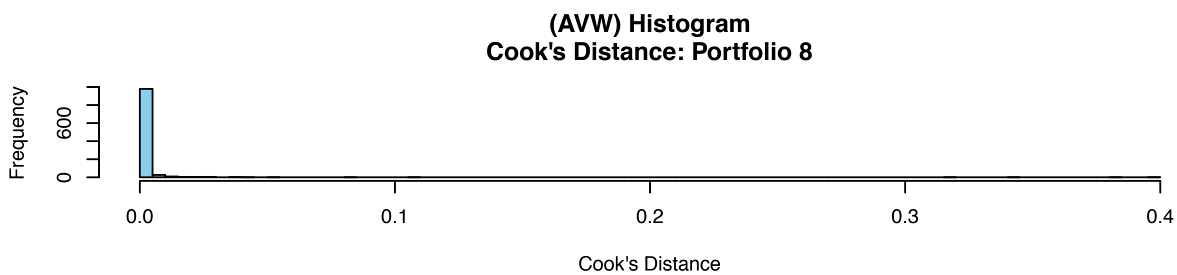


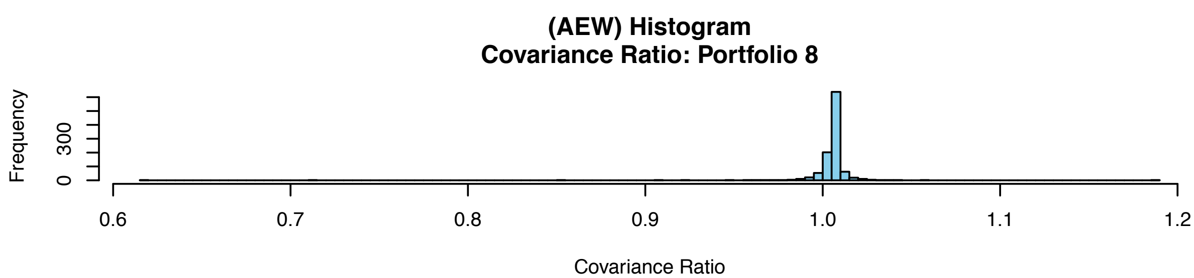


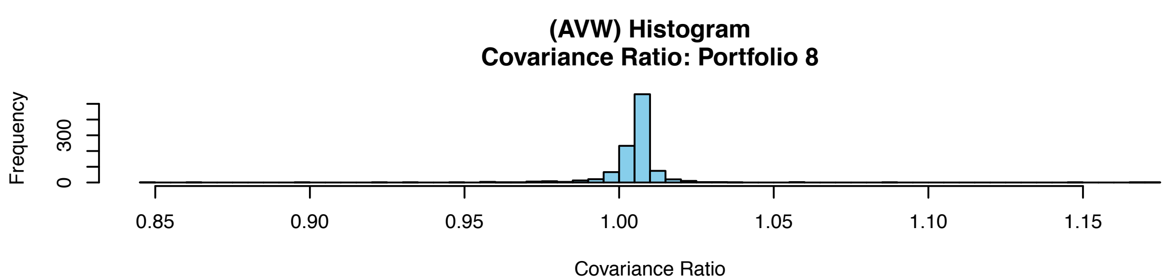


C.8 Portfolio 8

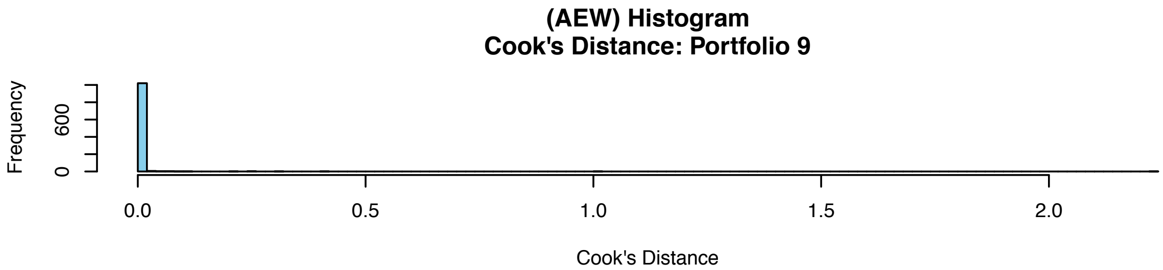


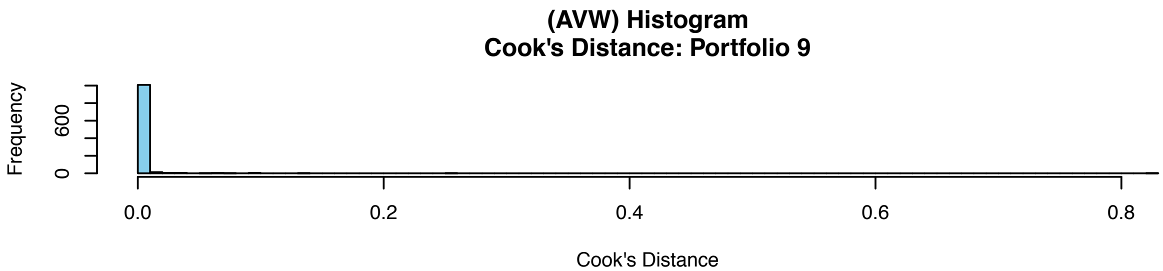


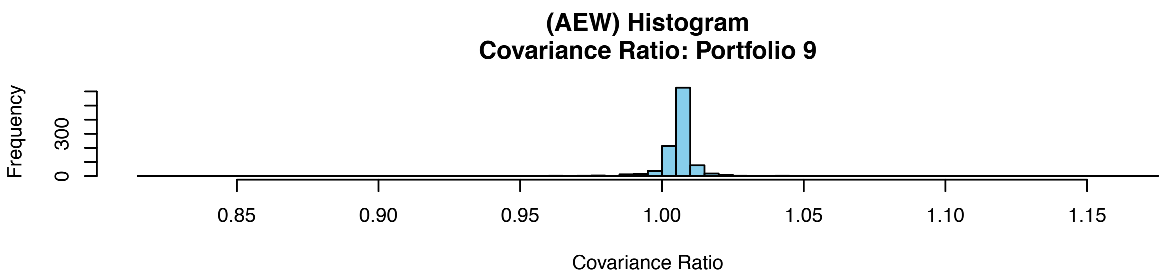


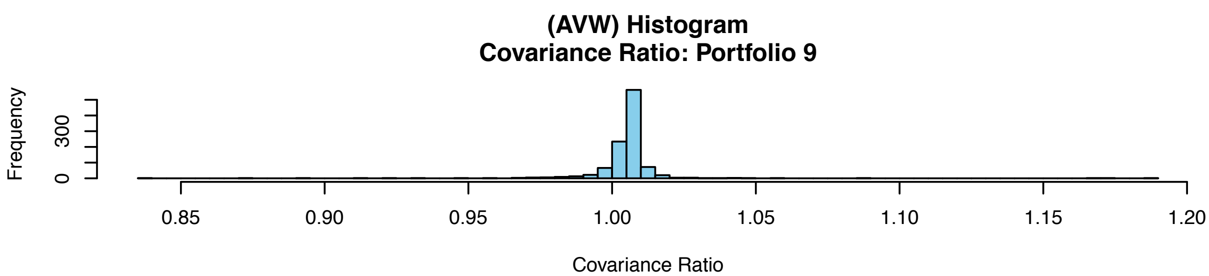


C.9 Portfolio 9

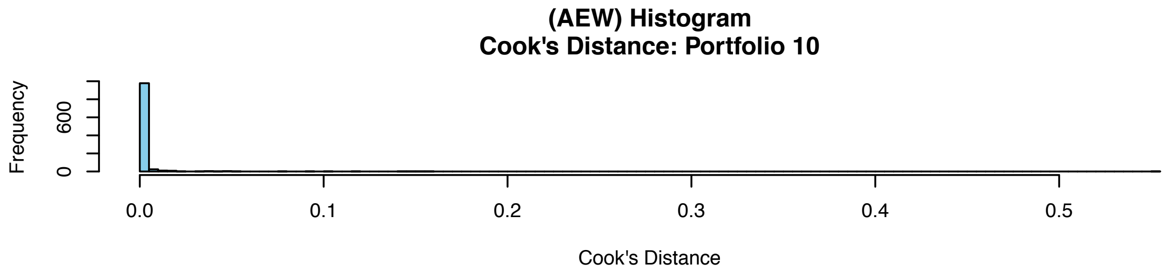


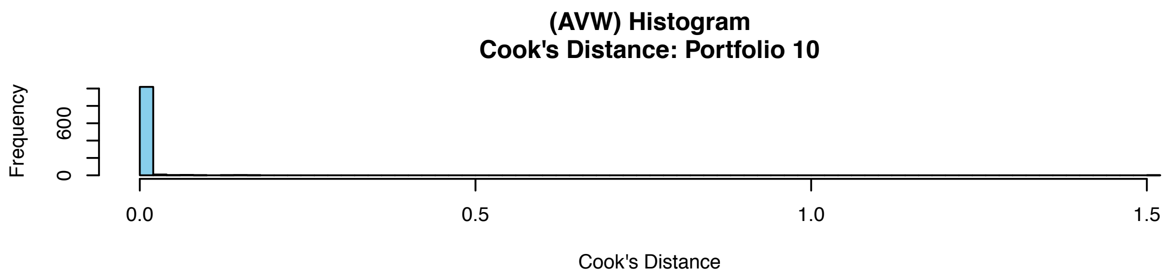


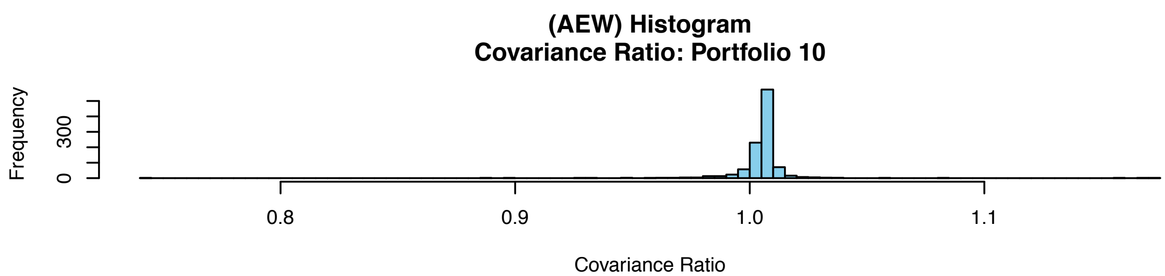


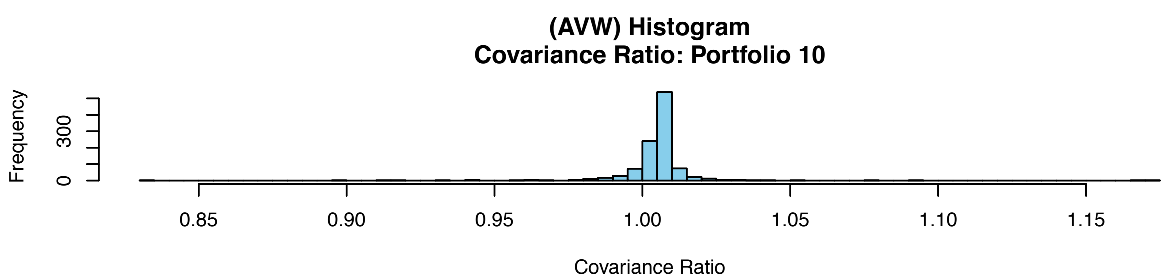


C.10 Portfolio 10









Appendix D

Influence Measures of Influential Observations

D.1 (AEW) Portfolio 1

```
## $`Cook's Distance`
##          Month    Ci
## 153 1939-09-01 1.038
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 889 2001-01-01 0.7361    0.26388    0.01444
## 153 1939-09-01 0.8099    0.19009    0.01444
## 67  1932-07-01 1.1757    0.17570    0.01444
## 77  1933-05-01 1.1689    0.16888    0.01444
## 68  1932-08-01 1.1662    0.16624    0.01444
## 781 1992-01-01 0.8716    0.12843    0.01444
## 107 1935-11-01 0.8892    0.11077    0.01444
## 11  1927-11-01 0.9030    0.09699    0.01444
## 985 2009-01-01 0.9155    0.08446    0.01444
## 878 2000-02-01 1.0844    0.08435    0.01444
## 865 1999-01-01 0.9198    0.08020    0.01444
## 877 2000-01-01 0.9219    0.07810    0.01444
## 194 1943-02-01 0.9309    0.06913    0.01444
## 169 1941-01-01 0.9318    0.06823    0.01444
## 729 1987-09-01 0.9354    0.06460    0.01444
## 988 2009-04-01 1.0646    0.06457    0.01444
## 76  1933-04-01 1.0576    0.05756    0.01444
## 181 1942-01-01 0.9430    0.05696    0.01444
## 888 2000-12-01 0.9436    0.05640    0.01444
## 61  1932-01-01 0.9485    0.05154    0.01444
## 890 2001-02-01 1.0419    0.04188    0.01444
## 992 2009-08-01 0.9583    0.04167    0.01444
## 730 1987-10-01 1.0397    0.03972    0.01444
## 768 1990-12-01 0.9620    0.03801    0.01444
## 989 2009-05-01 0.9622    0.03776    0.01444
## 887 2000-11-01 0.9636    0.03645    0.01444
## 882 2000-06-01 1.0349    0.03491    0.01444
## 17  1928-05-01 0.9680    0.03198    0.01444
## 574 1974-10-01 1.0302    0.03017    0.01444
## 85  1934-01-01 1.0302    0.03016    0.01444
## 841 1997-01-01 0.9702    0.02980    0.01444
## 54  1931-06-01 1.0283    0.02829    0.01444
## 979 2008-07-01 0.9730    0.02702    0.01444
```

```
## 65  1932-05-01 1.0266    0.02664    0.01444
## 34  1929-10-01 1.0264    0.02637    0.01444
## 840 1996-12-01 0.9742    0.02577    0.01444
## 57  1931-09-01 1.0256    0.02561    0.01444
## 917 2003-05-01 0.9756    0.02441    0.01444
## 673 1983-01-01 0.9757    0.02431    0.01444
## 622 1978-10-01 1.0241    0.02413    0.01444
## 129 1937-09-01 1.0239    0.02390    0.01444
## 160 1940-04-01 0.9763    0.02371    0.01444
## 852 1997-12-01 0.9770    0.02302    0.01444
## 898 2001-10-01 1.0227    0.02266    0.01444
## 577 1975-01-01 1.0226    0.02262    0.01444
## 639 1980-03-01 1.0225    0.02248    0.01444
## 525 1970-09-01 1.0222    0.02222    0.01444
## 879 2000-03-01 1.0222    0.02221    0.01444
## 770 1991-02-01 0.9786    0.02136    0.01444
## 283 1950-07-01 1.0207    0.02069    0.01444
## 64  1932-04-01 1.0206    0.02061    0.01444
## 135 1938-03-01 1.0199    0.01994    0.01444
## 860 1998-08-01 1.0199    0.01992    0.01444
## 37  1930-01-01 0.9801    0.01992    0.01444
## 53  1931-05-01 1.0191    0.01915    0.01444
## 565 1974-01-01 1.0189    0.01886    0.01444
## 147 1939-03-01 1.0186    0.01860    0.01444
## 82  1933-10-01 1.0185    0.01854    0.01444
## 589 1976-01-01 1.0185    0.01852    0.01444
## 138 1938-06-01 0.9823    0.01774    0.01444
## 880 2000-04-01 1.0174    0.01740    0.01444
## 71  1932-11-01 1.0169    0.01688    0.01444
## 886 2000-10-01 0.9832    0.01684    0.01444
## 39  1930-03-01 0.9833    0.01670    0.01444
## 42  1930-06-01 1.0165    0.01651    0.01444
## 853 1998-01-01 0.9839    0.01612    0.01444
## 50  1931-02-01 1.0160    0.01598    0.01444
## 697 1985-01-01 1.0156    0.01562    0.01444
## 564 1973-12-01 1.0155    0.01552    0.01444
## 60  1931-12-01 1.0155    0.01546    0.01444
## 559 1973-07-01 1.0154    0.01535    0.01444
## 987 2009-03-01 0.9848    0.01521    0.01444
## 876 1999-12-01 1.0149    0.01491    0.01444
## 81  1933-09-01 1.0149    0.01488    0.01444
```

```
## 83  1933-11-01 1.0147    0.01469    0.01444
## 35  1929-11-01 1.0145    0.01454    0.01444
```

D.2 (AVW) Portfolio 1

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##           Month   CVRi abs.CVRi_1 calpt.crit
## 987  2009-03-01 0.7036    0.29640    0.01444
## 67   1932-07-01 1.1871    0.18711    0.01444
## 77   1933-05-01 1.1744    0.17439    0.01444
## 68   1932-08-01 1.1624    0.16239    0.01444
## 6    1927-06-01 0.8398    0.16023    0.01444
## 980  2008-08-01 0.8936    0.10639    0.01444
## 992  2009-08-01 0.8954    0.10461    0.01444
## 878  2000-02-01 1.0844    0.08444    0.01444
## 153  1939-09-01 1.0838    0.08378    0.01444
## 981  2008-09-01 0.9260    0.07400    0.01444
## 988  2009-04-01 1.0662    0.06617    0.01444
## 887  2000-11-01 0.9347    0.06533    0.01444
## 66   1932-06-01 0.9426    0.05742    0.01444
## 99   1935-03-01 0.9532    0.04681    0.01444
## 3    1927-03-01 0.9536    0.04644    0.01444
## 986  2009-02-01 0.9551    0.04493    0.01444
## 131  1937-11-01 0.9569    0.04312    0.01444
## 730  1987-10-01 1.0403    0.04028    0.01444
## 882  2000-06-01 1.0393    0.03929    0.01444
## 85   1934-01-01 1.0368    0.03684    0.01444
## 907  2002-07-01 0.9642    0.03579    0.01444
## 879  2000-03-01 1.0353    0.03531    0.01444
## 57   1931-09-01 1.0350    0.03496    0.01444
## 889  2001-01-01 1.0343    0.03430    0.01444
## 105  1935-09-01 0.9677    0.03233    0.01444
## 902  2002-02-01 0.9678    0.03219    0.01444
## 890  2001-02-01 1.0311    0.03114    0.01444
## 886  2000-10-01 0.9694    0.03057    0.01444
## 34   1929-10-01 1.0294    0.02944    0.01444
## 65   1932-05-01 1.0283    0.02826    0.01444
## 910  2002-10-01 0.9725    0.02745    0.01444
## 622  1978-10-01 1.0259    0.02594    0.01444
## 28   1929-04-01 0.9745    0.02545    0.01444
## 135  1938-03-01 1.0250    0.02500    0.01444
```

```
## 876  1999-12-01 1.0249    0.02489    0.01444
## 559  1973-07-01 1.0245    0.02445    0.01444
## 911  2002-11-01 1.0228    0.02281    0.01444
## 121  1937-01-01 0.9777    0.02232    0.01444
## 880  2000-04-01 1.0223    0.02230    0.01444
## 80   1933-08-01 1.0220    0.02203    0.01444
## 49   1931-01-01 0.9793    0.02074    0.01444
## 283  1950-07-01 1.0207    0.02066    0.01444
## 908  2002-08-01 0.9794    0.02061    0.01444
## 565  1974-01-01 1.0203    0.02034    0.01444
## 61   1932-01-01 0.9797    0.02033    0.01444
## 898  2001-10-01 1.0203    0.02030    0.01444
## 867  1999-03-01 0.9801    0.01992    0.01444
## 574  1974-10-01 1.0199    0.01989    0.01444
## 985  2009-01-01 1.0197    0.01974    0.01444
## 888  2000-12-01 0.9803    0.01966    0.01444
## 78   1933-06-01 0.9807    0.01932    0.01444
## 64   1932-04-01 1.0193    0.01925    0.01444
## 147  1939-03-01 1.0189    0.01886    0.01444
## 70   1932-10-01 1.0186    0.01864    0.01444
## 860  1998-08-01 1.0186    0.01860    0.01444
## 577  1975-01-01 1.0182    0.01825    0.01444
## 82   1933-10-01 1.0182    0.01823    0.01444
## 1039 2013-07-01 0.9818    0.01816    0.01444
## 875  1999-11-01 1.0181    0.01809    0.01444
## 31   1929-07-01 0.9820    0.01800    0.01444
## 893  2001-05-01 0.9822    0.01779    0.01444
## 60   1931-12-01 1.0177    0.01772    0.01444
## 523  1970-07-01 0.9825    0.01752    0.01444
## 647  1980-11-01 1.0175    0.01751    0.01444
## 143  1938-11-01 0.9832    0.01682    0.01444
## 33   1929-09-01 0.9832    0.01675    0.01444
## 42   1930-06-01 1.0167    0.01673    0.01444
## 50   1931-02-01 0.9835    0.01650    0.01444
## 62   1932-02-01 0.9840    0.01597    0.01444
## 98   1935-02-01 0.9842    0.01583    0.01444
## 53   1931-05-01 1.0158    0.01575    0.01444
## 35   1929-11-01 1.0157    0.01567    0.01444
## 75   1933-03-01 0.9844    0.01562    0.01444
## 109  1936-01-01 1.0155    0.01553    0.01444
## 4    1927-04-01 0.9847    0.01534    0.01444
```

```
## 881  2000-05-01 1.0150    0.01500    0.01444
## 897  2001-09-01 1.0148    0.01485    0.01444
## 697  1985-01-01 1.0148    0.01477    0.01444
## 48   1930-12-01 1.0147    0.01470    0.01444
## 780  1991-12-01 1.0147    0.01468    0.01444
## 112  1936-04-01 1.0147    0.01468    0.01444
## 89   1934-05-01 1.0146    0.01461    0.01444
## 193  1943-01-01 1.0146    0.01459    0.01444
## 891  2001-03-01 1.0146    0.01458    0.01444
## 781  1992-01-01 1.0145    0.01453    0.01444
```

D.3 (AEW) Portfolio 2

```
## $`Cook's Distance`
##          Month    Ci
## 68 1932-08-01 3.733
##
## $`Covariance Ratio`
##            Month   CVRi abs.CVRi_1 calpt.crit
## 68   1932-08-01 0.6595    0.34053    0.01444
## 67   1932-07-01 1.1736    0.17364    0.01444
## 985  2009-01-01 0.8554    0.14460    0.01444
## 77   1933-05-01 1.1359    0.13586    0.01444
## 37   1930-01-01 0.9017    0.09832    0.01444
## 878  2000-02-01 1.0843    0.08430    0.01444
## 153  1939-09-01 1.0836    0.08363    0.01444
## 865  1999-01-01 0.9168    0.08318    0.01444
## 76   1933-04-01 1.0708    0.07076    0.01444
## 988  2009-04-01 1.0652    0.06522    0.01444
## 877  2000-01-01 0.9399    0.06012    0.01444
## 78   1933-06-01 0.9515    0.04853    0.01444
## 138  1938-06-01 1.0475    0.04745    0.01444
## 899  2001-11-01 0.9537    0.04632    0.01444
## 49   1931-01-01 0.9590    0.04103    0.01444
## 730  1987-10-01 1.0402    0.04022    0.01444
## 882  2000-06-01 1.0400    0.03999    0.01444
## 57   1931-09-01 1.0399    0.03987    0.01444
## 66   1932-06-01 0.9603    0.03974    0.01444
## 989  2009-05-01 0.9610    0.03900    0.01444
## 36   1929-12-01 0.9615    0.03848    0.01444
## 107  1935-11-01 0.9622    0.03778    0.01444
## 69   1932-09-01 0.9623    0.03769    0.01444
## 980  2008-08-01 0.9638    0.03620    0.01444
## 886  2000-10-01 0.9643    0.03573    0.01444
## 979  2008-07-01 0.9674    0.03262    0.01444
## 139  1938-07-01 0.9675    0.03254    0.01444
## 888  2000-12-01 0.9693    0.03073    0.01444
## 58   1931-10-01 0.9696    0.03039    0.01444
## 767  1990-11-01 0.9697    0.03032    0.01444
## 34   1929-10-01 1.0295    0.02955    0.01444
## 673  1983-01-01 0.9729    0.02709    0.01444
## 574  1974-10-01 1.0268    0.02680    0.01444
```

```
## 100  1935-04-01 0.9734    0.02663    0.01444
## 181  1942-01-01 0.9736    0.02637    0.01444
## 71   1932-11-01 1.0259    0.02585    0.01444
## 65   1932-05-01 1.0252    0.02523    0.01444
## 129  1937-09-01 1.0251    0.02513    0.01444
## 889  2001-01-01 0.9752    0.02480    0.01444
## 781  1992-01-01 0.9752    0.02479    0.01444
## 639  1980-03-01 1.0246    0.02457    0.01444
## 577  1975-01-01 1.0239    0.02387    0.01444
## 81   1933-09-01 1.0233    0.02326    0.01444
## 112  1936-04-01 0.9770    0.02295    0.01444
## 876  1999-12-01 1.0228    0.02278    0.01444
## 768  1990-12-01 0.9779    0.02212    0.01444
## 880  2000-04-01 1.0218    0.02176    0.01444
## 161  1940-05-01 1.0217    0.02166    0.01444
## 70   1932-10-01 0.9784    0.02163    0.01444
## 80   1933-08-01 1.0216    0.02156    0.01444
## 622  1978-10-01 1.0215    0.02153    0.01444
## 56   1931-08-01 0.9789    0.02108    0.01444
## 559  1973-07-01 1.0204    0.02039    0.01444
## 83   1933-11-01 1.0194    0.01945    0.01444
## 525  1970-09-01 1.0192    0.01924    0.01444
## 879  2000-03-01 1.0192    0.01922    0.01444
## 897  2001-09-01 0.9810    0.01897    0.01444
## 911  2002-11-01 1.0189    0.01895    0.01444
## 82   1933-10-01 1.0187    0.01866    0.01444
## 645  1980-09-01 0.9813    0.01865    0.01444
## 283  1950-07-01 1.0186    0.01865    0.01444
## 589  1976-01-01 1.0186    0.01855    0.01444
## 60   1931-12-01 1.0180    0.01797    0.01444
## 563  1973-11-01 1.0175    0.01751    0.01444
## 716  1986-08-01 0.9828    0.01720    0.01444
## 982  2008-10-01 1.0167    0.01669    0.01444
## 860  1998-08-01 1.0165    0.01648    0.01444
## 1018 2011-10-01 0.9839    0.01610    0.01444
## 841  1997-01-01 0.9842    0.01579    0.01444
## 904  2002-04-01 1.0158    0.01579    0.01444
## 42   1930-06-01 1.0156    0.01562    0.01444
## 898  2001-10-01 0.9844    0.01556    0.01444
## 874  1999-10-01 1.0155    0.01545    0.01444
## 523  1970-07-01 0.9847    0.01532    0.01444
```

```
## 74   1933-02-01 0.9848    0.01523    0.01444
## 697  1985-01-01 1.0152    0.01518    0.01444
## 64   1932-04-01 1.0149    0.01491    0.01444
## 564  1973-12-01 1.0149    0.01487    0.01444
## 147  1939-03-01 1.0147    0.01475    0.01444
## 98   1935-02-01 1.0146    0.01459    0.01444
## 193  1943-01-01 0.9855    0.01445    0.01444
```

D.4 (AVW) Portfolio 2

```
## $`Cook's Distance`
##         Month    Ci
## 67 1932-07-01 1.221
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 104 1935-08-01 0.7842    0.21580    0.01444
## 77  1933-05-01 1.1724    0.17238    0.01444
## 68  1932-08-01 1.1302    0.13025    0.01444
## 12  1927-12-01 0.8949    0.10510    0.01444
## 153 1939-09-01 1.0917    0.09174    0.01444
## 878 2000-02-01 1.0801    0.08011    0.01444
## 50  1931-02-01 0.9216    0.07838    0.01444
## 36  1929-12-01 0.9286    0.07145    0.01444
## 988 2009-04-01 1.0644    0.06443    0.01444
## 65  1932-05-01 0.9389    0.06113    0.01444
## 76  1933-04-01 1.0601    0.06008    0.01444
## 54  1931-06-01 0.9459    0.05406    0.01444
## 41  1930-05-01 0.9467    0.05334    0.01444
## 138 1938-06-01 1.0471    0.04706    0.01444
## 911 2002-11-01 0.9531    0.04691    0.01444
## 882 2000-06-01 1.0437    0.04370    0.01444
## 139 1938-07-01 0.9585    0.04150    0.01444
## 57  1931-09-01 1.0389    0.03892    0.01444
## 75  1933-03-01 0.9669    0.03307    0.01444
## 890 2001-02-01 1.0323    0.03233    0.01444
## 47  1930-11-01 0.9678    0.03221    0.01444
## 889 2001-01-01 1.0316    0.03160    0.01444
## 151 1939-07-01 0.9697    0.03033    0.01444
## 66  1932-06-01 0.9699    0.03007    0.01444
## 62  1932-02-01 0.9705    0.02952    0.01444
## 647 1980-11-01 1.0278    0.02778    0.01444
## 622 1978-10-01 1.0259    0.02594    0.01444
## 879 2000-03-01 1.0259    0.02592    0.01444
## 887 2000-11-01 1.0256    0.02563    0.01444
## 574 1974-10-01 1.0254    0.02539    0.01444
## 166 1940-10-01 0.9746    0.02538    0.01444
## 639 1980-03-01 1.0251    0.02515    0.01444
## 1   1927-01-01 0.9749    0.02512    0.01444
```

```
## 129 1937-09-01 1.0243    0.02431    0.01444
## 107 1935-11-01 0.9764    0.02356    0.01444
## 161 1940-05-01 1.0231    0.02314    0.01444
## 885 2000-09-01 0.9771    0.02293    0.01444
## 48  1930-12-01 0.9772    0.02279    0.01444
## 525 1970-09-01 1.0226    0.02257    0.01444
## 40  1930-04-01 0.9780    0.02196    0.01444
## 67  1932-07-01 1.0218    0.02181    0.01444
## 880 2000-04-01 1.0208    0.02079    0.01444
## 26  1929-02-01 0.9794    0.02062    0.01444
## 565 1974-01-01 1.0203    0.02032    0.01444
## 860 1998-08-01 1.0200    0.02003    0.01444
## 81  1933-09-01 1.0200    0.02001    0.01444
## 34  1929-10-01 1.0199    0.01986    0.01444
## 135 1938-03-01 1.0197    0.01968    0.01444
## 796 1993-04-01 0.9805    0.01952    0.01444
## 101 1935-05-01 0.9806    0.01942    0.01444
## 53  1931-05-01 1.0192    0.01923    0.01444
## 112 1936-04-01 1.0192    0.01917    0.01444
## 84  1933-12-01 0.9809    0.01912    0.01444
## 559 1973-07-01 1.0190    0.01903    0.01444
## 194 1943-02-01 0.9811    0.01885    0.01444
## 82  1933-10-01 1.0186    0.01858    0.01444
## 32  1929-08-01 1.0182    0.01823    0.01444
## 33  1929-09-01 0.9823    0.01772    0.01444
## 181 1942-01-01 1.0173    0.01730    0.01444
## 21  1928-09-01 0.9830    0.01697    0.01444
## 904 2002-04-01 1.0168    0.01683    0.01444
## 876 1999-12-01 1.0167    0.01672    0.01444
## 982 2008-10-01 1.0167    0.01666    0.01444
## 60  1931-12-01 1.0165    0.01654    0.01444
## 979 2008-07-01 0.9840    0.01596    0.01444
## 541 1972-01-01 0.9842    0.01578    0.01444
## 730 1987-10-01 1.0156    0.01561    0.01444
## 179 1941-11-01 0.9846    0.01540    0.01444
## 105 1935-09-01 0.9849    0.01513    0.01444
## 697 1985-01-01 1.0151    0.01508    0.01444
## 985 2009-01-01 1.0149    0.01485    0.01444
## 70  1932-10-01 1.0146    0.01459    0.01444
```

D.5 (AEW) Portfolio 3

```
## $`Cook's Distance`
##         Month    Ci
## 77 1933-05-01 2.469
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 77  1933-05-01 0.8140    0.18600    0.01444
## 68  1932-08-01 1.1619    0.16186    0.01444
## 67  1932-07-01 1.1420    0.14198    0.01444
## 78  1933-06-01 0.8890    0.11097    0.01444
## 71  1932-11-01 0.9014    0.09863    0.01444
## 58  1931-10-01 0.9102    0.08984    0.01444
## 153 1939-09-01 1.0839    0.08386    0.01444
## 80  1933-08-01 0.9299    0.07006    0.01444
## 76  1933-04-01 1.0622    0.06219    0.01444
## 985 2009-01-01 0.9432    0.05678    0.01444
## 40  1930-04-01 0.9444    0.05562    0.01444
## 988 2009-04-01 1.0542    0.05416    0.01444
## 989 2009-05-01 0.9548    0.04517    0.01444
## 730 1987-10-01 1.0388    0.03880    0.01444
## 577 1975-01-01 0.9613    0.03867    0.01444
## 138 1938-06-01 1.0361    0.03608    0.01444
## 529 1971-01-01 0.9644    0.03562    0.01444
## 890 2001-02-01 0.9645    0.03549    0.01444
## 865 1999-01-01 0.9649    0.03511    0.01444
## 16  1928-04-01 0.9654    0.03460    0.01444
## 889 2001-01-01 1.0306    0.03063    0.01444
## 574 1974-10-01 1.0305    0.03045    0.01444
## 37  1930-01-01 0.9707    0.02933    0.01444
## 135 1938-03-01 1.0289    0.02886    0.01444
## 767 1990-11-01 0.9716    0.02840    0.01444
## 65  1932-05-01 1.0277    0.02774    0.01444
## 34  1929-10-01 1.0270    0.02697    0.01444
## 673 1983-01-01 0.9738    0.02623    0.01444
## 891 2001-03-01 0.9750    0.02501    0.01444
## 639 1980-03-01 1.0248    0.02476    0.01444
## 66  1932-06-01 0.9753    0.02466    0.01444
## 887 2000-11-01 1.0246    0.02459    0.01444
## 559 1973-07-01 1.0246    0.02457    0.01444
```

```
## 92  1934-08-01 0.9755    0.02449    0.01444
## 990 2009-06-01 0.9761    0.02391    0.01444
## 161 1940-05-01 1.0238    0.02384    0.01444
## 892 2001-04-01 0.9762    0.02377    0.01444
## 911 2002-11-01 1.0230    0.02301    0.01444
## 520 1970-04-01 0.9777    0.02227    0.01444
## 895 2001-07-01 0.9778    0.02222    0.01444
## 779 1991-11-01 0.9785    0.02146    0.01444
## 899 2001-11-01 0.9789    0.02106    0.01444
## 882 2000-06-01 0.9790    0.02096    0.01444
## 64  1932-04-01 1.0209    0.02092    0.01444
## 57  1931-09-01 1.0206    0.02062    0.01444
## 32  1929-08-01 1.0196    0.01963    0.01444
## 589 1976-01-01 1.0196    0.01960    0.01444
## 647 1980-11-01 1.0196    0.01956    0.01444
## 876 1999-12-01 1.0194    0.01943    0.01444
## 91  1934-07-01 1.0194    0.01936    0.01444
## 70  1932-10-01 1.0191    0.01907    0.01444
## 112 1936-04-01 1.0189    0.01893    0.01444
## 147 1939-03-01 1.0189    0.01891    0.01444
## 83  1933-11-01 0.9812    0.01880    0.01444
## 129 1937-09-01 1.0185    0.01846    0.01444
## 541 1972-01-01 0.9819    0.01806    0.01444
## 875 1999-11-01 1.0180    0.01797    0.01444
## 283 1950-07-01 0.9821    0.01794    0.01444
## 563 1973-11-01 1.0179    0.01789    0.01444
## 61  1932-01-01 1.0176    0.01756    0.01444
## 81  1933-09-01 1.0175    0.01749    0.01444
## 979 2008-07-01 0.9827    0.01726    0.01444
## 564 1973-12-01 1.0169    0.01695    0.01444
## 108 1935-12-01 0.9831    0.01692    0.01444
## 54  1931-06-01 1.0166    0.01664    0.01444
## 109 1936-01-01 1.0166    0.01662    0.01444
## 904 2002-04-01 1.0166    0.01658    0.01444
## 565 1974-01-01 1.0163    0.01629    0.01444
## 50  1931-02-01 1.0158    0.01580    0.01444
## 982 2008-10-01 1.0157    0.01565    0.01444
## 525 1970-09-01 1.0154    0.01537    0.01444
## 874 1999-10-01 1.0149    0.01491    0.01444
## 573 1974-09-01 1.0149    0.01490    0.01444
## 881 2000-05-01 1.0149    0.01488    0.01444
```

```
## 860 1998-08-01 1.0148    0.01484    0.01444
## 30  1929-06-01 1.0147    0.01471    0.01444
## 986 2009-02-01 0.9854    0.01465    0.01444
## 48  1930-12-01 1.0146    0.01463    0.01444
## 697 1985-01-01 1.0146    0.01457    0.01444
```

D.6 (AVW) Portfolio 3

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 67  1932-07-01 1.1961    0.19608    0.01444
## 68  1932-08-01 1.1718    0.17175    0.01444
## 889 2001-01-01 0.8703    0.12972    0.01444
## 153 1939-09-01 1.0915    0.09154    0.01444
## 878 2000-02-01 1.0844    0.08445    0.01444
## 102 1935-06-01 0.9284    0.07155    0.01444
## 379 1958-07-01 0.9396    0.06043    0.01444
## 40  1930-04-01 0.9438    0.05619    0.01444
## 41  1930-05-01 0.9488    0.05124    0.01444
## 906 2002-06-01 0.9496    0.05038    0.01444
## 882 2000-06-01 1.0437    0.04368    0.01444
## 561 1973-09-01 0.9565    0.04354    0.01444
## 76  1933-04-01 1.0426    0.04258    0.01444
## 77  1933-05-01 1.0426    0.04258    0.01444
## 911 2002-11-01 0.9576    0.04239    0.01444
## 57  1931-09-01 1.0396    0.03960    0.01444
## 70  1932-10-01 0.9650    0.03495    0.01444
## 979 2008-07-01 0.9658    0.03415    0.01444
## 986 2009-02-01 0.9660    0.03404    0.01444
## 883 2000-07-01 0.9677    0.03230    0.01444
## 868 1999-04-01 0.9702    0.02976    0.01444
## 730 1987-10-01 1.0297    0.02969    0.01444
## 769 1991-01-01 0.9715    0.02850    0.01444
## 647 1980-11-01 1.0278    0.02777    0.01444
## 135 1938-03-01 1.0272    0.02717    0.01444
## 890 2001-02-01 1.0270    0.02701    0.01444
## 899 2001-11-01 0.9730    0.02696    0.01444
## 990 2009-06-01 0.9746    0.02540    0.01444
## 639 1980-03-01 1.0253    0.02527    0.01444
## 510 1969-06-01 0.9748    0.02524    0.01444
## 879 2000-03-01 1.0249    0.02487    0.01444
## 992 2009-08-01 0.9765    0.02347    0.01444
## 129 1937-09-01 1.0233    0.02333    0.01444
## 988 2009-04-01 1.0217    0.02174    0.01444
```

```
## 34  1929-10-01 0.9784    0.02158    0.01444
## 53  1931-05-01 1.0210    0.02105    0.01444
## 99  1935-03-01 0.9790    0.02100    0.01444
## 525 1970-09-01 1.0206    0.02055    0.01444
## 117 1936-09-01 0.9800    0.02000    0.01444
## 142 1938-10-01 0.9800    0.02000    0.01444
## 589 1976-01-01 1.0199    0.01989    0.01444
## 75  1933-03-01 0.9802    0.01977    0.01444
## 137 1938-05-01 0.9803    0.01969    0.01444
## 902 2002-02-01 0.9813    0.01870    0.01444
## 181 1942-01-01 1.0186    0.01864    0.01444
## 881 2000-05-01 0.9815    0.01854    0.01444
## 82  1933-10-01 1.0183    0.01834    0.01444
## 898 2001-10-01 0.9819    0.01810    0.01444
## 60  1931-12-01 1.0181    0.01807    0.01444
## 161 1940-05-01 1.0180    0.01803    0.01444
## 622 1978-10-01 1.0177    0.01773    0.01444
## 46  1930-10-01 0.9824    0.01760    0.01444
## 50  1931-02-01 1.0173    0.01727    0.01444
## 910 2002-10-01 1.0172    0.01720    0.01444
## 985 2009-01-01 1.0170    0.01702    0.01444
## 241 1947-01-01 0.9830    0.01702    0.01444
## 875 1999-11-01 1.0168    0.01683    0.01444
## 64  1932-04-01 1.0164    0.01645    0.01444
## 193 1943-01-01 1.0162    0.01618    0.01444
## 104 1935-08-01 0.9840    0.01595    0.01444
## 59  1931-11-01 1.0159    0.01589    0.01444
## 574 1974-10-01 1.0158    0.01584    0.01444
## 520 1970-04-01 1.0156    0.01561    0.01444
## 697 1985-01-01 1.0156    0.01558    0.01444
## 573 1974-09-01 1.0156    0.01556    0.01444
## 904 2002-04-01 1.0152    0.01525    0.01444
## 577 1975-01-01 1.0149    0.01493    0.01444
## 89  1934-05-01 1.0146    0.01456    0.01444
```

D.7 (AEW) Portfolio 4

```
## $`Cook's Distance`
##         Month    Ci
## 77 1933-05-01 1.992
## 67 1932-07-01 1.385
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 68  1932-08-01 1.1252    0.12525    0.01444
## 77  1933-05-01 0.8756    0.12439    0.01444
## 78  1933-06-01 0.8935    0.10645    0.01444
## 104 1935-08-01 0.9078    0.09221    0.01444
## 153 1939-09-01 1.0918    0.09176    0.01444
## 58  1931-10-01 0.9229    0.07713    0.01444
## 66  1932-06-01 0.9415    0.05854    0.01444
## 889 2001-01-01 1.0572    0.05723    0.01444
## 878 2000-02-01 1.0567    0.05674    0.01444
## 76  1933-04-01 0.9475    0.05249    0.01444
## 671 1982-11-01 0.9492    0.05084    0.01444
## 62  1932-02-01 0.9493    0.05066    0.01444
## 193 1943-01-01 0.9494    0.05059    0.01444
## 83  1933-11-01 0.9509    0.04911    0.01444
## 988 2009-04-01 1.0443    0.04431    0.01444
## 51  1931-03-01 0.9567    0.04326    0.01444
## 13  1928-01-01 0.9576    0.04236    0.01444
## 985 2009-01-01 0.9600    0.04004    0.01444
## 107 1935-11-01 0.9616    0.03841    0.01444
## 779 1991-11-01 0.9628    0.03724    0.01444
## 899 2001-11-01 0.9639    0.03605    0.01444
## 879 2000-03-01 1.0335    0.03346    0.01444
## 43  1930-07-01 0.9669    0.03313    0.01444
## 574 1974-10-01 1.0312    0.03116    0.01444
## 85  1934-01-01 1.0304    0.03038    0.01444
## 730 1987-10-01 1.0303    0.03033    0.01444
## 65  1932-05-01 1.0302    0.03015    0.01444
## 897 2001-09-01 0.9701    0.02991    0.01444
## 135 1938-03-01 1.0289    0.02895    0.01444
## 890 2001-02-01 0.9717    0.02826    0.01444
## 194 1943-02-01 0.9717    0.02826    0.01444
## 891 2001-03-01 0.9732    0.02681    0.01444
```

```
## 887 2000-11-01 1.0253    0.02526    0.01444
## 109 1936-01-01 0.9750    0.02504    0.01444
## 559 1973-07-01 1.0245    0.02454    0.01444
## 34  1929-10-01 1.0245    0.02450    0.01444
## 81  1933-09-01 1.0240    0.02405    0.01444
## 639 1980-03-01 1.0237    0.02370    0.01444
## 54  1931-06-01 1.0225    0.02252    0.01444
## 622 1978-10-01 1.0222    0.02221    0.01444
## 80  1933-08-01 0.9780    0.02203    0.01444
## 577 1975-01-01 1.0216    0.02158    0.01444
## 71  1932-11-01 1.0209    0.02089    0.01444
## 898 2001-10-01 1.0207    0.02069    0.01444
## 161 1940-05-01 1.0207    0.02068    0.01444
## 56  1931-08-01 0.9798    0.02020    0.01444
## 32  1929-08-01 1.0201    0.02009    0.01444
## 525 1970-09-01 1.0200    0.02001    0.01444
## 16  1928-04-01 0.9800    0.01996    0.01444
## 53  1931-05-01 1.0198    0.01983    0.01444
## 129 1937-09-01 1.0197    0.01972    0.01444
## 565 1974-01-01 1.0197    0.01967    0.01444
## 563 1973-11-01 1.0190    0.01896    0.01444
## 860 1998-08-01 1.0186    0.01860    0.01444
## 82  1933-10-01 1.0185    0.01849    0.01444
## 875 1999-11-01 1.0181    0.01809    0.01444
## 589 1976-01-01 1.0178    0.01778    0.01444
## 181 1942-01-01 1.0177    0.01770    0.01444
## 112 1936-04-01 1.0170    0.01705    0.01444
## 60  1931-12-01 1.0166    0.01662    0.01444
## 982 2008-10-01 1.0166    0.01656    0.01444
## 904 2002-04-01 1.0162    0.01618    0.01444
## 40  1930-04-01 0.9838    0.01617    0.01444
## 61  1932-01-01 1.0159    0.01588    0.01444
## 874 1999-10-01 1.0158    0.01584    0.01444
## 649 1981-01-01 1.0151    0.01511    0.01444
## 42  1930-06-01 1.0151    0.01505    0.01444
## 647 1980-11-01 1.0149    0.01494    0.01444
## 91  1934-07-01 1.0149    0.01486    0.01444
## 520 1970-04-01 0.9854    0.01460    0.01444
```

D.8 (AVW) Portfolio 4

```
## $`Cook's Distance`
##         Month    Ci
## 76 1933-04-01 1.274
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 76  1933-04-01 0.6539    0.34609    0.01444
## 67  1932-07-01 1.1937    0.19372    0.01444
## 77  1933-05-01 1.1593    0.15933    0.01444
## 68  1932-08-01 1.0956    0.09559    0.01444
## 885 2000-09-01 0.9126    0.08737    0.01444
## 878 2000-02-01 1.0840    0.08401    0.01444
## 153 1939-09-01 1.0814    0.08138    0.01444
## 138 1938-06-01 0.9262    0.07380    0.01444
## 886 2000-10-01 0.9337    0.06634    0.01444
## 988 2009-04-01 1.0655    0.06552    0.01444
## 889 2001-01-01 1.0575    0.05746    0.01444
## 132 1937-12-01 0.9457    0.05430    0.01444
## 40  1930-04-01 0.9475    0.05252    0.01444
## 888 2000-12-01 0.9502    0.04980    0.01444
## 66  1932-06-01 0.9519    0.04814    0.01444
## 104 1935-08-01 0.9555    0.04450    0.01444
## 879 2000-03-01 1.0439    0.04385    0.01444
## 882 2000-06-01 1.0428    0.04275    0.01444
## 31  1929-07-01 0.9581    0.04188    0.01444
## 730 1987-10-01 1.0402    0.04024    0.01444
## 897 2001-09-01 0.9612    0.03882    0.01444
## 75  1933-03-01 0.9633    0.03674    0.01444
## 69  1932-09-01 0.9646    0.03537    0.01444
## 911 2002-11-01 0.9655    0.03455    0.01444
## 166 1940-10-01 0.9669    0.03311    0.01444
## 876 1999-12-01 0.9674    0.03255    0.01444
## 569 1974-05-01 0.9679    0.03213    0.01444
## 577 1975-01-01 0.9707    0.02931    0.01444
## 647 1980-11-01 1.0279    0.02792    0.01444
## 54  1931-06-01 1.0270    0.02699    0.01444
## 622 1978-10-01 1.0254    0.02538    0.01444
## 8   1927-08-01 0.9752    0.02476    0.01444
## 62  1932-02-01 0.9762    0.02381    0.01444
```

```
## 71  1932-11-01 1.0233    0.02330    0.01444
## 983 2008-11-01 0.9773    0.02272    0.01444
## 42  1930-06-01 0.9779    0.02210    0.01444
## 58  1931-10-01 0.9780    0.02196    0.01444
## 72  1932-12-01 1.0219    0.02193    0.01444
## 517 1970-01-01 0.9781    0.02189    0.01444
## 95  1934-11-01 0.9782    0.02177    0.01444
## 899 2001-11-01 0.9784    0.02162    0.01444
## 283 1950-07-01 1.0207    0.02071    0.01444
## 639 1980-03-01 1.0207    0.02068    0.01444
## 50  1931-02-01 0.9794    0.02061    0.01444
## 34  1929-10-01 1.0204    0.02040    0.01444
## 147 1939-03-01 1.0203    0.02028    0.01444
## 860 1998-08-01 1.0197    0.01969    0.01444
## 91  1934-07-01 1.0194    0.01941    0.01444
## 525 1970-09-01 1.0192    0.01923    0.01444
## 487 1967-07-01 0.9812    0.01881    0.01444
## 673 1983-01-01 0.9815    0.01846    0.01444
## 52  1931-04-01 0.9817    0.01828    0.01444
## 139 1938-07-01 0.9817    0.01828    0.01444
## 371 1957-11-01 0.9818    0.01824    0.01444
## 985 2009-01-01 1.0181    0.01812    0.01444
## 910 2002-10-01 1.0181    0.01810    0.01444
## 180 1941-12-01 0.9820    0.01802    0.01444
## 589 1976-01-01 1.0174    0.01737    0.01444
## 2   1927-02-01 0.9827    0.01728    0.01444
## 16  1928-04-01 0.9829    0.01705    0.01444
## 780 1991-12-01 1.0170    0.01696    0.01444
## 986 2009-02-01 0.9832    0.01676    0.01444
## 109 1936-01-01 1.0167    0.01675    0.01444
## 904 2002-04-01 1.0167    0.01666    0.01444
## 864 1998-12-01 0.9837    0.01625    0.01444
## 61  1932-01-01 1.0160    0.01601    0.01444
## 874 1999-10-01 1.0158    0.01584    0.01444
## 46  1930-10-01 0.9843    0.01567    0.01444
## 136 1938-04-01 1.0157    0.01567    0.01444
## 697 1985-01-01 1.0156    0.01564    0.01444
## 175 1941-07-01 0.9845    0.01545    0.01444
## 649 1981-01-01 1.0148    0.01482    0.01444
## 30  1929-06-01 1.0146    0.01462    0.01444
```

D.9 (AEW) Portfolio 5

```
## $`Cook's Distance`
##         Month    Ci
## 68 1932-08-01 2.973
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 68  1932-08-01 0.7455    0.25451    0.01444
## 77  1933-05-01 1.1741    0.17415    0.01444
## 138 1938-06-01 0.8610    0.13901    0.01444
## 153 1939-09-01 0.9074    0.09264    0.01444
## 67  1932-07-01 1.0839    0.08393    0.01444
## 104 1935-08-01 0.9210    0.07904    0.01444
## 61  1932-01-01 0.9320    0.06799    0.01444
## 988 2009-04-01 1.0639    0.06391    0.01444
## 54  1931-06-01 0.9378    0.06218    0.01444
## 80  1933-08-01 0.9471    0.05288    0.01444
## 889 2001-01-01 1.0502    0.05024    0.01444
## 85  1934-01-01 0.9524    0.04758    0.01444
## 671 1982-11-01 0.9553    0.04473    0.01444
## 985 2009-01-01 0.9554    0.04459    0.01444
## 897 2001-09-01 0.9666    0.03339    0.01444
## 878 2000-02-01 1.0327    0.03275    0.01444
## 779 1991-11-01 0.9707    0.02933    0.01444
## 880 2000-04-01 0.9710    0.02905    0.01444
## 882 2000-06-01 0.9712    0.02883    0.01444
## 75  1933-03-01 0.9715    0.02847    0.01444
## 57  1931-09-01 1.0283    0.02835    0.01444
## 574 1974-10-01 1.0277    0.02774    0.01444
## 877 2000-01-01 0.9724    0.02765    0.01444
## 622 1978-10-01 1.0258    0.02583    0.01444
## 137 1938-05-01 0.9748    0.02524    0.01444
## 639 1980-03-01 1.0250    0.02497    0.01444
## 129 1937-09-01 1.0249    0.02485    0.01444
## 730 1987-10-01 1.0242    0.02421    0.01444
## 71  1932-11-01 1.0240    0.02402    0.01444
## 81  1933-09-01 1.0239    0.02392    0.01444
## 161 1940-05-01 1.0236    0.02361    0.01444
## 76  1933-04-01 1.0234    0.02345    0.01444
## 521 1970-05-01 0.9770    0.02296    0.01444
```

```
## 525 1970-09-01 1.0224    0.02239    0.01444
## 879 2000-03-01 1.0219    0.02192    0.01444
## 72  1932-12-01 1.0219    0.02185    0.01444
## 32  1929-08-01 1.0207    0.02065    0.01444
## 64  1932-04-01 0.9802    0.01979    0.01444
## 860 1998-08-01 1.0197    0.01974    0.01444
## 147 1939-03-01 1.0195    0.01949    0.01444
## 91  1934-07-01 1.0193    0.01926    0.01444
## 29  1929-05-01 0.9808    0.01920    0.01444
## 43  1930-07-01 0.9810    0.01896    0.01444
## 892 2001-04-01 0.9814    0.01861    0.01444
## 668 1982-08-01 0.9814    0.01858    0.01444
## 197 1943-05-01 0.9814    0.01855    0.01444
## 898 2001-10-01 1.0184    0.01835    0.01444
## 893 2001-05-01 0.9818    0.01819    0.01444
## 283 1950-07-01 1.0181    0.01807    0.01444
## 682 1983-10-01 0.9833    0.01672    0.01444
## 65  1932-05-01 1.0165    0.01648    0.01444
## 257 1948-05-01 0.9836    0.01642    0.01444
## 193 1943-01-01 1.0164    0.01638    0.01444
## 59  1931-11-01 1.0163    0.01634    0.01444
## 563 1973-11-01 1.0160    0.01605    0.01444
## 564 1973-12-01 1.0160    0.01601    0.01444
## 989 2009-05-01 1.0156    0.01563    0.01444
## 573 1974-09-01 1.0154    0.01536    0.01444
## 577 1975-01-01 0.9850    0.01502    0.01444
## 649 1981-01-01 1.0150    0.01499    0.01444
## 12  1927-12-01 0.9851    0.01491    0.01444
## 56  1931-08-01 0.9853    0.01467    0.01444
## 34  1929-10-01 1.0146    0.01458    0.01444
## 982 2008-10-01 1.0146    0.01455    0.01444
## 876 1999-12-01 1.0145    0.01446    0.01444
```

D.10 (AVW) Portfolio 5

```
## $`Cook's Distance`
##         Month    Ci
## 68 1932-08-01 1.631
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 67  1932-07-01 1.1840    0.18396    0.01444
## 138 1938-06-01 0.8273    0.17269    0.01444
## 77  1933-05-01 1.1473    0.14728    0.01444
## 34  1929-10-01 0.9151    0.08494    0.01444
## 68  1932-08-01 0.9190    0.08100    0.01444
## 887 2000-11-01 0.9294    0.07057    0.01444
## 882 2000-06-01 0.9335    0.06655    0.01444
## 229 1946-01-01 0.9443    0.05575    0.01444
## 988 2009-04-01 1.0531    0.05308    0.01444
## 897 2001-09-01 0.9512    0.04879    0.01444
## 911 2002-11-01 0.9550    0.04503    0.01444
## 879 2000-03-01 1.0443    0.04431    0.01444
## 57  1931-09-01 1.0396    0.03962    0.01444
## 912 2002-12-01 0.9611    0.03886    0.01444
## 76  1933-04-01 0.9649    0.03510    0.01444
## 868 1999-04-01 0.9672    0.03279    0.01444
## 43  1930-07-01 0.9683    0.03171    0.01444
## 153 1939-09-01 1.0307    0.03072    0.01444
## 54  1931-06-01 1.0301    0.03014    0.01444
## 181 1942-01-01 0.9699    0.03006    0.01444
## 50  1931-02-01 0.9708    0.02918    0.01444
## 730 1987-10-01 1.0267    0.02670    0.01444
## 70  1932-10-01 0.9737    0.02630    0.01444
## 132 1937-12-01 0.9738    0.02620    0.01444
## 574 1974-10-01 1.0255    0.02549    0.01444
## 639 1980-03-01 1.0252    0.02516    0.01444
## 129 1937-09-01 1.0251    0.02513    0.01444
## 161 1940-05-01 1.0229    0.02288    0.01444
## 647 1980-11-01 1.0228    0.02280    0.01444
## 110 1936-02-01 0.9776    0.02238    0.01444
## 889 2001-01-01 1.0215    0.02151    0.01444
## 104 1935-08-01 0.9788    0.02119    0.01444
## 53  1931-05-01 1.0210    0.02096    0.01444
```

```
## 65  1932-05-01 1.0203    0.02030    0.01444
## 880 2000-04-01 1.0201    0.02013    0.01444
## 99  1935-03-01 0.9801    0.01990    0.01444
## 283 1950-07-01 1.0199    0.01987    0.01444
## 525 1970-09-01 1.0195    0.01954    0.01444
## 589 1976-01-01 1.0193    0.01926    0.01444
## 91  1934-07-01 1.0191    0.01913    0.01444
## 83  1933-11-01 1.0189    0.01891    0.01444
## 72  1932-12-01 1.0187    0.01867    0.01444
## 82  1933-10-01 1.0186    0.01855    0.01444
## 85  1934-01-01 0.9818    0.01817    0.01444
## 922 2003-10-01 0.9819    0.01809    0.01444
## 64  1932-04-01 1.0179    0.01787    0.01444
## 780 1991-12-01 1.0173    0.01728    0.01444
## 899 2001-11-01 0.9828    0.01716    0.01444
## 563 1973-11-01 1.0170    0.01698    0.01444
## 564 1973-12-01 1.0169    0.01688    0.01444
## 112 1936-04-01 1.0168    0.01676    0.01444
## 78  1933-06-01 1.0166    0.01665    0.01444
## 982 2008-10-01 0.9838    0.01622    0.01444
## 42  1930-06-01 1.0157    0.01575    0.01444
## 874 1999-10-01 0.9844    0.01558    0.01444
## 565 1974-01-01 1.0155    0.01554    0.01444
## 989 2009-05-01 1.0150    0.01502    0.01444
## 881 2000-05-01 1.0150    0.01501    0.01444
## 61  1932-01-01 1.0150    0.01497    0.01444
## 910 2002-10-01 0.9852    0.01482    0.01444
## 48  1930-12-01 1.0146    0.01465    0.01444
## 80  1933-08-01 0.9854    0.01459    0.01444
## 649 1981-01-01 1.0146    0.01458    0.01444
```

D.11 (AEW) Portfolio 6

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 77  1933-05-01 1.1625    0.16250    0.01444
## 138 1938-06-01 0.8803    0.11971    0.01444
## 75  1933-03-01 0.8900    0.11004    0.01444
## 16  1928-04-01 0.9090    0.09103    0.01444
## 882 2000-06-01 0.9112    0.08875    0.01444
## 67  1932-07-01 1.0872    0.08723    0.01444
## 76  1933-04-01 0.9285    0.07153    0.01444
## 80  1933-08-01 0.9289    0.07105    0.01444
## 103 1935-07-01 0.9324    0.06760    0.01444
## 153 1939-09-01 0.9365    0.06354    0.01444
## 876 1999-12-01 0.9394    0.06061    0.01444
## 68  1932-08-01 1.0582    0.05818    0.01444
## 988 2009-04-01 1.0577    0.05769    0.01444
## 889 2001-01-01 1.0541    0.05411    0.01444
## 877 2000-01-01 0.9482    0.05182    0.01444
## 69  1932-09-01 0.9494    0.05064    0.01444
## 104 1935-08-01 0.9498    0.05016    0.01444
## 81  1933-09-01 0.9533    0.04667    0.01444
## 78  1933-06-01 0.9573    0.04272    0.01444
## 867 1999-03-01 0.9676    0.03237    0.01444
## 647 1980-11-01 1.0283    0.02828    0.01444
## 985 2009-01-01 0.9731    0.02692    0.01444
## 57  1931-09-01 1.0267    0.02667    0.01444
## 65  1932-05-01 1.0265    0.02650    0.01444
## 63  1932-03-01 0.9739    0.02611    0.01444
## 887 2000-11-01 1.0254    0.02542    0.01444
## 129 1937-09-01 1.0249    0.02493    0.01444
## 639 1980-03-01 1.0249    0.02490    0.01444
## 161 1940-05-01 1.0247    0.02469    0.01444
## 559 1973-07-01 1.0243    0.02434    0.01444
## 668 1982-08-01 0.9757    0.02431    0.01444
## 34  1929-10-01 1.0237    0.02373    0.01444
## 622 1978-10-01 1.0228    0.02280    0.01444
## 72  1932-12-01 1.0221    0.02208    0.01444
```

```
## 878 2000-02-01 0.9782    0.02182    0.01444
## 121 1937-01-01 0.9783    0.02171    0.01444
## 898 2001-10-01 1.0209    0.02086    0.01444
## 32  1929-08-01 1.0203    0.02033    0.01444
## 525 1970-09-01 1.0202    0.02021    0.01444
## 91  1934-07-01 1.0194    0.01944    0.01444
## 885 2000-09-01 0.9806    0.01936    0.01444
## 563 1973-11-01 1.0193    0.01932    0.01444
## 83  1933-11-01 1.0193    0.01932    0.01444
## 89  1934-05-01 0.9808    0.01915    0.01444
## 82  1933-10-01 1.0186    0.01863    0.01444
## 860 1998-08-01 1.0183    0.01833    0.01444
## 71  1932-11-01 1.0181    0.01809    0.01444
## 283 1950-07-01 1.0181    0.01806    0.01444
## 910 2002-10-01 1.0180    0.01802    0.01444
## 899 2001-11-01 0.9822    0.01777    0.01444
## 194 1943-02-01 0.9823    0.01774    0.01444
## 105 1935-09-01 0.9825    0.01752    0.01444
## 912 2002-12-01 0.9829    0.01710    0.01444
## 135 1938-03-01 1.0170    0.01700    0.01444
## 875 1999-11-01 1.0166    0.01665    0.01444
## 20  1928-08-01 0.9835    0.01648    0.01444
## 102 1935-06-01 0.9835    0.01647    0.01444
## 601 1977-01-01 0.9836    0.01638    0.01444
## 874 1999-10-01 1.0158    0.01585    0.01444
## 70  1932-10-01 1.0157    0.01573    0.01444
## 59  1931-11-01 1.0157    0.01571    0.01444
## 30  1929-06-01 1.0154    0.01540    0.01444
## 896 2001-08-01 0.9849    0.01508    0.01444
## 110 1936-02-01 0.9850    0.01502    0.01444
## 649 1981-01-01 1.0150    0.01501    0.01444
## 895 2001-07-01 0.9851    0.01494    0.01444
## 721 1987-01-01 1.0149    0.01488    0.01444
## 193 1943-01-01 1.0148    0.01478    0.01444
## 136 1938-04-01 1.0148    0.01475    0.01444
## 730 1987-10-01 1.0147    0.01468    0.01444
```

D.12 (AVW) Portfolio 6

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 67  1932-07-01 1.1774    0.17736    0.01444
## 68  1932-08-01 1.1713    0.17133    0.01444
## 138 1938-06-01 0.8593    0.14066    0.01444
## 77  1933-05-01 1.1405    0.14053    0.01444
## 876 1999-12-01 0.8979    0.10210    0.01444
## 153 1939-09-01 1.0883    0.08833    0.01444
## 479 1966-11-01 0.9253    0.07475    0.01444
## 889 2001-01-01 0.9292    0.07075    0.01444
## 885 2000-09-01 0.9304    0.06958    0.01444
## 878 2000-02-01 1.0673    0.06731    0.01444
## 81  1933-09-01 0.9331    0.06688    0.01444
## 561 1973-09-01 0.9395    0.06045    0.01444
## 76  1933-04-01 1.0593    0.05930    0.01444
## 897 2001-09-01 0.9460    0.05403    0.01444
## 988 2009-04-01 1.0533    0.05335    0.01444
## 892 2001-04-01 0.9573    0.04269    0.01444
## 670 1982-10-01 0.9586    0.04139    0.01444
## 79  1933-07-01 0.9605    0.03951    0.01444
## 85  1934-01-01 1.0378    0.03778    0.01444
## 135 1938-03-01 0.9636    0.03641    0.01444
## 57  1931-09-01 1.0355    0.03553    0.01444
## 574 1974-10-01 0.9677    0.03234    0.01444
## 884 2000-08-01 0.9680    0.03198    0.01444
## 287 1950-11-01 0.9698    0.03025    0.01444
## 911 2002-11-01 0.9707    0.02928    0.01444
## 54  1931-06-01 1.0278    0.02784    0.01444
## 80  1933-08-01 0.9730    0.02699    0.01444
## 133 1938-01-01 0.9745    0.02548    0.01444
## 730 1987-10-01 1.0255    0.02546    0.01444
## 639 1980-03-01 1.0253    0.02527    0.01444
## 887 2000-11-01 1.0251    0.02508    0.01444
## 161 1940-05-01 1.0247    0.02472    0.01444
## 64  1932-04-01 0.9767    0.02328    0.01444
## 867 1999-03-01 0.9771    0.02292    0.01444
```

```
## 129 1937-09-01 1.0224    0.02241    0.01444
## 40  1930-04-01 0.9777    0.02227    0.01444
## 870 1999-06-01 0.9782    0.02184    0.01444
## 624 1978-12-01 0.9783    0.02165    0.01444
## 898 2001-10-01 1.0215    0.02155    0.01444
## 53  1931-05-01 1.0211    0.02115    0.01444
## 880 2000-04-01 1.0210    0.02095    0.01444
## 868 1999-04-01 0.9791    0.02092    0.01444
## 890 2001-02-01 1.0206    0.02064    0.01444
## 283 1950-07-01 1.0206    0.02055    0.01444
## 398 1960-02-01 0.9797    0.02027    0.01444
## 881 2000-05-01 0.9798    0.02021    0.01444
## 589 1976-01-01 1.0201    0.02009    0.01444
## 525 1970-09-01 1.0198    0.01985    0.01444
## 147 1939-03-01 1.0198    0.01984    0.01444
## 562 1973-10-01 0.9805    0.01945    0.01444
## 32  1929-08-01 1.0190    0.01904    0.01444
## 83  1933-11-01 1.0186    0.01862    0.01444
## 877 2000-01-01 0.9814    0.01860    0.01444
## 65  1932-05-01 1.0185    0.01851    0.01444
## 976 2008-04-01 0.9815    0.01848    0.01444
## 985 2009-01-01 1.0185    0.01847    0.01444
## 60  1931-12-01 1.0180    0.01797    0.01444
## 82  1933-10-01 1.0180    0.01795    0.01444
## 50  1931-02-01 1.0175    0.01752    0.01444
## 904 2002-04-01 0.9825    0.01747    0.01444
## 564 1973-12-01 1.0170    0.01701    0.01444
## 780 1991-12-01 1.0169    0.01692    0.01444
## 520 1970-04-01 1.0169    0.01688    0.01444
## 860 1998-08-01 1.0166    0.01660    0.01444
## 49  1931-01-01 0.9834    0.01658    0.01444
## 109 1936-01-01 1.0165    0.01645    0.01444
## 193 1943-01-01 1.0163    0.01633    0.01444
## 72  1932-12-01 1.0162    0.01625    0.01444
## 181 1942-01-01 1.0162    0.01622    0.01444
## 891 2001-03-01 1.0162    0.01621    0.01444
## 559 1973-07-01 0.9843    0.01574    0.01444
## 137 1938-05-01 0.9845    0.01551    0.01444
## 989 2009-05-01 1.0155    0.01547    0.01444
## 136 1938-04-01 0.9847    0.01534    0.01444
## 649 1981-01-01 1.0151    0.01511    0.01444
```

```
## 577 1975-01-01 1.0147    0.01469    0.01444
## 982 2008-10-01 1.0147    0.01468    0.01444
## 35  1929-11-01 0.9854    0.01462    0.01444
## 48  1930-12-01 1.0145    0.01452    0.01444
## 368 1957-08-01 0.9855    0.01449    0.01444
```

D.13 (AEW) Portfolio 7

```
## $`Cook's Distance`
##         Month    Ci
## 77 1933-05-01 3.747
## 67 1932-07-01 1.702
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 77  1933-05-01 0.6659    0.33412    0.01444
## 882 2000-06-01 0.8308    0.16916    0.01444
## 68  1932-08-01 1.1549    0.15489    0.01444
## 876 1999-12-01 0.8992    0.10082    0.01444
## 58  1931-10-01 0.9338    0.06623    0.01444
## 988 2009-04-01 1.0535    0.05347    0.01444
## 51  1931-03-01 0.9511    0.04885    0.01444
## 138 1938-06-01 0.9524    0.04755    0.01444
## 108 1935-12-01 0.9577    0.04230    0.01444
## 76  1933-04-01 1.0416    0.04159    0.01444
## 67  1932-07-01 0.9589    0.04105    0.01444
## 991 2009-07-01 0.9595    0.04053    0.01444
## 985 2009-01-01 0.9613    0.03872    0.01444
## 879 2000-03-01 0.9617    0.03828    0.01444
## 40  1930-04-01 0.9622    0.03776    0.01444
## 104 1935-08-01 0.9665    0.03350    0.01444
## 881 2000-05-01 0.9674    0.03257    0.01444
## 730 1987-10-01 1.0324    0.03241    0.01444
## 878 2000-02-01 0.9680    0.03205    0.01444
## 85  1934-01-01 1.0318    0.03179    0.01444
## 16  1928-04-01 0.9683    0.03166    0.01444
## 890 2001-02-01 1.0282    0.02824    0.01444
## 647 1980-11-01 1.0282    0.02823    0.01444
## 880 2000-04-01 0.9724    0.02760    0.01444
## 57  1931-09-01 1.0268    0.02685    0.01444
## 574 1974-10-01 1.0255    0.02553    0.01444
## 887 2000-11-01 1.0255    0.02547    0.01444
## 129 1937-09-01 1.0249    0.02485    0.01444
## 161 1940-05-01 1.0241    0.02410    0.01444
## 71  1932-11-01 1.0239    0.02391    0.01444
## 118 1936-10-01 0.9762    0.02382    0.01444
## 867 1999-03-01 0.9764    0.02360    0.01444
```

```
## 639 1980-03-01 1.0229    0.02290    0.01444
## 911 2002-11-01 1.0229    0.02289    0.01444
## 107 1935-11-01 0.9773    0.02272    0.01444
## 34  1929-10-01 1.0227    0.02270    0.01444
## 542 1972-02-01 0.9776    0.02237    0.01444
## 72  1932-12-01 1.0218    0.02175    0.01444
## 283 1950-07-01 1.0210    0.02100    0.01444
## 622 1978-10-01 1.0209    0.02089    0.01444
## 32  1929-08-01 0.9792    0.02081    0.01444
## 565 1974-01-01 1.0204    0.02042    0.01444
## 559 1973-07-01 1.0200    0.02002    0.01444
## 81  1933-09-01 1.0198    0.01978    0.01444
## 372 1957-12-01 0.9813    0.01868    0.01444
## 860 1998-08-01 1.0185    0.01851    0.01444
## 905 2002-05-01 0.9816    0.01837    0.01444
## 82  1933-10-01 1.0182    0.01819    0.01444
## 563 1973-11-01 1.0182    0.01817    0.01444
## 910 2002-10-01 1.0176    0.01765    0.01444
## 907 2002-07-01 0.9824    0.01760    0.01444
## 781 1992-01-01 0.9826    0.01741    0.01444
## 147 1939-03-01 1.0165    0.01655    0.01444
## 982 2008-10-01 1.0165    0.01651    0.01444
## 50  1931-02-01 1.0165    0.01649    0.01444
## 898 2001-10-01 1.0164    0.01643    0.01444
## 59  1931-11-01 1.0164    0.01640    0.01444
## 36  1929-12-01 0.9841    0.01595    0.01444
## 525 1970-09-01 1.0159    0.01586    0.01444
## 520 1970-04-01 1.0158    0.01582    0.01444
## 136 1938-04-01 1.0156    0.01562    0.01444
## 60  1931-12-01 1.0156    0.01557    0.01444
## 848 1997-08-01 0.9844    0.01557    0.01444
## 35  1929-11-01 1.0156    0.01556    0.01444
## 573 1974-09-01 1.0154    0.01543    0.01444
## 54  1931-06-01 1.0150    0.01504    0.01444
## 80  1933-08-01 0.9855    0.01449    0.01444
```

D.14 (AVW) Portfolio 7

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 876 1999-12-01 0.7974    0.20262    0.01444
## 67  1932-07-01 1.1763    0.17632    0.01444
## 68  1932-08-01 1.1708    0.17079    0.01444
## 77  1933-05-01 1.1357    0.13566    0.01444
## 138 1938-06-01 0.8671    0.13288    0.01444
## 34  1929-10-01 0.8932    0.10675    0.01444
## 153 1939-09-01 1.0871    0.08706    0.01444
## 36  1929-12-01 0.9171    0.08286    0.01444
## 343 1955-07-01 0.9205    0.07948    0.01444
## 139 1938-07-01 0.9260    0.07395    0.01444
## 76  1933-04-01 1.0654    0.06540    0.01444
## 880 2000-04-01 0.9363    0.06368    0.01444
## 988 2009-04-01 1.0602    0.06019    0.01444
## 889 2001-01-01 1.0574    0.05737    0.01444
## 983 2008-11-01 0.9467    0.05331    0.01444
## 881 2000-05-01 0.9516    0.04837    0.01444
## 75  1933-03-01 0.9527    0.04734    0.01444
## 64  1932-04-01 0.9534    0.04656    0.01444
## 56  1931-08-01 0.9560    0.04404    0.01444
## 981 2008-09-01 0.9569    0.04308    0.01444
## 885 2000-09-01 0.9579    0.04210    0.01444
## 938 2005-02-01 0.9582    0.04179    0.01444
## 577 1975-01-01 0.9593    0.04070    0.01444
## 23  1928-11-01 0.9600    0.04002    0.01444
## 85  1934-01-01 1.0356    0.03555    0.01444
## 882 2000-06-01 0.9657    0.03425    0.01444
## 888 2000-12-01 0.9660    0.03401    0.01444
## 80  1933-08-01 0.9685    0.03146    0.01444
## 884 2000-08-01 0.9706    0.02942    0.01444
## 115 1936-07-01 0.9706    0.02941    0.01444
## 730 1987-10-01 1.0291    0.02911    0.01444
## 111 1936-03-01 0.9714    0.02856    0.01444
## 647 1980-11-01 1.0250    0.02503    0.01444
## 890 2001-02-01 1.0244    0.02437    0.01444
```

```
## 81  1933-09-01 1.0241    0.02412    0.01444
## 161 1940-05-01 1.0241    0.02406    0.01444
## 879 2000-03-01 1.0238    0.02377    0.01444
## 639 1980-03-01 1.0230    0.02297    0.01444
## 72  1932-12-01 1.0221    0.02214    0.01444
## 87  1934-03-01 0.9779    0.02211    0.01444
## 65  1932-05-01 1.0221    0.02209    0.01444
## 898 2001-10-01 1.0219    0.02189    0.01444
## 525 1970-09-01 1.0218    0.02179    0.01444
## 216 1944-12-01 0.9784    0.02156    0.01444
## 565 1974-01-01 1.0204    0.02041    0.01444
## 976 2008-04-01 0.9797    0.02026    0.01444
## 860 1998-08-01 1.0202    0.02023    0.01444
## 589 1976-01-01 1.0199    0.01994    0.01444
## 53  1931-05-01 1.0199    0.01990    0.01444
## 911 2002-11-01 1.0197    0.01972    0.01444
## 887 2000-11-01 0.9806    0.01941    0.01444
## 283 1950-07-01 1.0194    0.01936    0.01444
## 129 1937-09-01 1.0193    0.01925    0.01444
## 70  1932-10-01 1.0189    0.01887    0.01444
## 563 1973-11-01 1.0185    0.01849    0.01444
## 60  1931-12-01 1.0182    0.01822    0.01444
## 54  1931-06-01 1.0177    0.01766    0.01444
## 107 1935-11-01 1.0172    0.01723    0.01444
## 78  1933-06-01 1.0170    0.01703    0.01444
## 83  1933-11-01 1.0167    0.01674    0.01444
## 520 1970-04-01 1.0165    0.01645    0.01444
## 193 1943-01-01 1.0162    0.01624    0.01444
## 891 2001-03-01 1.0161    0.01608    0.01444
## 697 1985-01-01 1.0156    0.01558    0.01444
## 574 1974-10-01 1.0155    0.01547    0.01444
## 59  1931-11-01 1.0153    0.01531    0.01444
## 32  1929-08-01 1.0151    0.01514    0.01444
## 175 1941-07-01 0.9851    0.01493    0.01444
## 42  1930-06-01 1.0149    0.01486    0.01444
## 147 1939-03-01 0.9852    0.01480    0.01444
## 721 1987-01-01 1.0148    0.01478    0.01444
## 424 1962-04-01 0.9853    0.01473    0.01444
## 30  1929-06-01 1.0146    0.01463    0.01444
## 89  1934-05-01 1.0145    0.01449    0.01444
```

D.15 (AEW) Portfolio 8

```
## $`Cook's Distance`
##          Month    Ci
## 77  1933-05-01 1.663
## 153 1939-09-01 1.465
## 76  1933-04-01 1.408
## 68  1932-08-01 1.122
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 76  1933-04-01 0.6191    0.38093    0.01444
## 153 1939-09-01 0.7125    0.28753    0.01444
## 67  1932-07-01 1.1867    0.18672    0.01444
## 882 2000-06-01 0.8532    0.14679    0.01444
## 879 2000-03-01 0.9080    0.09201    0.01444
## 77  1933-05-01 0.9202    0.07977    0.01444
## 878 2000-02-01 1.0592    0.05919    0.01444
## 985 2009-01-01 0.9499    0.05008    0.01444
## 880 2000-04-01 0.9563    0.04367    0.01444
## 890 2001-02-01 1.0417    0.04171    0.01444
## 781 1992-01-01 0.9611    0.03893    0.01444
## 730 1987-10-01 1.0361    0.03605    0.01444
## 881 2000-05-01 0.9658    0.03420    0.01444
## 57  1931-09-01 1.0332    0.03318    0.01444
## 647 1980-11-01 1.0270    0.02697    0.01444
## 85  1934-01-01 1.0262    0.02621    0.01444
## 94  1934-10-01 0.9741    0.02590    0.01444
## 887 2000-11-01 1.0254    0.02539    0.01444
## 34  1929-10-01 1.0250    0.02502    0.01444
## 161 1940-05-01 1.0248    0.02483    0.01444
## 559 1973-07-01 1.0244    0.02443    0.01444
## 639 1980-03-01 1.0239    0.02387    0.01444
## 81  1933-09-01 1.0237    0.02370    0.01444
## 911 2002-11-01 1.0230    0.02297    0.01444
## 622 1978-10-01 1.0230    0.02297    0.01444
## 135 1938-03-01 1.0229    0.02287    0.01444
## 129 1937-09-01 1.0216    0.02158    0.01444
## 898 2001-10-01 1.0208    0.02085    0.01444
## 71  1932-11-01 0.9797    0.02030    0.01444
## 860 1998-08-01 1.0202    0.02023    0.01444
```

```
## 589 1976-01-01 1.0198    0.01982    0.01444
## 110 1936-02-01 0.9807    0.01929    0.01444
## 988 2009-04-01 1.0193    0.01928    0.01444
## 563 1973-11-01 1.0192    0.01918    0.01444
## 112 1936-04-01 1.0188    0.01882    0.01444
## 72  1932-12-01 1.0188    0.01881    0.01444
## 16  1928-04-01 0.9813    0.01866    0.01444
## 54  1931-06-01 1.0185    0.01849    0.01444
## 70  1932-10-01 1.0182    0.01818    0.01444
## 910 2002-10-01 1.0180    0.01804    0.01444
## 525 1970-09-01 1.0178    0.01783    0.01444
## 50  1931-02-01 1.0174    0.01743    0.01444
## 780 1991-12-01 0.9828    0.01720    0.01444
## 181 1942-01-01 1.0172    0.01718    0.01444
## 565 1974-01-01 1.0172    0.01717    0.01444
## 61  1932-01-01 1.0170    0.01697    0.01444
## 577 1975-01-01 1.0168    0.01685    0.01444
## 283 1950-07-01 1.0167    0.01667    0.01444
## 122 1937-02-01 0.9838    0.01619    0.01444
## 107 1935-11-01 1.0161    0.01610    0.01444
## 60  1931-12-01 1.0159    0.01588    0.01444
## 891 2001-03-01 1.0159    0.01587    0.01444
## 564 1973-12-01 1.0157    0.01570    0.01444
## 697 1985-01-01 1.0150    0.01495    0.01444
## 649 1981-01-01 1.0149    0.01493    0.01444
## 721 1987-01-01 1.0148    0.01483    0.01444
```

D.16 (AVW) Portfolio 8

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 68  1932-08-01 1.1716    0.17162    0.01444
## 77  1933-05-01 1.1660    0.16602    0.01444
## 83  1933-11-01 0.8470    0.15302    0.01444
## 67  1932-07-01 1.1488    0.14883    0.01444
## 138 1938-06-01 0.8616    0.13841    0.01444
## 868 1999-04-01 0.8965    0.10350    0.01444
## 153 1939-09-01 1.0890    0.08899    0.01444
## 76  1933-04-01 0.9224    0.07764    0.01444
## 876 1999-12-01 0.9320    0.06804    0.01444
## 889 2001-01-01 1.0569    0.05689    0.01444
## 988 2009-04-01 1.0568    0.05680    0.01444
## 84  1933-12-01 0.9495    0.05046    0.01444
## 162 1940-06-01 0.9568    0.04315    0.01444
## 561 1973-09-01 0.9573    0.04268    0.01444
## 490 1967-10-01 0.9595    0.04053    0.01444
## 389 1959-05-01 0.9598    0.04018    0.01444
## 57  1931-09-01 1.0399    0.03995    0.01444
## 878 2000-02-01 0.9637    0.03631    0.01444
## 880 2000-04-01 0.9655    0.03451    0.01444
## 879 2000-03-01 1.0319    0.03190    0.01444
## 54  1931-06-01 1.0318    0.03182    0.01444
## 227 1945-11-01 0.9704    0.02961    0.01444
## 137 1938-05-01 0.9730    0.02699    0.01444
## 870 1999-06-01 0.9731    0.02693    0.01444
## 66  1932-06-01 0.9732    0.02684    0.01444
## 884 2000-08-01 0.9745    0.02553    0.01444
## 71  1932-11-01 1.0254    0.02538    0.01444
## 85  1934-01-01 1.0252    0.02520    0.01444
## 75  1933-03-01 0.9749    0.02509    0.01444
## 161 1940-05-01 1.0248    0.02483    0.01444
## 185 1942-05-01 0.9759    0.02409    0.01444
## 204 1943-12-01 0.9760    0.02399    0.01444
## 65  1932-05-01 1.0236    0.02364    0.01444
## 885 2000-09-01 0.9768    0.02321    0.01444
```

```
## 730 1987-10-01 1.0232    0.02321    0.01444
## 147 1939-03-01 0.9770    0.02304    0.01444
## 999 2010-03-01 0.9772    0.02281    0.01444
## 898 2001-10-01 1.0225    0.02249    0.01444
## 25  1929-01-01 0.9780    0.02198    0.01444
## 639 1980-03-01 1.0219    0.02189    0.01444
## 559 1973-07-01 1.0217    0.02169    0.01444
## 81  1933-09-01 1.0216    0.02158    0.01444
## 343 1955-07-01 0.9793    0.02072    0.01444
## 72  1932-12-01 1.0206    0.02056    0.01444
## 34  1929-10-01 1.0204    0.02044    0.01444
## 443 1963-11-01 0.9799    0.02010    0.01444
## 860 1998-08-01 1.0200    0.02004    0.01444
## 495 1968-03-01 0.9800    0.01997    0.01444
## 525 1970-09-01 1.0199    0.01988    0.01444
## 589 1976-01-01 1.0198    0.01983    0.01444
## 123 1937-03-01 0.9807    0.01934    0.01444
## 78  1933-06-01 0.9813    0.01873    0.01444
## 53  1931-05-01 1.0186    0.01858    0.01444
## 82  1933-10-01 1.0184    0.01841    0.01444
## 577 1975-01-01 1.0183    0.01826    0.01444
## 61  1932-01-01 1.0181    0.01812    0.01444
## 882 2000-06-01 1.0180    0.01800    0.01444
## 890 2001-02-01 1.0177    0.01773    0.01444
## 887 2000-11-01 1.0173    0.01730    0.01444
## 112 1936-04-01 1.0165    0.01645    0.01444
## 911 2002-11-01 1.0165    0.01645    0.01444
## 897 2001-09-01 1.0163    0.01631    0.01444
## 520 1970-04-01 1.0162    0.01624    0.01444
## 904 2002-04-01 0.9838    0.01622    0.01444
## 60  1931-12-01 1.0161    0.01612    0.01444
## 50  1931-02-01 1.0159    0.01592    0.01444
## 874 1999-10-01 1.0159    0.01585    0.01444
## 107 1935-11-01 1.0156    0.01561    0.01444
## 697 1985-01-01 1.0154    0.01543    0.01444
## 565 1974-01-01 1.0154    0.01542    0.01444
## 649 1981-01-01 1.0151    0.01508    0.01444
## 780 1991-12-01 1.0149    0.01493    0.01444
## 891 2001-03-01 1.0149    0.01491    0.01444
## 721 1987-01-01 1.0147    0.01472    0.01444
## 134 1938-02-01 0.9853    0.01471    0.01444
```

```
## 985 2009-01-01 1.0146    0.01460    0.01444
## 781 1992-01-01 1.0145    0.01454    0.01444
```

D.17 (AEW) Portfolio 9

```
## $`Cook's Distance`
##         Month    Ci
## 77 1933-05-01 2.223
## 67 1932-07-01 1.016
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 193 1943-01-01 0.8168    0.18316    0.01444
## 85  1934-01-01 0.8266    0.17338    0.01444
## 68  1932-08-01 1.1711    0.17111    0.01444
## 77  1933-05-01 0.8453    0.15468    0.01444
## 877 2000-01-01 0.8634    0.13665    0.01444
## 78  1933-06-01 0.8823    0.11769    0.01444
## 882 2000-06-01 0.8872    0.11281    0.01444
## 879 2000-03-01 0.8928    0.10716    0.01444
## 781 1992-01-01 0.9161    0.08394    0.01444
## 878 2000-02-01 1.0808    0.08083    0.01444
## 58  1931-10-01 0.9354    0.06456    0.01444
## 76  1933-04-01 1.0643    0.06429    0.01444
## 67  1932-07-01 1.0496    0.04958    0.01444
## 65  1932-05-01 0.9523    0.04774    0.01444
## 66  1932-06-01 0.9543    0.04572    0.01444
## 138 1938-06-01 1.0428    0.04280    0.01444
## 890 2001-02-01 1.0418    0.04182    0.01444
## 988 2009-04-01 1.0407    0.04070    0.01444
## 889 2001-01-01 0.9603    0.03969    0.01444
## 730 1987-10-01 1.0396    0.03962    0.01444
## 780 1991-12-01 0.9615    0.03850    0.01444
## 876 1999-12-01 0.9648    0.03522    0.01444
## 57  1931-09-01 1.0337    0.03373    0.01444
## 881 2000-05-01 0.9670    0.03303    0.01444
## 647 1980-11-01 1.0271    0.02714    0.01444
## 109 1936-01-01 0.9732    0.02682    0.01444
## 135 1938-03-01 1.0267    0.02671    0.01444
## 153 1939-09-01 0.9742    0.02580    0.01444
## 887 2000-11-01 1.0257    0.02568    0.01444
## 9   1927-09-01 0.9748    0.02518    0.01444
## 489 1967-09-01 0.9757    0.02427    0.01444
## 639 1980-03-01 1.0239    0.02394    0.01444
```

```
## 81  1933-09-01 1.0238    0.02377    0.01444
## 54  1931-06-01 1.0235    0.02351    0.01444
## 989 2009-05-01 0.9773    0.02274    0.01444
## 898 2001-10-01 1.0227    0.02269    0.01444
## 161 1940-05-01 1.0224    0.02239    0.01444
## 911 2002-11-01 1.0223    0.02227    0.01444
## 80  1933-08-01 1.0215    0.02149    0.01444
## 525 1970-09-01 1.0210    0.02098    0.01444
## 858 1998-06-01 0.9793    0.02071    0.01444
## 71  1932-11-01 1.0202    0.02019    0.01444
## 677 1983-05-01 0.9798    0.02017    0.01444
## 283 1950-07-01 1.0198    0.01977    0.01444
## 860 1998-08-01 1.0196    0.01965    0.01444
## 565 1974-01-01 1.0196    0.01962    0.01444
## 147 1939-03-01 1.0181    0.01806    0.01444
## 64  1932-04-01 1.0180    0.01802    0.01444
## 82  1933-10-01 1.0180    0.01801    0.01444
## 107 1935-11-01 1.0177    0.01775    0.01444
## 112 1936-04-01 1.0177    0.01768    0.01444
## 875 1999-11-01 1.0177    0.01768    0.01444
## 129 1937-09-01 1.0175    0.01753    0.01444
## 559 1973-07-01 1.0168    0.01678    0.01444
## 42  1930-06-01 1.0168    0.01676    0.01444
## 904 2002-04-01 1.0166    0.01660    0.01444
## 891 2001-03-01 1.0161    0.01612    0.01444
## 59  1931-11-01 1.0156    0.01560    0.01444
## 910 2002-10-01 1.0155    0.01555    0.01444
## 892 2001-04-01 1.0154    0.01538    0.01444
## 50  1931-02-01 1.0150    0.01503    0.01444
## 697 1985-01-01 1.0150    0.01499    0.01444
## 622 1978-10-01 1.0147    0.01468    0.01444
## 98  1935-02-01 1.0145    0.01454    0.01444
## 909 2002-09-01 1.0145    0.01453    0.01444
```

D.18 (AVW) Portfolio 9

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##           Month   CVRi abs.CVRi_1 calpt.crit
## 67   1932-07-01 1.1862    0.18625    0.01444
## 68   1932-08-01 1.1719    0.17186    0.01444
## 77   1933-05-01 1.1692    0.16919    0.01444
## 878  2000-02-01 0.8389    0.16115    0.01444
## 15   1928-03-01 0.8749    0.12507    0.01444
## 879  2000-03-01 0.8928    0.10720    0.01444
## 153  1939-09-01 1.0892    0.08921    0.01444
## 23   1928-11-01 0.9139    0.08610    0.01444
## 876  1999-12-01 0.9226    0.07739    0.01444
## 80   1933-08-01 0.9321    0.06791    0.01444
## 889  2001-01-01 1.0569    0.05690    0.01444
## 647  1980-11-01 0.9478    0.05220    0.01444
## 138  1938-06-01 1.0478    0.04783    0.01444
## 882  2000-06-01 0.9577    0.04225    0.01444
## 890  2001-02-01 1.0414    0.04138    0.01444
## 730  1987-10-01 1.0403    0.04031    0.01444
## 57   1931-09-01 1.0378    0.03776    0.01444
## 30   1929-06-01 0.9650    0.03496    0.01444
## 877  2000-01-01 0.9653    0.03470    0.01444
## 76   1933-04-01 1.0343    0.03434    0.01444
## 1033 2013-01-01 0.9666    0.03340    0.01444
## 54   1931-06-01 1.0297    0.02969    0.01444
## 442  1963-10-01 0.9717    0.02829    0.01444
## 280  1950-04-01 0.9718    0.02816    0.01444
## 222  1945-06-01 0.9724    0.02765    0.01444
## 66   1932-06-01 0.9728    0.02715    0.01444
## 574  1974-10-01 1.0260    0.02602    0.01444
## 988  2009-04-01 1.0257    0.02575    0.01444
## 985  2009-01-01 0.9748    0.02524    0.01444
## 887  2000-11-01 1.0252    0.02517    0.01444
## 639  1980-03-01 1.0247    0.02471    0.01444
## 638  1980-02-01 0.9753    0.02471    0.01444
## 81   1933-09-01 1.0241    0.02408    0.01444
## 525  1970-09-01 1.0223    0.02230    0.01444
```

```
## 227  1945-11-01 0.9777    0.02229    0.01444
## 479  1966-11-01 0.9778    0.02221    0.01444
## 124  1937-04-01 0.9786    0.02143    0.01444
## 288  1950-12-01 0.9787    0.02132    0.01444
## 53   1931-05-01 1.0211    0.02112    0.01444
## 680  1983-08-01 0.9793    0.02066    0.01444
## 115  1936-07-01 0.9801    0.01989    0.01444
## 129  1937-09-01 1.0198    0.01981    0.01444
## 65   1932-05-01 1.0197    0.01975    0.01444
## 118  1936-10-01 0.9803    0.01968    0.01444
## 72   1932-12-01 1.0195    0.01951    0.01444
## 676  1983-04-01 0.9806    0.01940    0.01444
## 563  1973-11-01 1.0194    0.01939    0.01444
## 622  1978-10-01 0.9806    0.01936    0.01444
## 898  2001-10-01 1.0189    0.01892    0.01444
## 865  1999-01-01 0.9815    0.01853    0.01444
## 112  1936-04-01 1.0185    0.01849    0.01444
## 70   1932-10-01 1.0183    0.01827    0.01444
## 910  2002-10-01 1.0178    0.01780    0.01444
## 60   1931-12-01 1.0176    0.01758    0.01444
## 884  2000-08-01 0.9827    0.01734    0.01444
## 780  1991-12-01 1.0172    0.01719    0.01444
## 37   1930-01-01 0.9828    0.01719    0.01444
## 34   1929-10-01 1.0171    0.01706    0.01444
## 147  1939-03-01 1.0168    0.01683    0.01444
## 520  1970-04-01 1.0168    0.01680    0.01444
## 559  1973-07-01 1.0168    0.01678    0.01444
## 897  2001-09-01 1.0166    0.01663    0.01444
## 294  1951-06-01 0.9836    0.01637    0.01444
## 989  2009-05-01 1.0163    0.01635    0.01444
## 193  1943-01-01 1.0163    0.01630    0.01444
## 891  2001-03-01 1.0163    0.01628    0.01444
## 881  2000-05-01 0.9844    0.01561    0.01444
## 136  1938-04-01 1.0156    0.01558    0.01444
## 35   1929-11-01 1.0154    0.01541    0.01444
## 42   1930-06-01 1.0148    0.01481    0.01444
## 577  1975-01-01 1.0148    0.01476    0.01444
## 860  1998-08-01 1.0146    0.01461    0.01444
## 667  1982-07-01 0.9854    0.01458    0.01444
## 982  2008-10-01 1.0144    0.01444    0.01444
```

D.19 (AEW) Portfolio 10

```
## $`Cook's Distance`
## [1] "None"
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 193 1943-01-01 0.7444    0.25565    0.01444
## 67  1932-07-01 1.1742    0.17419    0.01444
## 77  1933-05-01 1.1659    0.16594    0.01444
## 68  1932-08-01 1.1562    0.15617    0.01444
## 181 1942-01-01 0.8887    0.11126    0.01444
## 781 1992-01-01 0.8956    0.10445    0.01444
## 878 2000-02-01 1.0839    0.08388    0.01444
## 78  1933-06-01 0.9298    0.07015    0.01444
## 153 1939-09-01 0.9340    0.06602    0.01444
## 76  1933-04-01 1.0553    0.05532    0.01444
## 877 2000-01-01 0.9471    0.05287    0.01444
## 981 2008-09-01 0.9476    0.05238    0.01444
## 13  1928-01-01 0.9593    0.04071    0.01444
## 138 1938-06-01 0.9615    0.03852    0.01444
## 23  1928-11-01 0.9617    0.03833    0.01444
## 85  1934-01-01 1.0362    0.03619    0.01444
## 57  1931-09-01 1.0357    0.03572    0.01444
## 890 2001-02-01 1.0343    0.03426    0.01444
## 189 1942-09-01 0.9669    0.03306    0.01444
## 882 2000-06-01 1.0326    0.03263    0.01444
## 139 1938-07-01 0.9686    0.03139    0.01444
## 574 1974-10-01 1.0305    0.03048    0.01444
## 74  1933-02-01 0.9707    0.02935    0.01444
## 27  1929-03-01 0.9710    0.02898    0.01444
## 647 1980-11-01 1.0283    0.02831    0.01444
## 879 2000-03-01 0.9721    0.02786    0.01444
## 71  1932-11-01 1.0259    0.02586    0.01444
## 876 1999-12-01 1.0258    0.02582    0.01444
## 622 1978-10-01 1.0256    0.02559    0.01444
## 979 2008-07-01 0.9746    0.02539    0.01444
## 129 1937-09-01 1.0251    0.02510    0.01444
## 559 1973-07-01 1.0243    0.02425    0.01444
## 730 1987-10-01 1.0240    0.02395    0.01444
## 988 2009-04-01 1.0238    0.02378    0.01444
```

```
## 868 1999-04-01 0.9773    0.02269    0.01444
## 161 1940-05-01 1.0226    0.02262    0.01444
## 639 1980-03-01 1.0226    0.02255    0.01444
## 525 1970-09-01 1.0225    0.02251    0.01444
## 980 2008-08-01 0.9778    0.02219    0.01444
## 989 2009-05-01 0.9778    0.02215    0.01444
## 880 2000-04-01 1.0214    0.02141    0.01444
## 887 2000-11-01 0.9798    0.02021    0.01444
## 147 1939-03-01 1.0198    0.01984    0.01444
## 135 1938-03-01 0.9803    0.01970    0.01444
## 32  1929-08-01 1.0195    0.01950    0.01444
## 975 2008-03-01 0.9806    0.01940    0.01444
## 72  1932-12-01 1.0193    0.01930    0.01444
## 112 1936-04-01 1.0191    0.01906    0.01444
## 673 1983-01-01 0.9812    0.01879    0.01444
## 58  1931-10-01 0.9813    0.01866    0.01444
## 82  1933-10-01 1.0182    0.01817    0.01444
## 73  1933-01-01 0.9821    0.01788    0.01444
## 589 1976-01-01 1.0178    0.01780    0.01444
## 60  1931-12-01 1.0177    0.01772    0.01444
## 860 1998-08-01 1.0175    0.01746    0.01444
## 577 1975-01-01 1.0174    0.01745    0.01444
## 34  1929-10-01 0.9826    0.01745    0.01444
## 49  1931-01-01 0.9827    0.01732    0.01444
## 196 1943-04-01 0.9829    0.01714    0.01444
## 50  1931-02-01 1.0170    0.01701    0.01444
## 563 1973-11-01 1.0170    0.01699    0.01444
## 875 1999-11-01 0.9832    0.01683    0.01444
## 497 1968-05-01 0.9832    0.01682    0.01444
## 80  1933-08-01 1.0167    0.01669    0.01444
## 889 2001-01-01 0.9836    0.01642    0.01444
## 891 2001-03-01 1.0163    0.01631    0.01444
## 493 1968-01-01 0.9838    0.01618    0.01444
## 565 1974-01-01 1.0157    0.01573    0.01444
## 36  1929-12-01 0.9846    0.01543    0.01444
## 697 1985-01-01 1.0154    0.01541    0.01444
## 573 1974-09-01 1.0151    0.01511    0.01444
## 649 1981-01-01 1.0150    0.01497    0.01444
## 81  1933-09-01 1.0149    0.01494    0.01444
## 35  1929-11-01 1.0148    0.01485    0.01444
## 897 2001-09-01 1.0148    0.01485    0.01444
```

```
## 520 1970-04-01 1.0148    0.01483    0.01444
## 30  1929-06-01 1.0147    0.01473    0.01444
## 881 2000-05-01 1.0147    0.01470    0.01444
```

D.20 (AVW) Portfolio 10

```
## $`Cook's Distance`
##         Month    Ci
## 77 1933-05-01 1.513
##
## $`Covariance Ratio`
##          Month   CVRi abs.CVRi_1 calpt.crit
## 67  1932-07-01 1.1725    0.17255    0.01444
## 68  1932-08-01 1.1693    0.16935    0.01444
## 71  1932-11-01 0.8319    0.16808    0.01444
## 23  1928-11-01 0.8963    0.10366    0.01444
## 153 1939-09-01 1.0910    0.09096    0.01444
## 887 2000-11-01 0.9130    0.08696    0.01444
## 70  1932-10-01 0.9160    0.08404    0.01444
## 878 2000-02-01 1.0788    0.07883    0.01444
## 25  1929-01-01 0.9347    0.06535    0.01444
## 77  1933-05-01 0.9412    0.05880    0.01444
## 196 1943-04-01 0.9447    0.05531    0.01444
## 889 2001-01-01 1.0539    0.05387    0.01444
## 979 2008-07-01 0.9553    0.04469    0.01444
## 890 2001-02-01 1.0423    0.04234    0.01444
## 879 2000-03-01 1.0397    0.03975    0.01444
## 30  1929-06-01 0.9640    0.03605    0.01444
## 885 2000-09-01 0.9642    0.03584    0.01444
## 138 1938-06-01 1.0328    0.03277    0.01444
## 62  1932-02-01 0.9697    0.03032    0.01444
## 65  1932-05-01 1.0303    0.03030    0.01444
## 135 1938-03-01 1.0262    0.02618    0.01444
## 639 1980-03-01 1.0252    0.02524    0.01444
## 559 1973-07-01 1.0246    0.02456    0.01444
## 178 1941-10-01 0.9756    0.02441    0.01444
## 129 1937-09-01 1.0244    0.02437    0.01444
## 577 1975-01-01 1.0241    0.02410    0.01444
## 85  1934-01-01 1.0235    0.02352    0.01444
## 57  1931-09-01 1.0233    0.02333    0.01444
## 574 1974-10-01 1.0228    0.02280    0.01444
## 898 2001-10-01 1.0224    0.02239    0.01444
## 76  1933-04-01 1.0219    0.02186    0.01444
## 470 1966-02-01 0.9782    0.02182    0.01444
## 80  1933-08-01 1.0212    0.02124    0.01444
```

```
## 525 1970-09-01 1.0209    0.02095    0.01444
## 622 1978-10-01 1.0203    0.02030    0.01444
## 479 1966-11-01 0.9797    0.02025    0.01444
## 283 1950-07-01 1.0202    0.02019    0.01444
## 976 2008-04-01 0.9810    0.01900    0.01444
## 876 1999-12-01 1.0187    0.01871    0.01444
## 181 1942-01-01 1.0187    0.01866    0.01444
## 647 1980-11-01 1.0185    0.01854    0.01444
## 589 1976-01-01 1.0184    0.01837    0.01444
## 198 1943-06-01 0.9817    0.01828    0.01444
## 91  1934-07-01 1.0182    0.01821    0.01444
## 910 2002-10-01 1.0182    0.01815    0.01444
## 60  1931-12-01 1.0180    0.01805    0.01444
## 61  1932-01-01 0.9820    0.01805    0.01444
## 875 1999-11-01 1.0180    0.01798    0.01444
## 64  1932-04-01 0.9822    0.01775    0.01444
## 107 1935-11-01 1.0177    0.01765    0.01444
## 828 1995-12-01 0.9827    0.01729    0.01444
## 83  1933-11-01 0.9828    0.01715    0.01444
## 478 1966-10-01 0.9830    0.01697    0.01444
## 780 1991-12-01 1.0169    0.01685    0.01444
## 985 2009-01-01 1.0167    0.01671    0.01444
## 860 1998-08-01 1.0167    0.01668    0.01444
## 42  1930-06-01 1.0166    0.01660    0.01444
## 891 2001-03-01 1.0165    0.01648    0.01444
## 982 2008-10-01 1.0163    0.01634    0.01444
## 950 2006-02-01 0.9837    0.01631    0.01444
## 53  1931-05-01 1.0162    0.01620    0.01444
## 345 1955-09-01 0.9839    0.01612    0.01444
## 847 1997-07-01 0.9839    0.01610    0.01444
## 563 1973-11-01 1.0158    0.01583    0.01444
## 904 2002-04-01 1.0158    0.01583    0.01444
## 501 1968-09-01 0.9845    0.01554    0.01444
## 697 1985-01-01 1.0155    0.01548    0.01444
## 136 1938-04-01 1.0154    0.01537    0.01444
## 32  1929-08-01 1.0153    0.01527    0.01444
## 35  1929-11-01 1.0152    0.01525    0.01444
## 881 2000-05-01 1.0150    0.01499    0.01444
## 147 1939-03-01 1.0150    0.01497    0.01444
## 50  1931-02-01 1.0149    0.01493    0.01444
## 34  1929-10-01 0.9851    0.01486    0.01444
```

```
## 892 2001-04-01 1.0148    0.01482    0.01444
## 842 1997-02-01 0.9853    0.01472    0.01444
## 48  1930-12-01 1.0145    0.01447    0.01444
```

Appendix E

Excluded Months By Panel and Weighting Method

```
## $`(AEW) Panel B's Excluded Months`
## [1] "1932-07-01" "1932-08-01" "1933-04-01" "1933-05-01" "1939-09-01"
##
## $`(AEW) Panel B's Number of Excluded Months`
## [1] 5
##
## $`(AVW) Panel B's Excluded Months`
## [1] "1932-07-01" "1932-08-01" "1933-04-01" "1933-05-01"
##
## $`(AVW) Panel B's Number of Excluded Months`
## [1] 4
##
## $`(AEW) Panel C's Excluded Months`
##       [,1]         [,2]         [,3]         [,4]         [,5]
##  [1,] "1927-09-01" "1927-11-01" "1927-12-01" "1928-01-01" "1928-04-01"
##  [2,] "1928-05-01" "1928-08-01" "1928-11-01" "1929-03-01" "1929-05-01"
##  [3,] "1929-06-01" "1929-08-01" "1929-10-01" "1929-11-01" "1929-12-01"
##  [4,] "1930-01-01" "1930-03-01" "1930-04-01" "1930-06-01" "1930-07-01"
##  [5,] "1930-12-01" "1931-01-01" "1931-02-01" "1931-03-01" "1931-05-01"
##  [6,] "1931-06-01" "1931-08-01" "1931-09-01" "1931-10-01" "1931-11-01"
##  [7,] "1931-12-01" "1932-01-01" "1932-02-01" "1932-03-01" "1932-04-01"
##  [8,] "1932-05-01" "1932-06-01" "1932-07-01" "1932-08-01" "1932-09-01"
##  [9,] "1932-10-01" "1932-11-01" "1932-12-01" "1933-01-01" "1933-02-01"
## [10,] "1933-03-01" "1933-04-01" "1933-05-01" "1933-06-01" "1933-08-01"
## [11,] "1933-09-01" "1933-10-01" "1933-11-01" "1934-01-01" "1934-05-01"
## [12,] "1934-07-01" "1934-08-01" "1934-10-01" "1935-02-01" "1935-04-01"
```

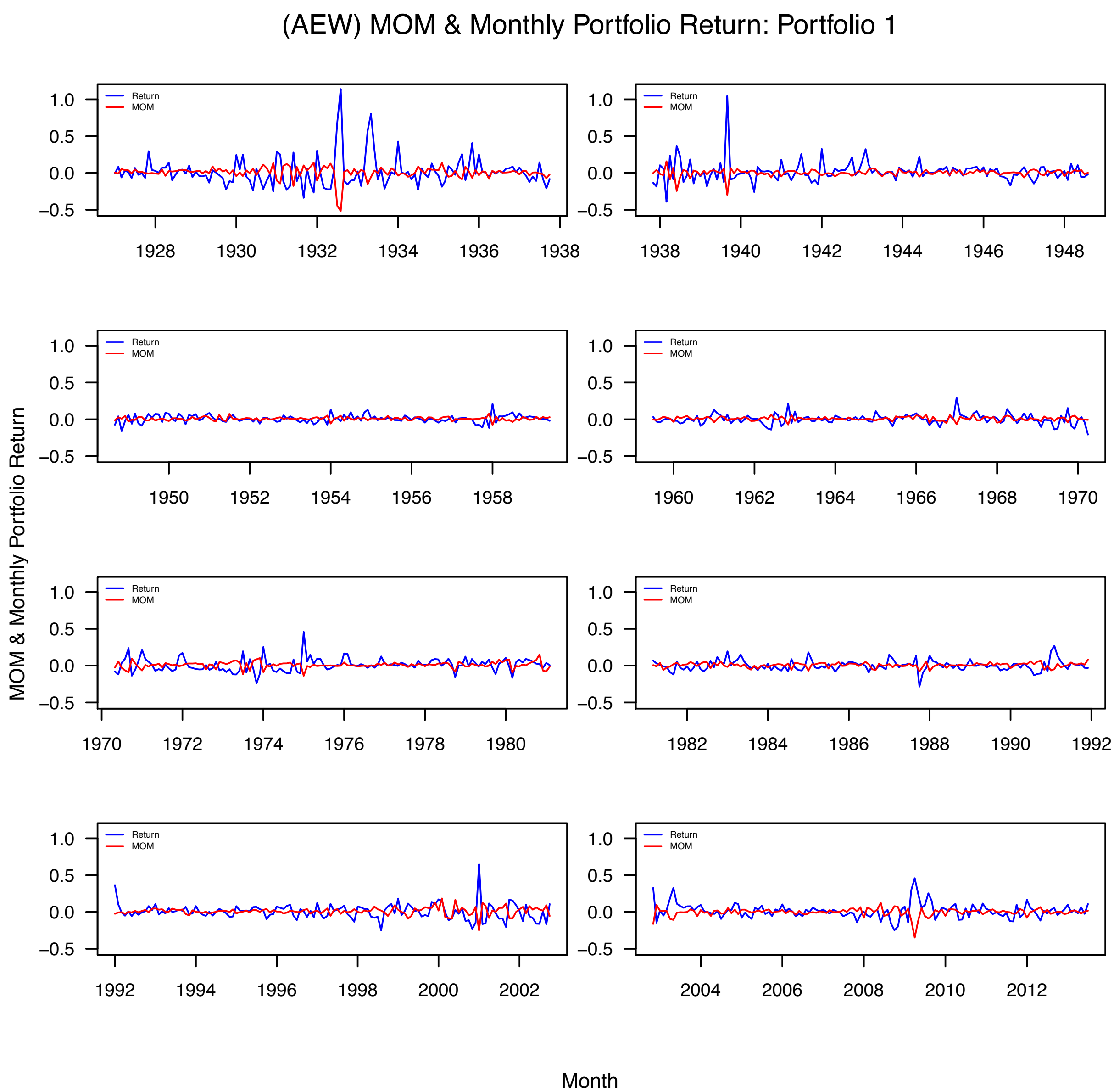
```
## [13,] "1935-06-01" "1935-07-01" "1935-08-01" "1935-09-01" "1935-11-01"
## [14,] "1935-12-01" "1936-01-01" "1936-02-01" "1936-04-01" "1936-10-01"
## [15,] "1937-01-01" "1937-02-01" "1937-09-01" "1938-03-01" "1938-04-01"
## [16,] "1938-05-01" "1938-06-01" "1938-07-01" "1939-03-01" "1939-09-01"
## [17,] "1940-04-01" "1940-05-01" "1941-01-01" "1942-01-01" "1942-09-01"
## [18,] "1943-01-01" "1943-02-01" "1943-04-01" "1943-05-01" "1948-05-01"
## [19,] "1950-07-01" "1957-12-01" "1967-09-01" "1968-01-01" "1968-05-01"
## [20,] "1970-04-01" "1970-05-01" "1970-07-01" "1970-09-01" "1971-01-01"
## [21,] "1972-01-01" "1972-02-01" "1973-07-01" "1973-11-01" "1973-12-01"
## [22,] "1974-01-01" "1974-09-01" "1974-10-01" "1975-01-01" "1976-01-01"
## [23,] "1977-01-01" "1978-10-01" "1980-03-01" "1980-09-01" "1980-11-01"
## [24,] "1981-01-01" "1982-08-01" "1982-11-01" "1983-01-01" "1983-05-01"
## [25,] "1983-10-01" "1985-01-01" "1986-08-01" "1987-01-01" "1987-09-01"
## [26,] "1987-10-01" "1990-11-01" "1990-12-01" "1991-02-01" "1991-11-01"
## [27,] "1991-12-01" "1992-01-01" "1996-12-01" "1997-01-01" "1997-08-01"
## [28,] "1997-12-01" "1998-01-01" "1998-06-01" "1998-08-01" "1999-01-01"
## [29,] "1999-03-01" "1999-04-01" "1999-10-01" "1999-11-01" "1999-12-01"
## [30,] "2000-01-01" "2000-02-01" "2000-03-01" "2000-04-01" "2000-05-01"
## [31,] "2000-06-01" "2000-09-01" "2000-10-01" "2000-11-01" "2000-12-01"
## [32,] "2001-01-01" "2001-02-01" "2001-03-01" "2001-04-01" "2001-05-01"
## [33,] "2001-07-01" "2001-08-01" "2001-09-01" "2001-10-01" "2001-11-01"
## [34,] "2002-04-01" "2002-05-01" "2002-07-01" "2002-09-01" "2002-10-01"
## [35,] "2002-11-01" "2002-12-01" "2003-05-01" "2008-03-01" "2008-07-01"
## [36,] "2008-08-01" "2008-09-01" "2008-10-01" "2009-01-01" "2009-02-01"
## [37,] "2009-03-01" "2009-04-01" "2009-05-01" "2009-06-01" "2009-07-01"
## [38,] "2009-08-01" "2011-10-01" ""           ""           ""
##
## $`(AEW) Panel C's Number of Excluded Months`
## [1] 187
##
## $`(AVW) Panel C's Excluded Months`
##       [,1]         [,2]         [,3]         [,4]         [,5]
##  [1,] "1927-01-01" "1927-02-01" "1927-03-01" "1927-04-01" "1927-06-01"
##  [2,] "1927-08-01" "1927-12-01" "1928-03-01" "1928-04-01" "1928-09-01"
##  [3,] "1928-11-01" "1929-01-01" "1929-02-01" "1929-04-01" "1929-06-01"
##  [4,] "1929-07-01" "1929-08-01" "1929-09-01" "1929-10-01" "1929-11-01"
##  [5,] "1929-12-01" "1930-01-01" "1930-04-01" "1930-05-01" "1930-06-01"
##  [6,] "1930-07-01" "1930-10-01" "1930-11-01" "1930-12-01" "1931-01-01"
##  [7,] "1931-02-01" "1931-04-01" "1931-05-01" "1931-06-01" "1931-08-01"
##  [8,] "1931-09-01" "1931-10-01" "1931-11-01" "1931-12-01" "1932-01-01"
##  [9,] "1932-02-01" "1932-04-01" "1932-05-01" "1932-06-01" "1932-07-01"
```

```
## [10,] "1932-08-01" "1932-09-01" "1932-10-01" "1932-11-01" "1932-12-01"
## [11,] "1933-03-01" "1933-04-01" "1933-05-01" "1933-06-01" "1933-07-01"
## [12,] "1933-08-01" "1933-09-01" "1933-10-01" "1933-11-01" "1933-12-01"
## [13,] "1934-01-01" "1934-03-01" "1934-05-01" "1934-07-01" "1934-11-01"
## [14,] "1935-02-01" "1935-03-01" "1935-05-01" "1935-06-01" "1935-08-01"
## [15,] "1935-09-01" "1935-11-01" "1936-01-01" "1936-02-01" "1936-03-01"
## [16,] "1936-04-01" "1936-07-01" "1936-09-01" "1936-10-01" "1937-01-01"
## [17,] "1937-03-01" "1937-04-01" "1937-09-01" "1937-11-01" "1937-12-01"
## [18,] "1938-01-01" "1938-02-01" "1938-03-01" "1938-04-01" "1938-05-01"
## [19,] "1938-06-01" "1938-07-01" "1938-10-01" "1938-11-01" "1939-03-01"
## [20,] "1939-07-01" "1939-09-01" "1940-05-01" "1940-06-01" "1940-10-01"
## [21,] "1941-07-01" "1941-10-01" "1941-11-01" "1941-12-01" "1942-01-01"
## [22,] "1942-05-01" "1943-01-01" "1943-02-01" "1943-04-01" "1943-06-01"
## [23,] "1943-12-01" "1944-12-01" "1945-06-01" "1945-11-01" "1946-01-01"
## [24,] "1947-01-01" "1950-04-01" "1950-07-01" "1950-11-01" "1950-12-01"
## [25,] "1951-06-01" "1955-07-01" "1955-09-01" "1957-08-01" "1957-11-01"
## [26,] "1958-07-01" "1959-05-01" "1960-02-01" "1962-04-01" "1963-10-01"
## [27,] "1963-11-01" "1966-02-01" "1966-10-01" "1966-11-01" "1967-07-01"
## [28,] "1967-10-01" "1968-03-01" "1968-09-01" "1969-06-01" "1970-01-01"
## [29,] "1970-04-01" "1970-07-01" "1970-09-01" "1972-01-01" "1973-07-01"
## [30,] "1973-09-01" "1973-10-01" "1973-11-01" "1973-12-01" "1974-01-01"
## [31,] "1974-05-01" "1974-09-01" "1974-10-01" "1975-01-01" "1976-01-01"
## [32,] "1978-10-01" "1978-12-01" "1980-02-01" "1980-03-01" "1980-11-01"
## [33,] "1981-01-01" "1982-07-01" "1982-10-01" "1983-01-01" "1983-04-01"
## [34,] "1983-08-01" "1985-01-01" "1987-01-01" "1987-10-01" "1991-01-01"
## [35,] "1991-12-01" "1992-01-01" "1993-04-01" "1995-12-01" "1997-02-01"
## [36,] "1997-07-01" "1998-08-01" "1998-12-01" "1999-01-01" "1999-03-01"
## [37,] "1999-04-01" "1999-06-01" "1999-10-01" "1999-11-01" "1999-12-01"
## [38,] "2000-01-01" "2000-02-01" "2000-03-01" "2000-04-01" "2000-05-01"
## [39,] "2000-06-01" "2000-07-01" "2000-08-01" "2000-09-01" "2000-10-01"
## [40,] "2000-11-01" "2000-12-01" "2001-01-01" "2001-02-01" "2001-03-01"
## [41,] "2001-04-01" "2001-05-01" "2001-09-01" "2001-10-01" "2001-11-01"
## [42,] "2002-02-01" "2002-04-01" "2002-06-01" "2002-07-01" "2002-08-01"
## [43,] "2002-10-01" "2002-11-01" "2002-12-01" "2003-10-01" "2005-02-01"
## [44,] "2006-02-01" "2008-04-01" "2008-07-01" "2008-08-01" "2008-09-01"
## [45,] "2008-10-01" "2008-11-01" "2009-01-01" "2009-02-01" "2009-03-01"
## [46,] "2009-04-01" "2009-05-01" "2009-06-01" "2009-08-01" "2010-03-01"
## [47,] "2013-01-01" "2013-07-01" ""           ""           ""
##
## $`(AVW) Panel C's Number of Excluded Months`
## [1] 232
```

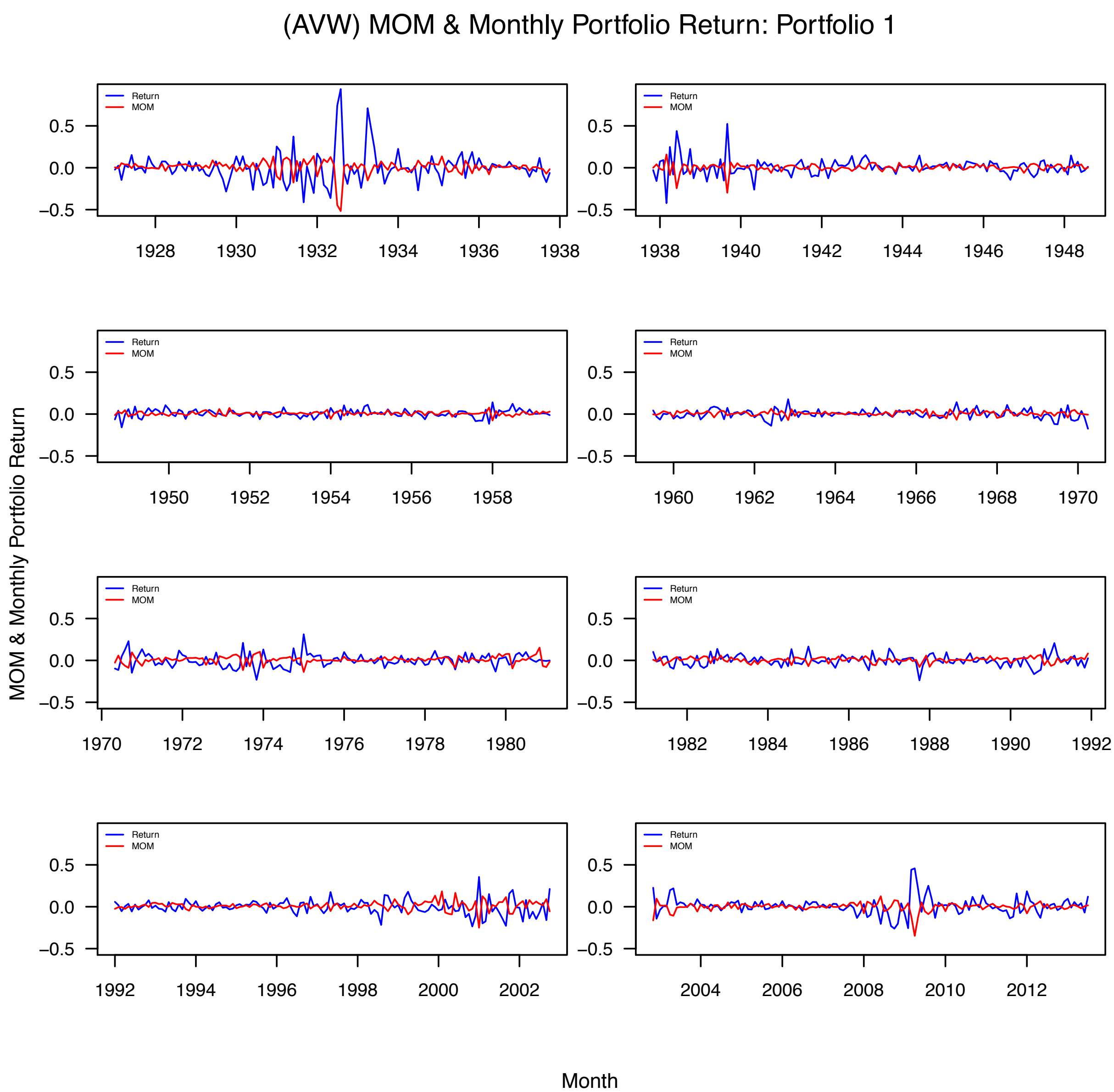
Appendix F

Plot of MOM vs Monthly Portfolio Return

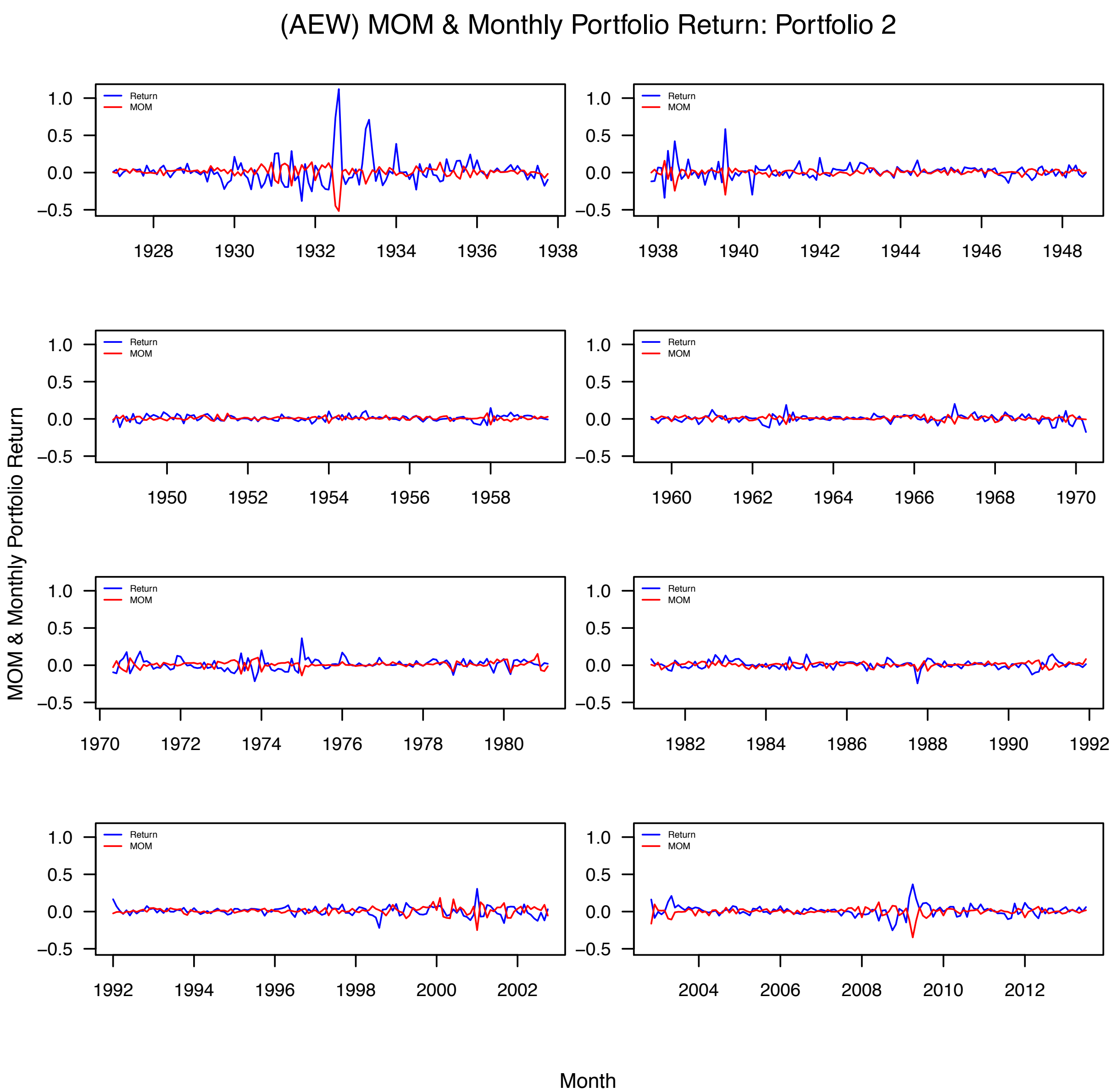
F.1 (AEW) Portfolio 1



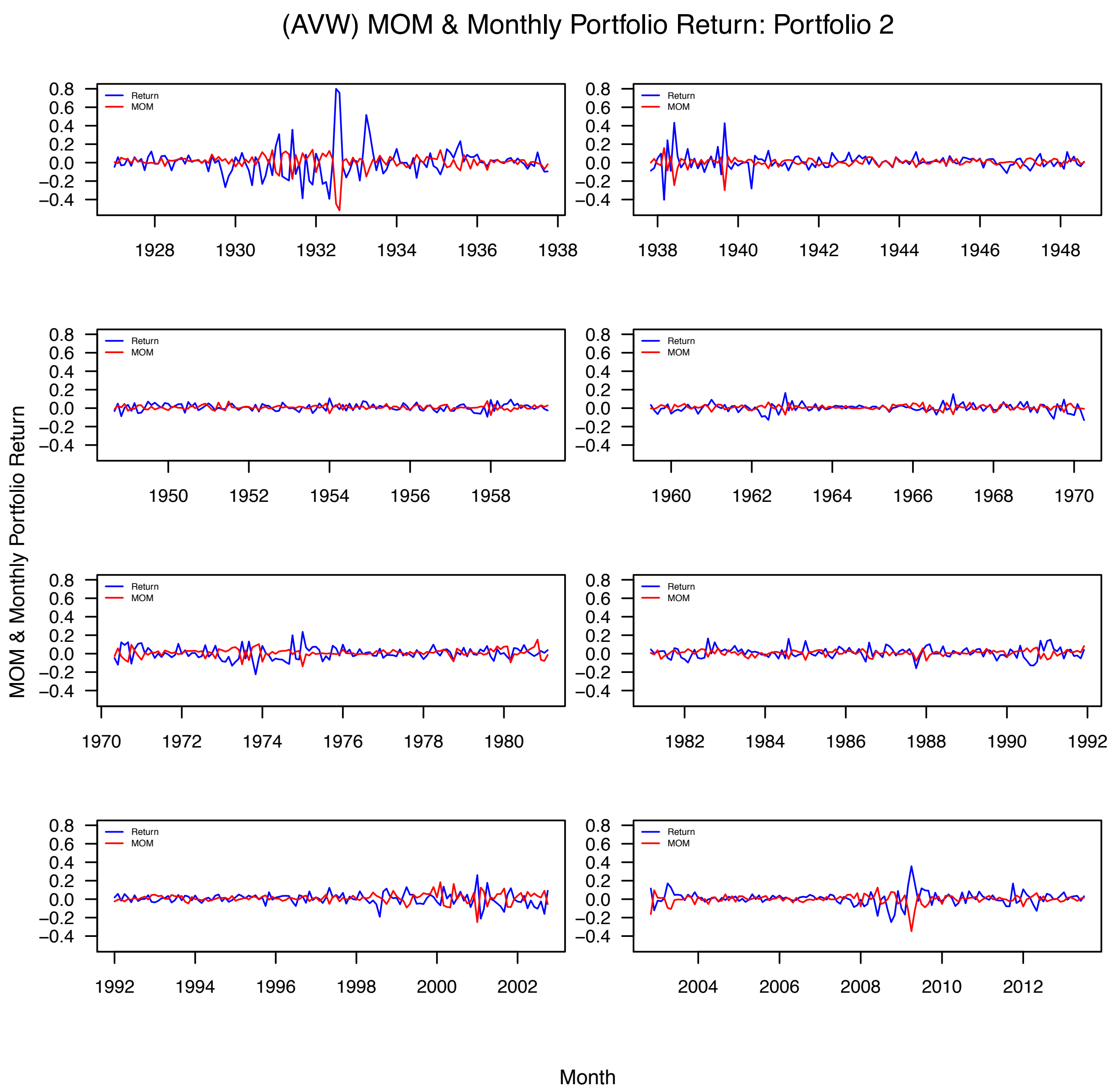
F.2 (AVW) Portfolio 1



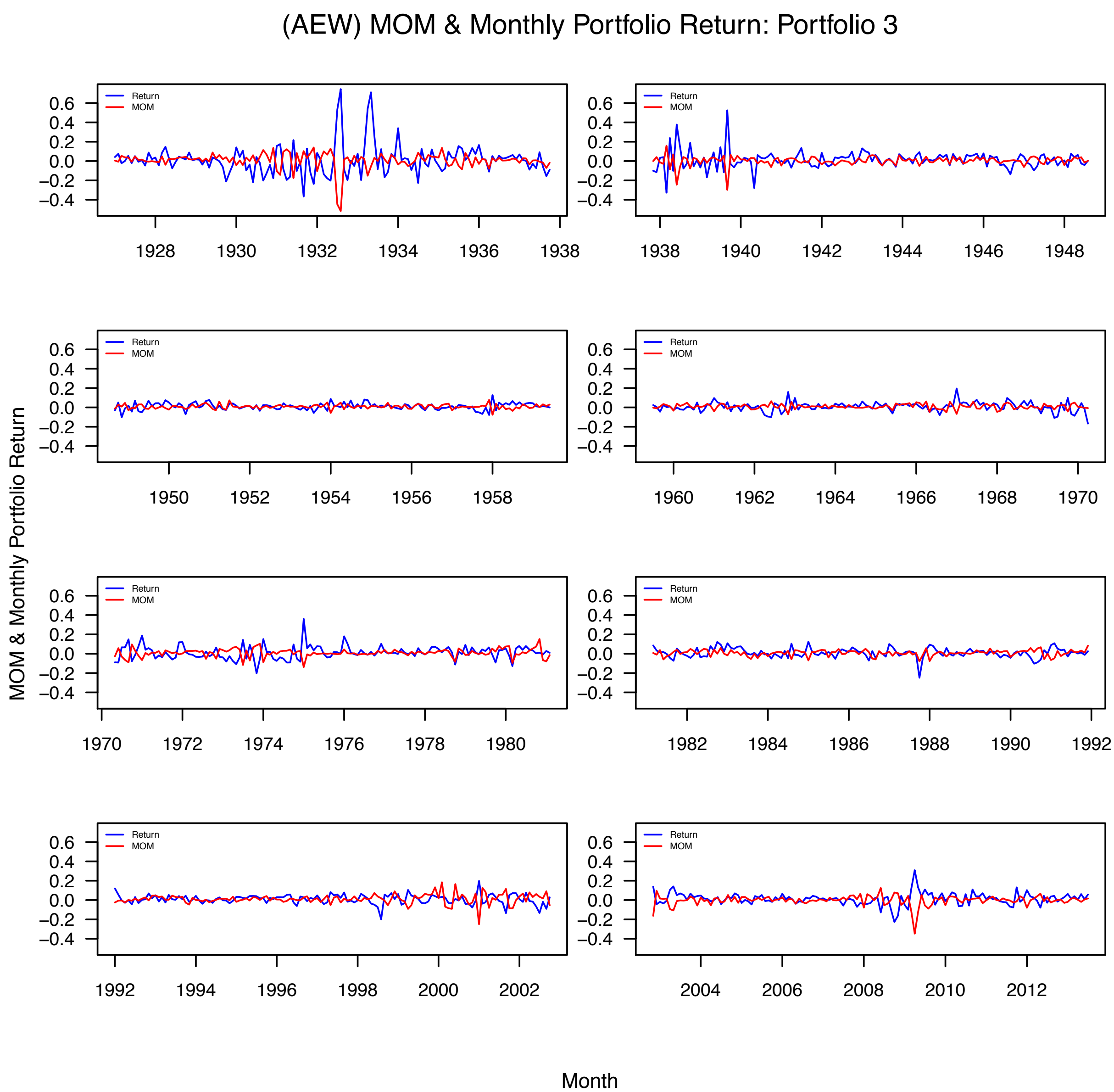
F.3 (AEW) Portfolio 2



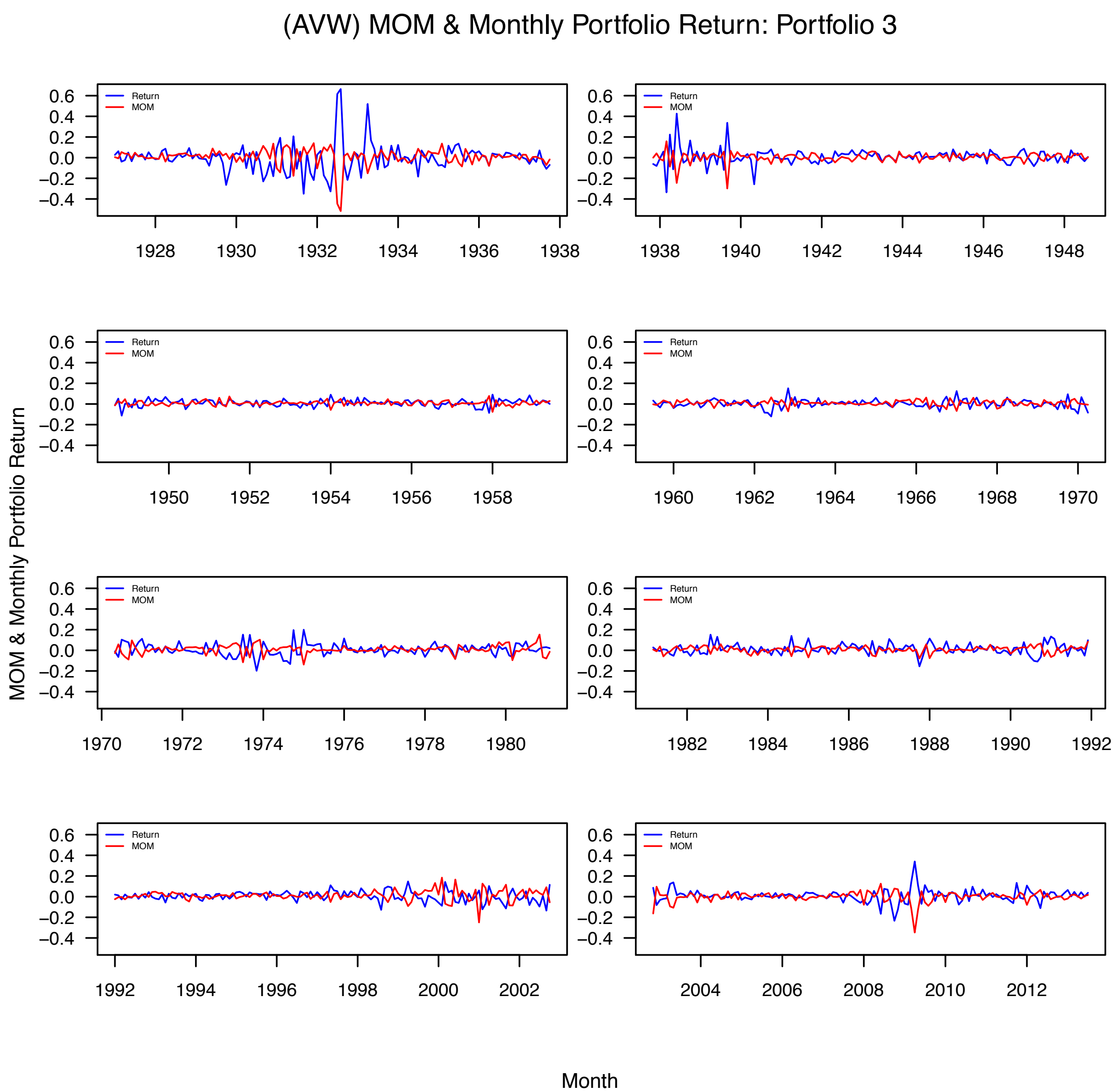
F.4 (AVW) Portfolio 2



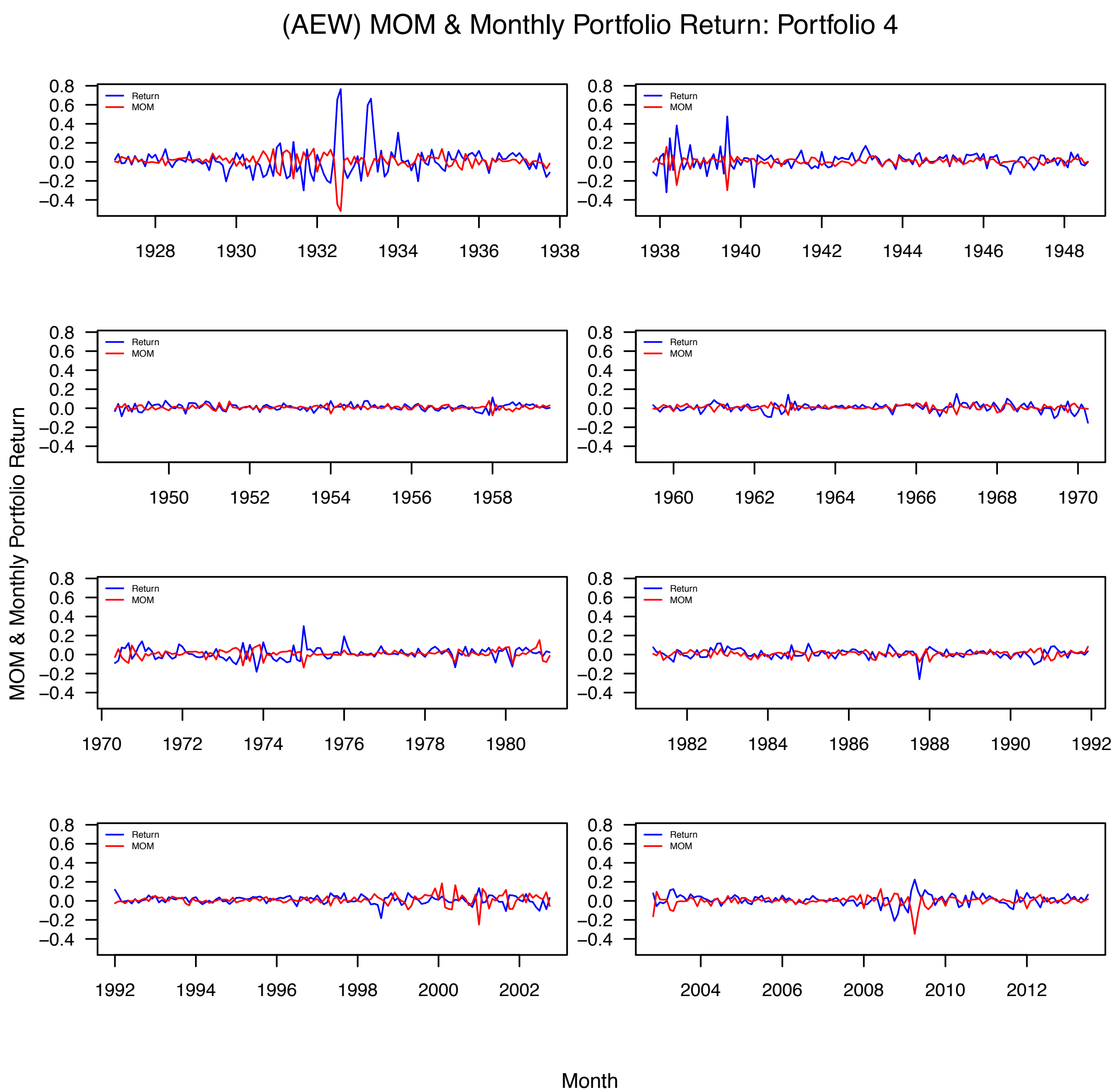
F.5 (AEW) Portfolio 3



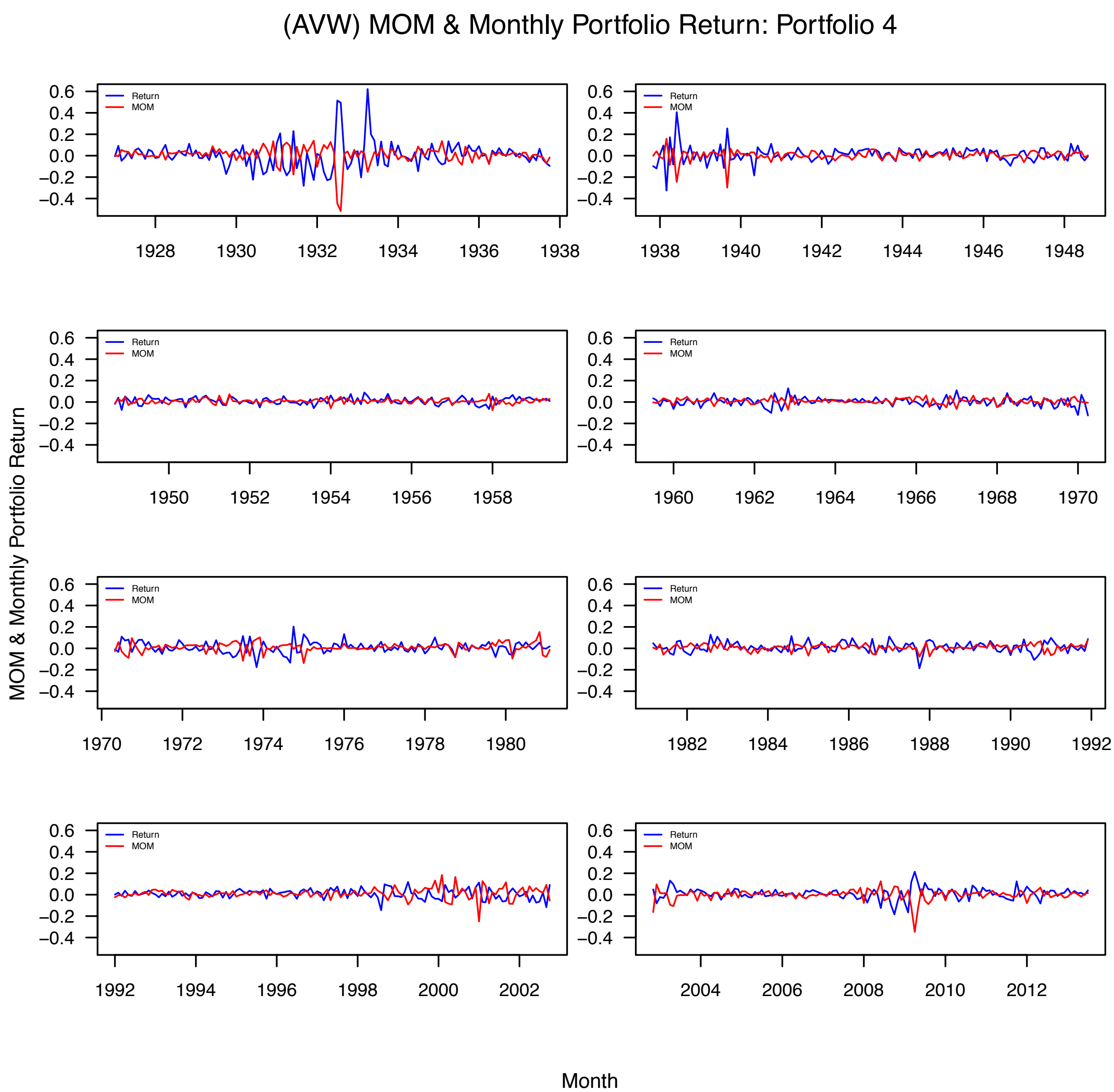
F.6 (AVW) Portfolio 3



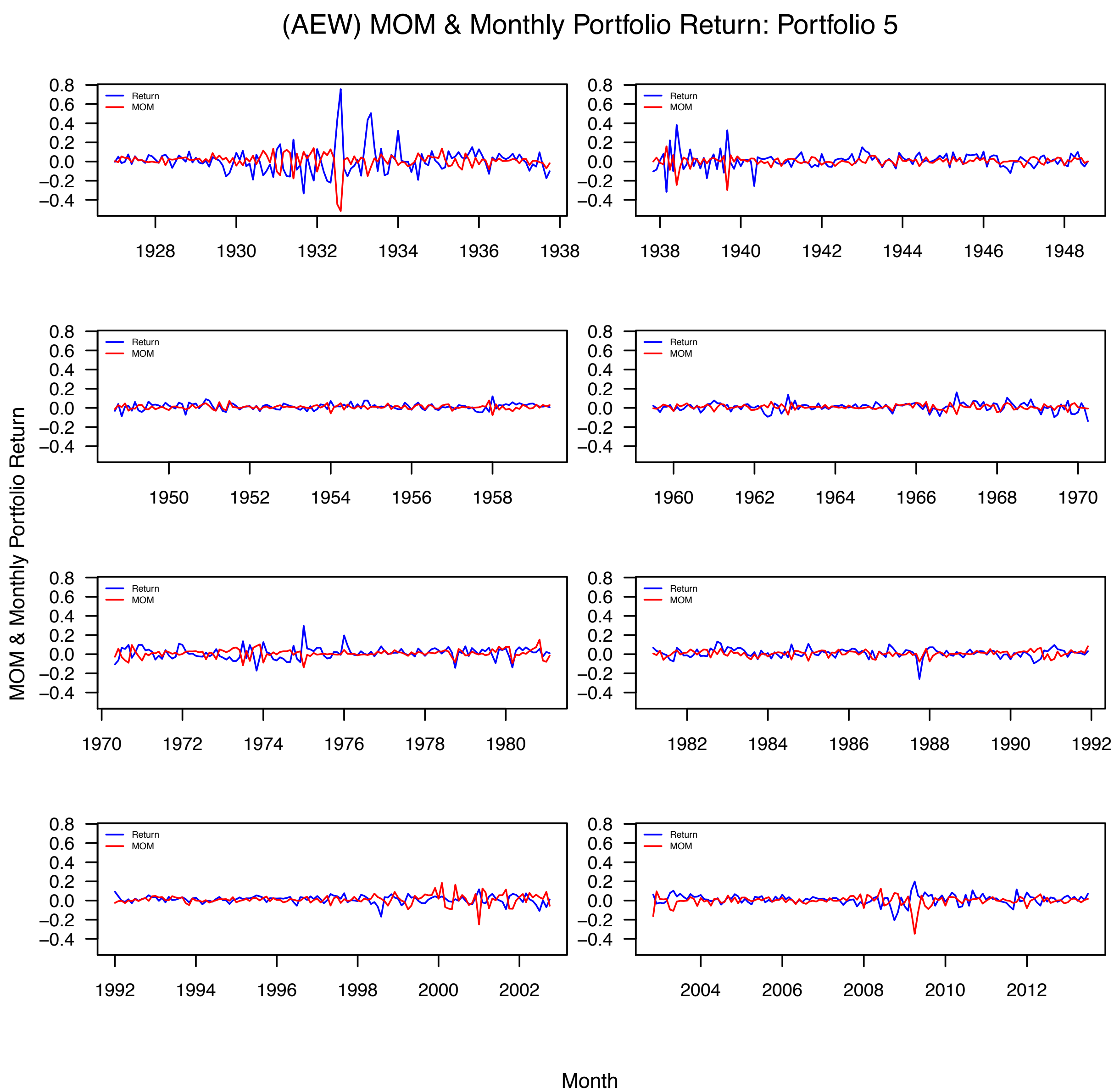
F.7 (AEW) Portfolio 4



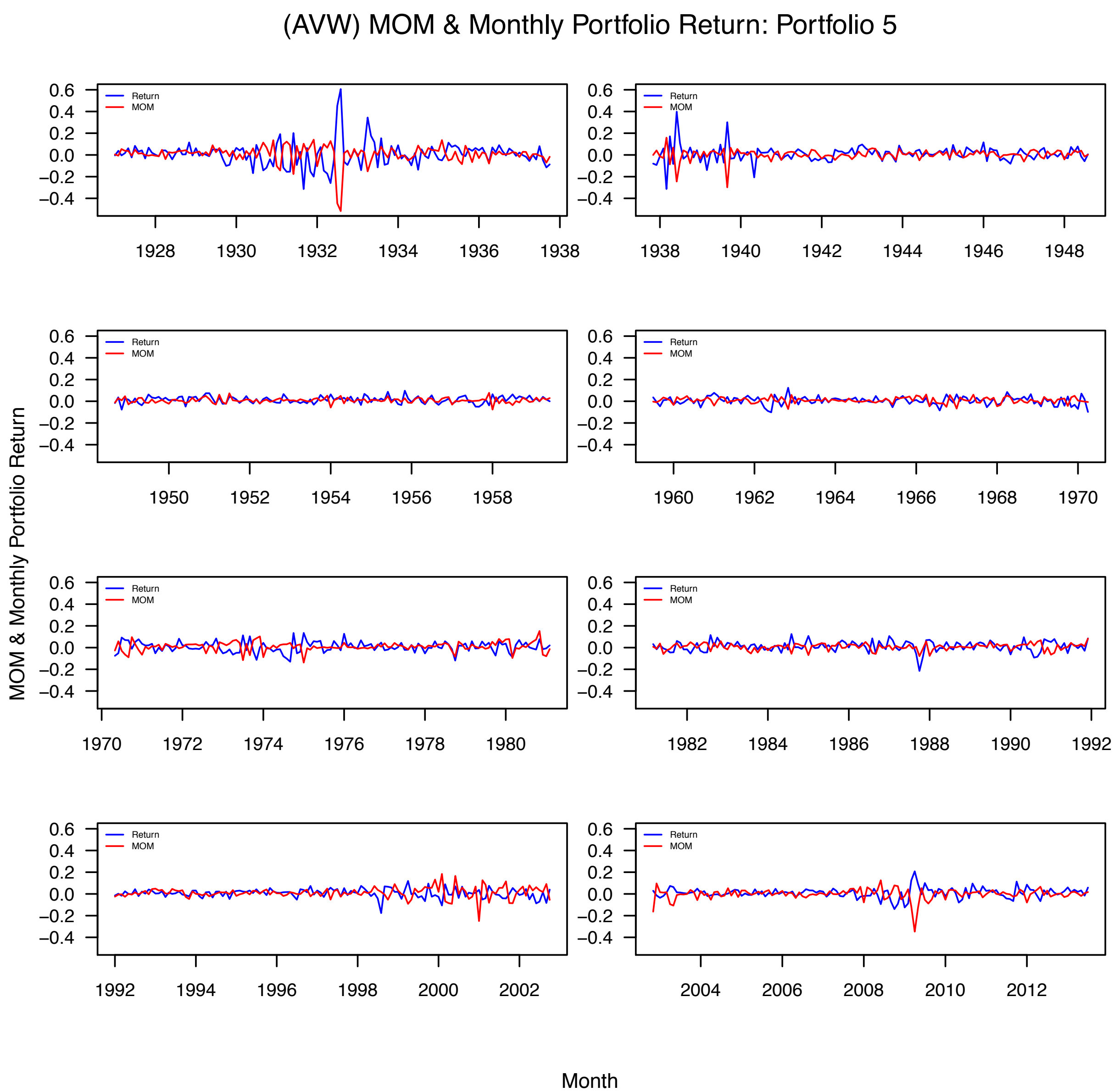
F.8 (AVW) Portfolio 4



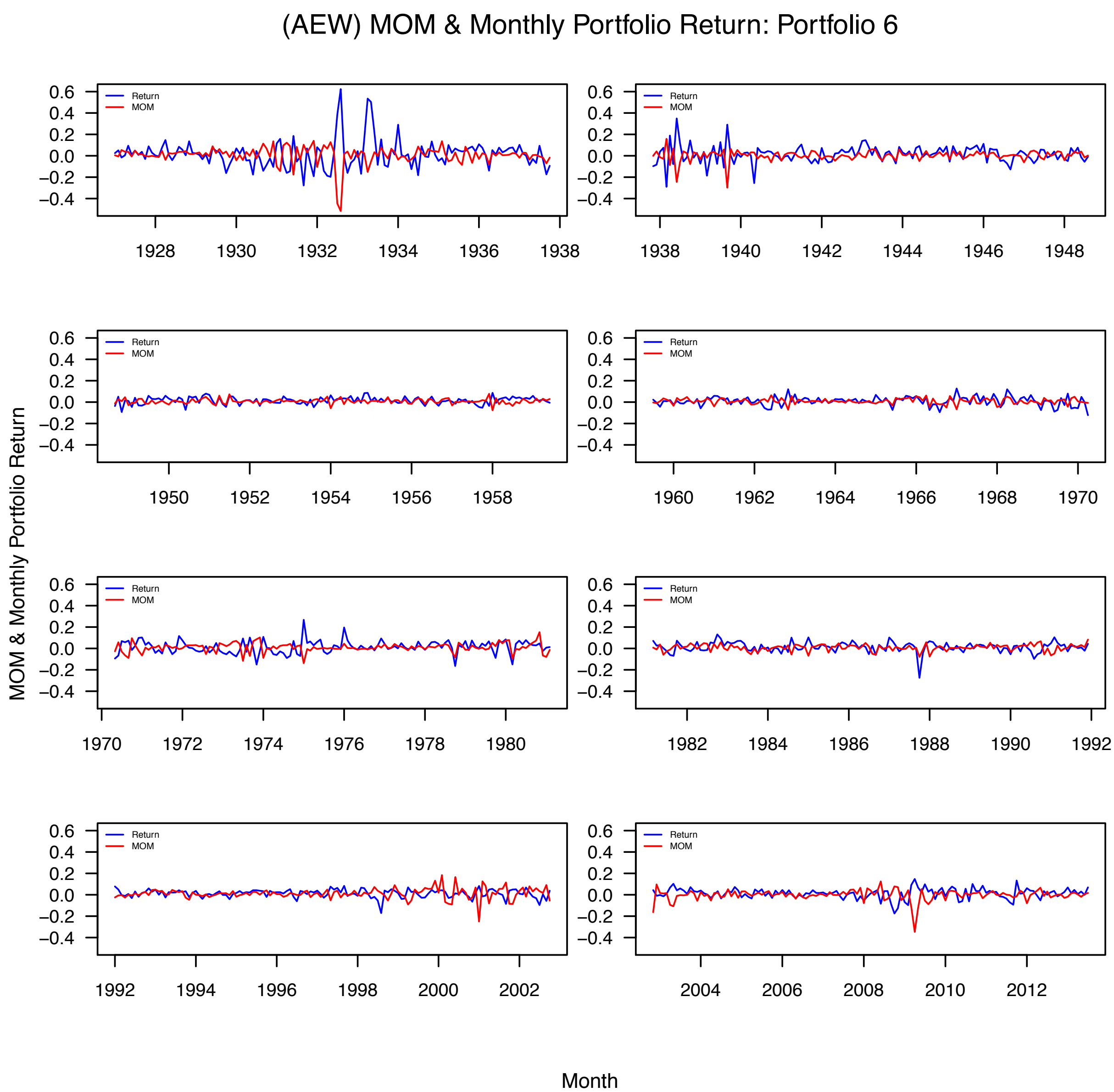
F.9 (AEW) Portfolio 5



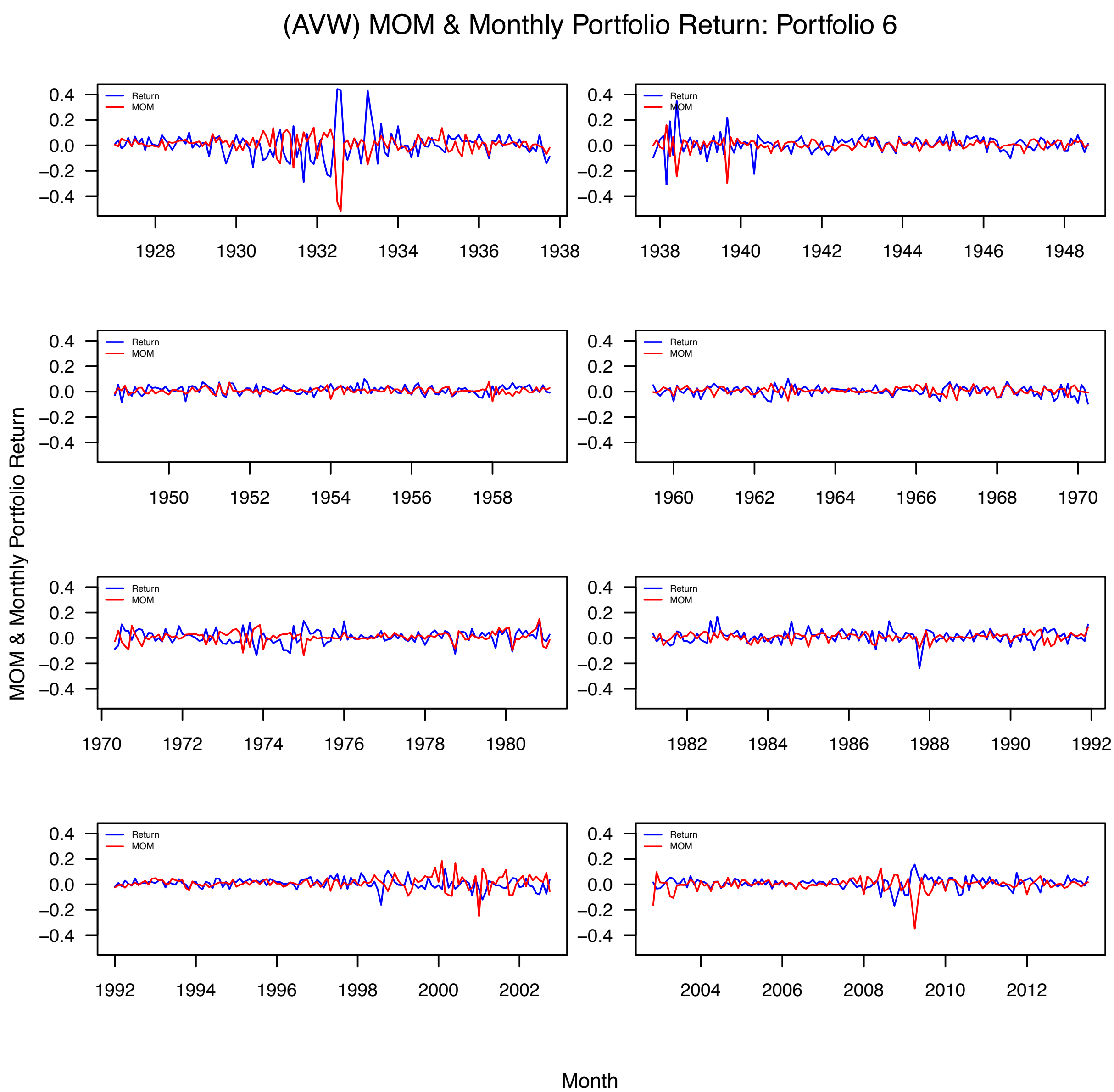
F.10 (AVW) Portfolio 5



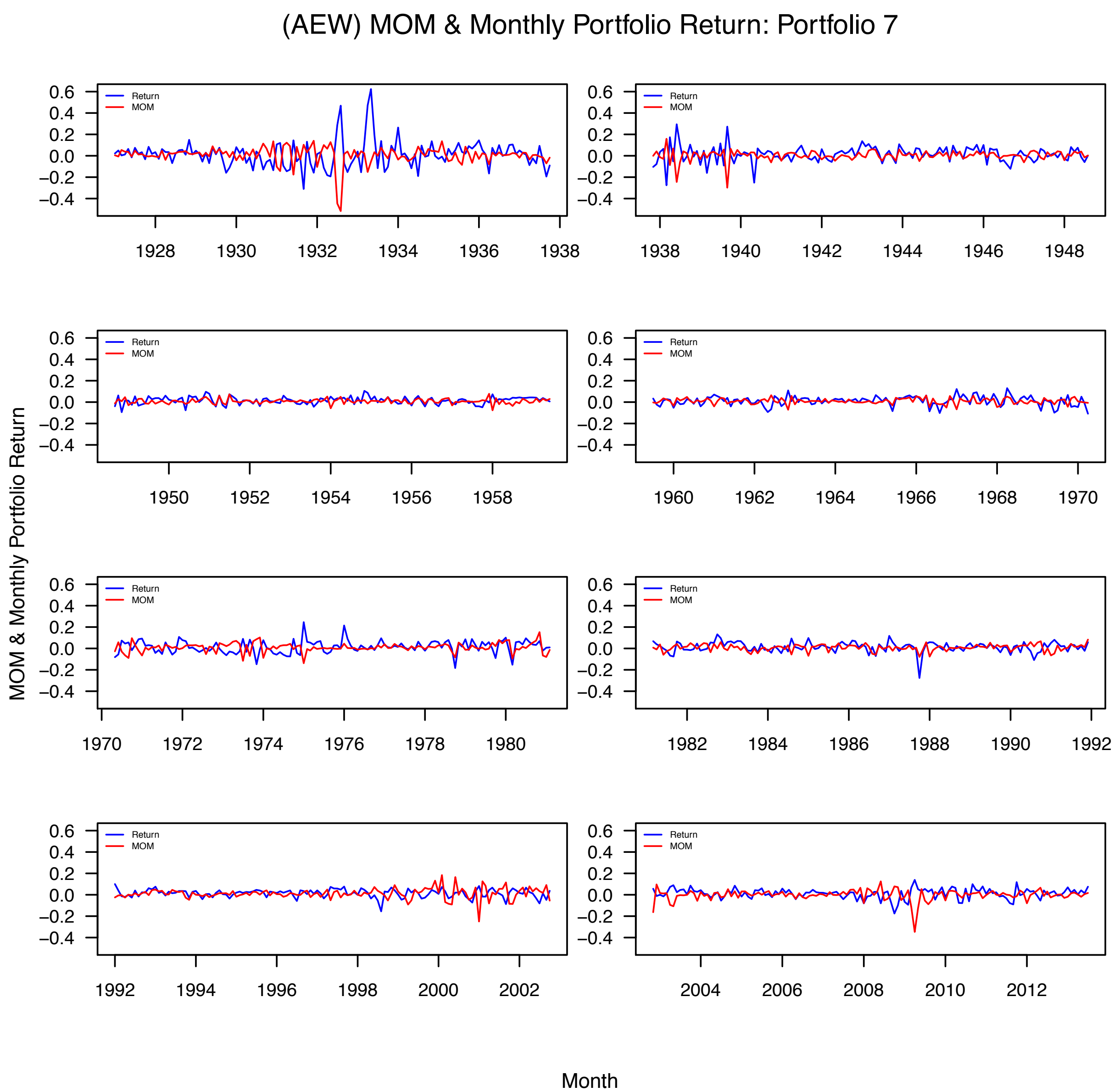
F.11 (AEW) Portfolio 6



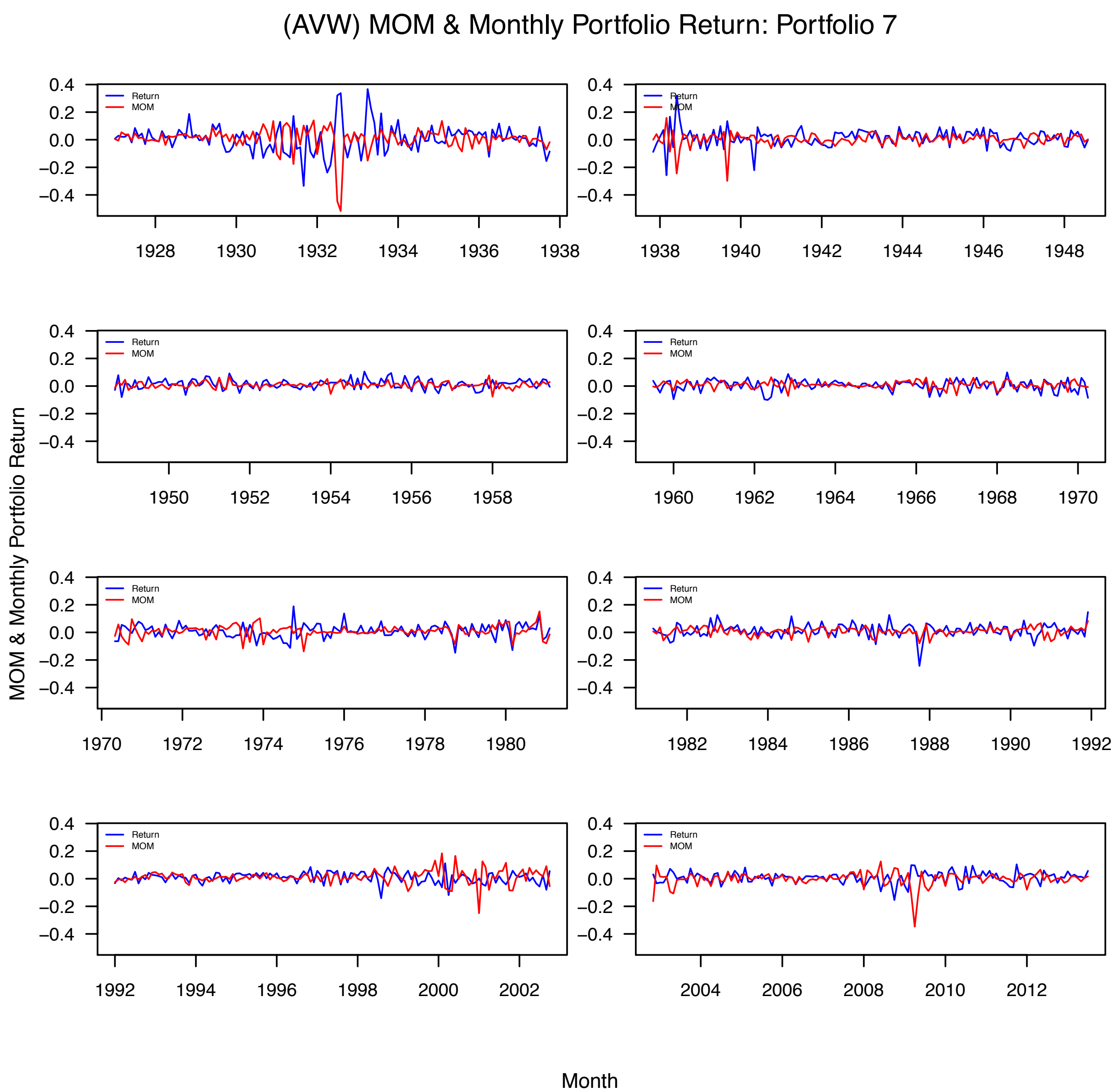
F.12 (AVW) Portfolio 6



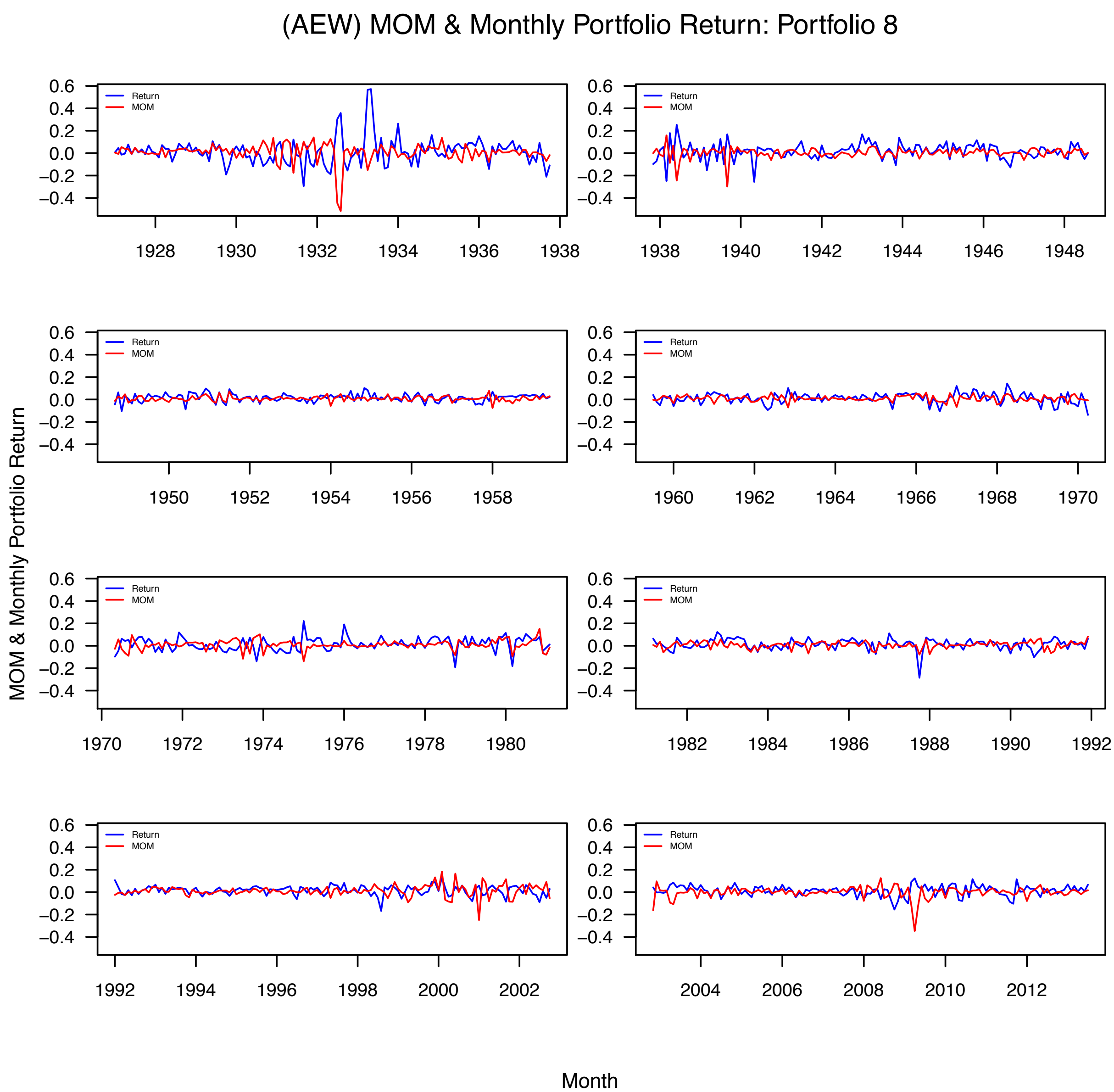
F.13 (AEW) Portfolio 7



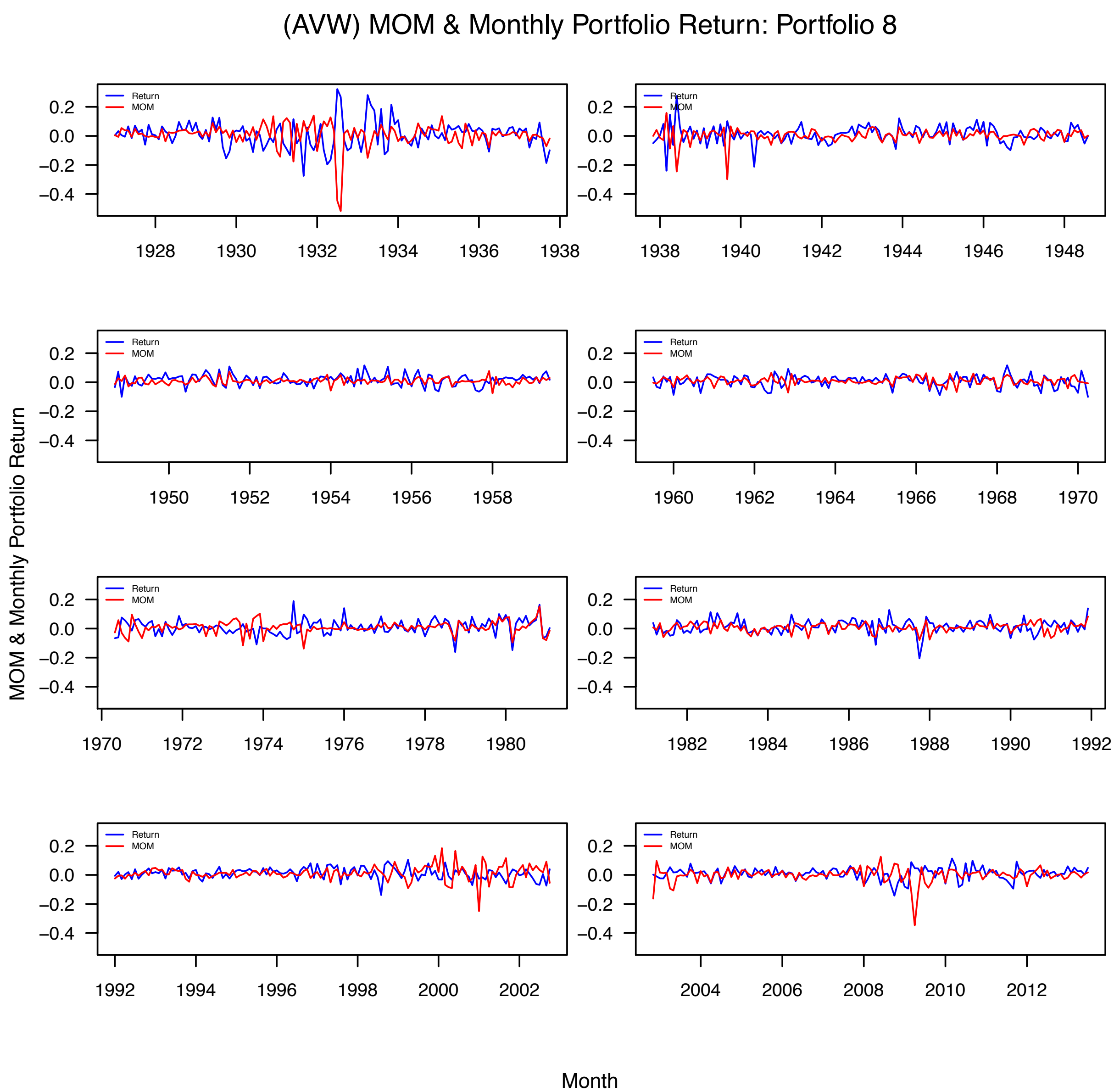
F.14 (AVW) Portfolio 7



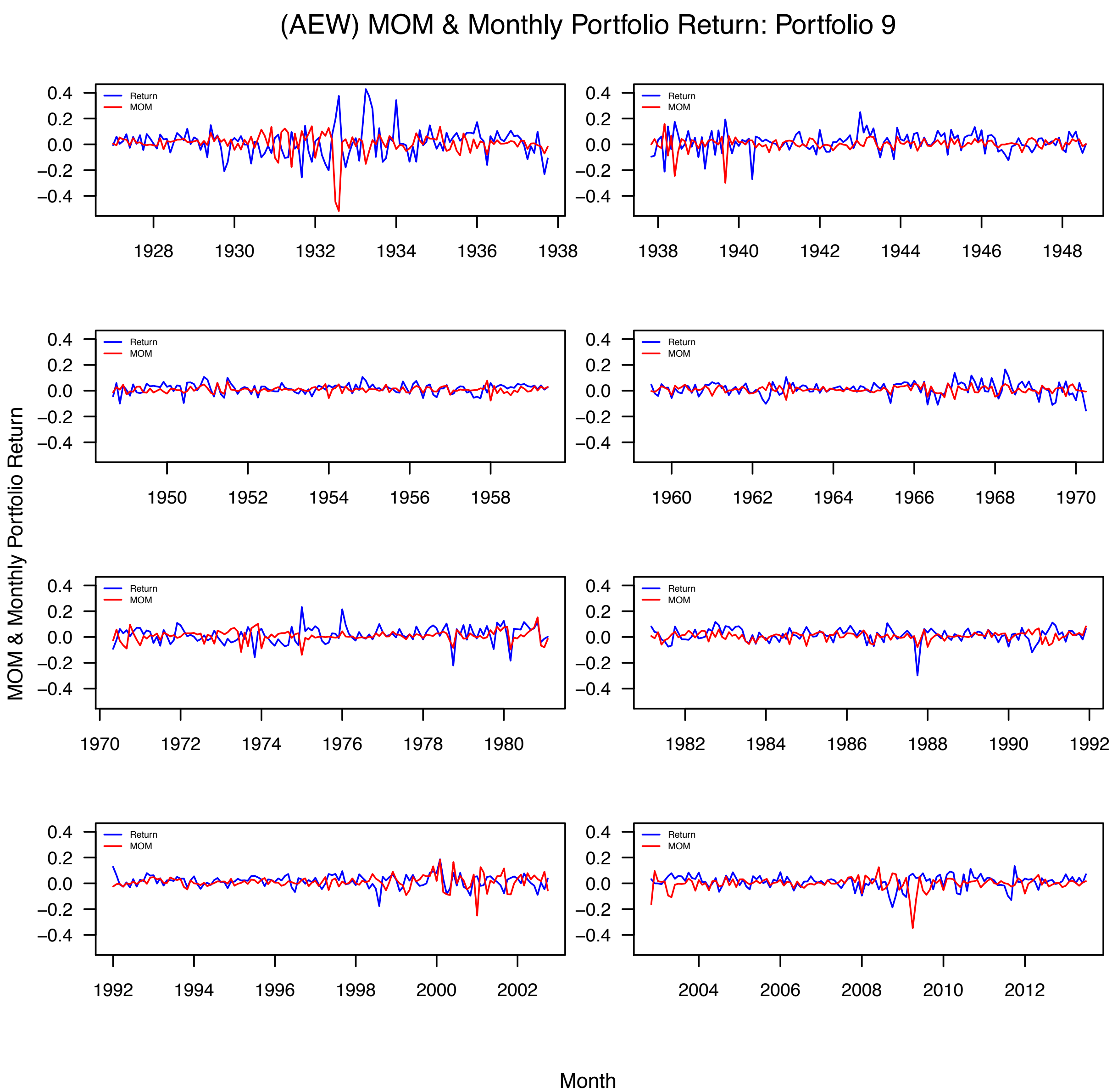
F.15 (AEW) Portfolio 8



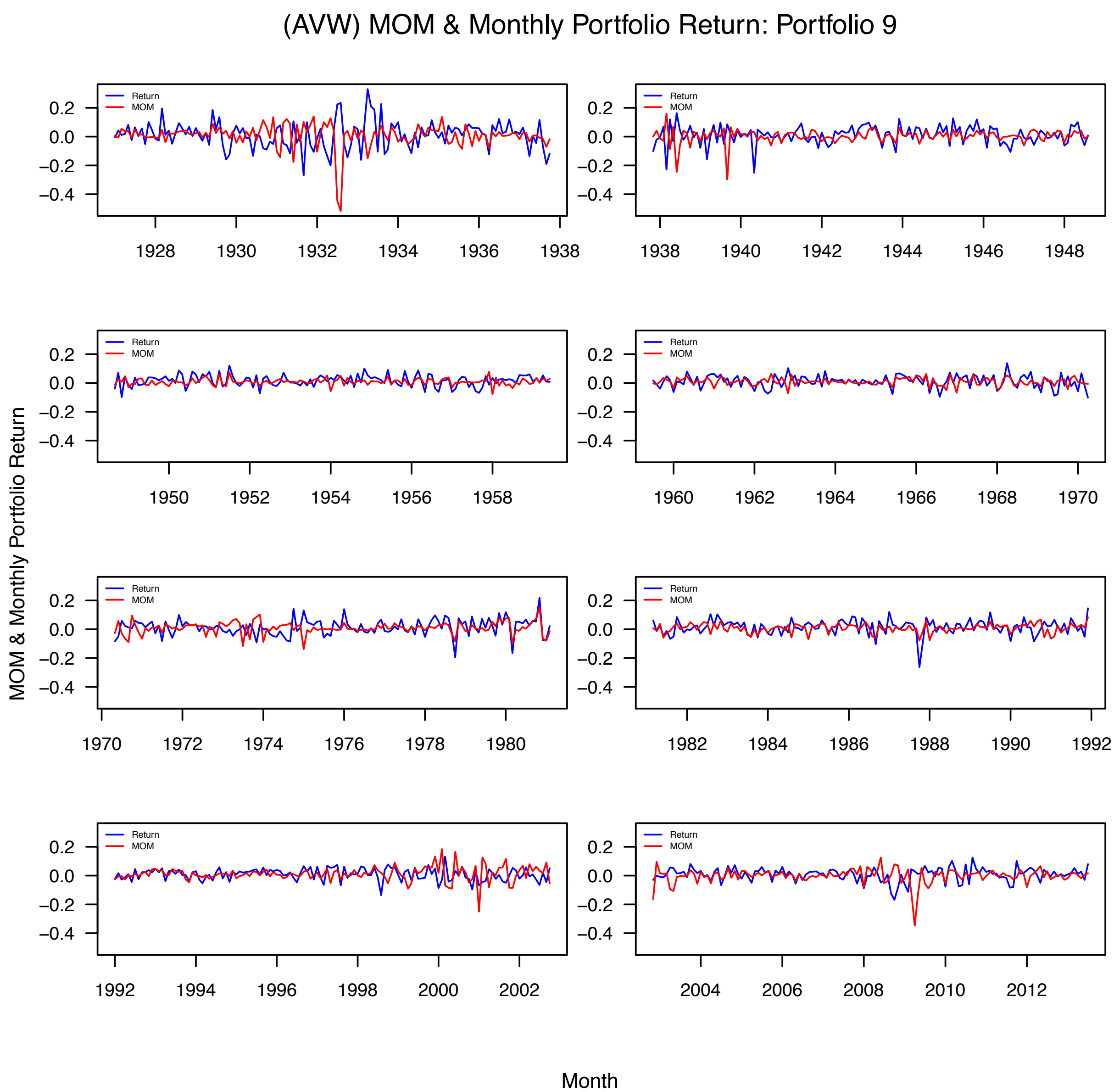
F.16 (AVW) Portfolio 8



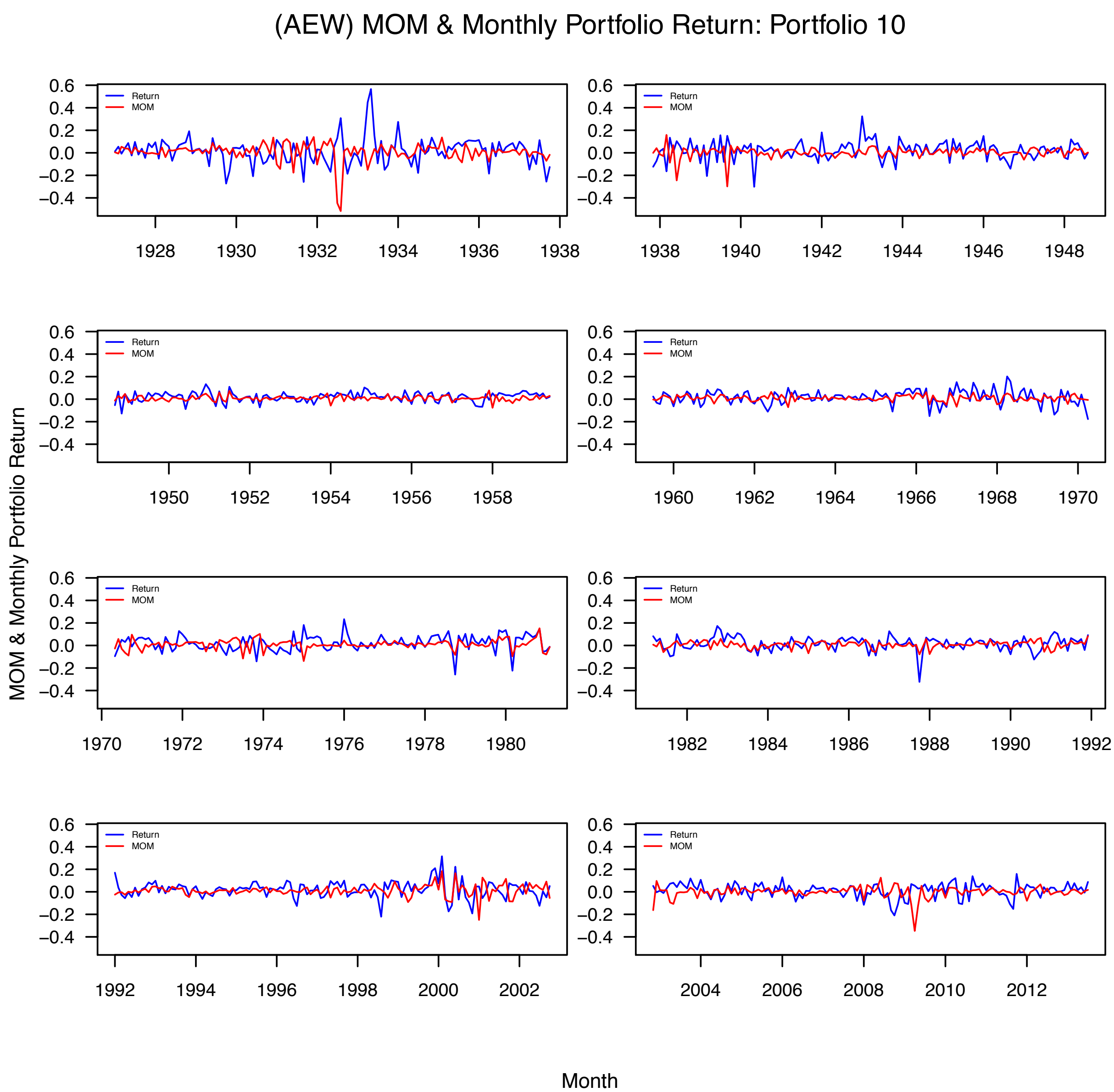
F.17 (AEW) Portfolio 9



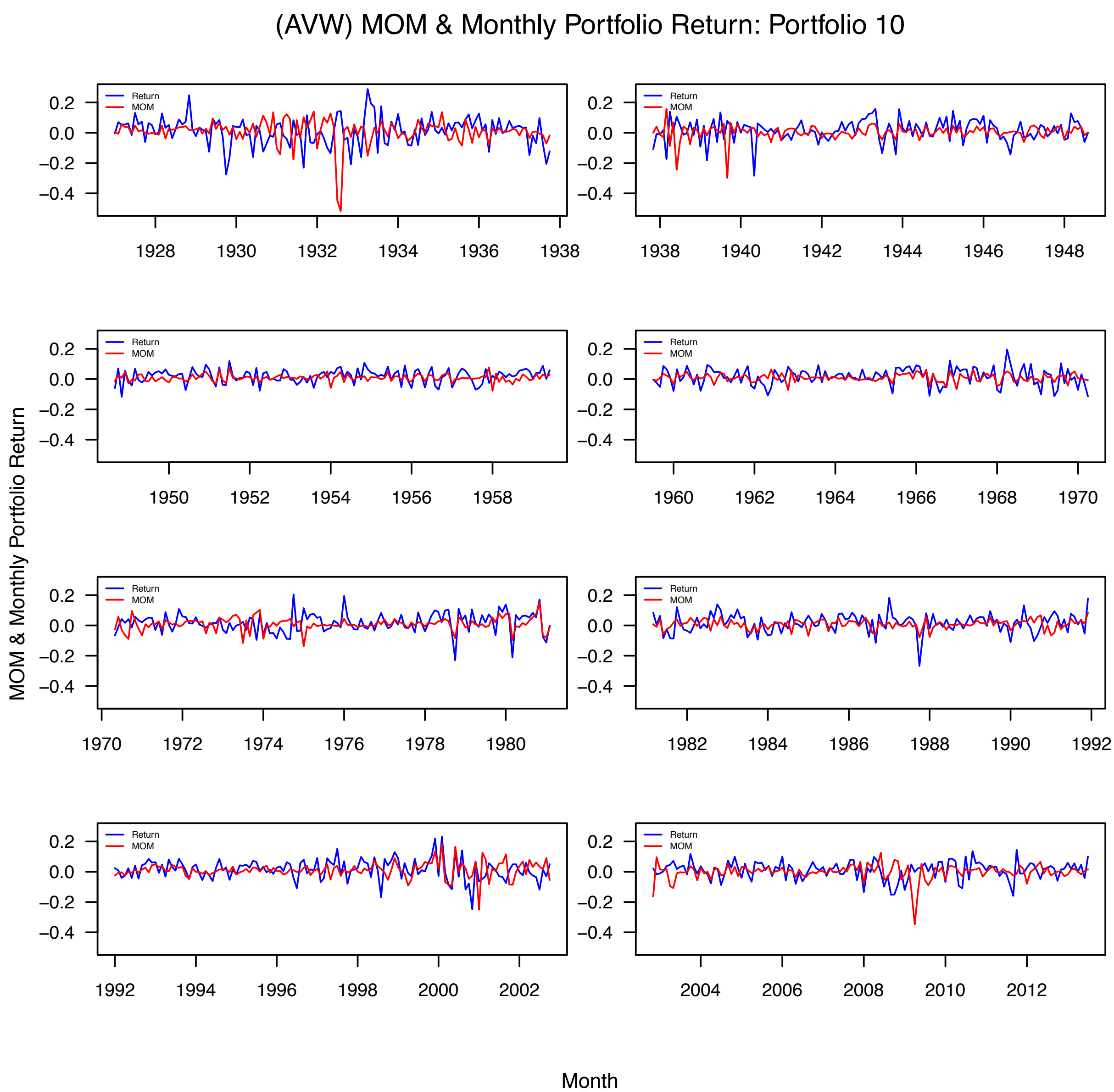
F.18 (AVW) Portfolio 9



F.19 (AEW) Portfolio 10



F.20 (AVW) Portfolio 10



Appendix G

R Codes

```
##############################################################################
### The Beginning of R codes for functions and variables
##############################################################################
### Import the data ###
##############################################################################
library(sandwich)
library(lmtest)
library(tseries)
library(xtable)
library(nortest)
library(car)
### Import the data
portfolios.e <- read.table("10_Portfolios_AveEquWeight.txt", header=T,
quote="\"")
portfolios.v <- read.table("10_Portfolios_AveValWeight.txt", header=T,
quote="\"")
researchfactor <- read.table("F-F_Research_Data_Factors.txt", header=T,
quote="\"")
momfactor <- read.table("F-F_Momentum_Factor.TXT", header=T,
quote="\"")
### Create function to combine the data
dataFun <- function(portfolios, researchfactor, momfactor){
    ### Combine the data
    data <- cbind(portfolios, researchfactor[,2:4], momfactor[,2],
    researchfactor[,5])
    ### Rename the variables
    names(data)[2:11] <- paste("Portfolio", 1:10, sep="")
    names(data)[12] <- "RMRF"
```

```
    names(data)[15:16] <- c("MOM", "RF")
    ### Convert the data in percentage
    data[,2:16] <- data[,2:16] / 100
    ### Compute the excess portfolio returns
    data[,2:11] <- data[,2:11] - data[,16]
    ### Convert the month from numeric to date format
    month.temp <- as.character(data[,1])
    data[,1] <- paste(substring(month.temp, 1, 4),
    substring(month.temp, 5, 6), "01", sep="-")
    data[,1] <- as.Date(data[,1])
    return (data)
}
### Get the average equal weighted (AEW) data with excess return
data.e <- dataFun(portfolios.e, researchfactor, momfactor)
### Get the average value weighted (AVW) data with excess return
data.v <- dataFun(portfolios.v, researchfactor, momfactor)
### Data with real return
pdata.e <- data.e
pdata.v <- data.v
pdata.e[,2:11] <- pdata.e[,2:11] + pdata.e[,16]
pdata.v[,2:11] <- pdata.v[,2:11] + pdata.v[,16]
### List of data with excess return
data.l <- list(data.e, data.v)
### List of data with real return
pdata.l <- list(pdata.e, pdata.v)
##############################################################################
### Create functions and variables for Chapter 1
##############################################################################
### Create function to generate residual plots
residplotFun <- function(datalist, datalistnum, portfolio){
  data <- datalist[[datalistnum]]
  i <- portfolio + 1
  fit <- lm(data[,i] ~ RMRF + SMB + HML + MOM, data = data)
  titlename <- paste(c("(AEW)", "(AVW)")[datalistnum],
                     "Residual Plots: Portfolio", portfolio, sep = " ")
  par(mfrow=c(3,2), oma=c(0,0,4,0), mar=c(5.1,4.1,1.1,2.1), las=1, cex=0.7)
  plot(data[,"Month"], residuals(fit),
       main = "Time Series of Residuals",
       xlab = "Month", ylab = "Residuals",
       type = "l", col="blue")
  plot(fitted(fit), residuals(fit),
```

```
      main = "Fitted vs Residuals",
      xlab = "Fitted", ylab = "Residuals", col = "blue")
  abline (h=0, col = "red")
  plot(data[,"RMRF"], residuals(fit),
      main = "RMRF vs Residuals",
      xlab = "RMRF", ylab = "Residuals", col = "blue")
  abline (h=0, col = "red")
  plot(data[,"SMB"], residuals(fit),
      main = "SMB vs Residuals",
      xlab = "SMB", ylab = "Residuals", col = "blue")
  abline (h=0, col = "red")
  plot(data[,"HML"], residuals(fit),
      main = "HML vs Residuals",
      xlab = "HML", ylab = "Residuals", col = "blue")
  abline (h=0, col = "red")
  plot(data[,"MOM"], residuals(fit),
      main = "MOM vs Residuals",
      xlab = "MOM", ylab = "Residuals", col = "blue")
  abline (h=0, col = "red")
  mtext(titlename, 3, 1, outer=TRUE, cex=1)
  # Restore default clipping rect
  par(mar = c(5, 4, 4, 2) + 0.1)
  par(mfrow=c(1,1))
}
##############################################################################
### Create function to compute p-value of Lilliefors test for normality
normtestpvalFun <- function(datalist){
  portfolio <- 1:10
  pvalAEW <- c(NA, 10)
  pvalAVW <- c(NA, 10)
  nullAEW <- c(NA, 10)
  nullAVW <- c(NA, 10)
  for(i in 1:10){
    fit1 <- lm(datalist[[1]][,i+1] ~ RMRF + SMB + HML + MOM, data=datalist[[1]])
    resid1 <- residuals(fit1)
    pvalAEW[i] <- lillie.test(resid1)$p.value
    if(pvalAEW[i] < 0.05){
      nullAEW[i] <- "Reject"
    } else {nullAEW[i] <- "Accept"}
    fit2 <- lm(datalist[[2]][,i+1] ~ RMRF + SMB + HML + MOM, data=datalist[[2]])
    resid2 <- residuals(fit2)
```

```
    pvalAVW[i] <- lillie.test(resid2)$p.value
    if(pvalAVW[i] < 0.05){
      nullAVW[i] <- "Reject"
    } else {nullAVW[i] <- "Accept"}
  }
  return(data.frame(portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW))
}
### Compute the p-value
normtestpval.A <- normtestpvalFun(data.l)
##############################################################################
### Create function to compute mean of residuals
meanresidFun <- function(datalist){
  portfolio <- 1:10
  meanresidAEW <- c(NA, 10)
  meanresidAVW <- c(NA, 10)
  for(i in 1:10){
    fit1 <- lm(datalist[[1]][,i+1] ~ RMRF + SMB + HML + MOM, data=datalist[[1]])
    meanresidAEW[i] <- mean(residuals(fit1))
    fit2 <- lm(datalist[[2]][,i+1] ~ RMRF + SMB + HML + MOM, data=datalist[[2]])
    meanresidAVW[i] <- mean(residuals(fit2))
  }
  return(data.frame(portfolio, meanresidAEW, meanresidAVW))
}
### Compute the mean of residuals
meanresid.A <- meanresidFun(data.l)
##############################################################################
### Compute the p-values of non-constant variance score test
datalist <- data.l
portfolio <- 1:10
pvalAEW <- c(NA, 10)
pvalAVW <- c(NA, 10)
nullAEW <- c(NA, 10)
nullAVW <- c(NA, 10)
for(i in 1:10){
  fit1 <- lm(datalist[[1]][,i+1] ~ RMRF + SMB + HML + MOM,
             data=datalist[[1]])
  pvalAEW[i] <- ncvTest(fit1)$p
  if(pvalAEW[i] < 0.05){
    nullAEW[i] <- "Reject"
  } else {nullAEW[i] <- "Accept"}
  fit2 <- lm(datalist[[2]][,i+1] ~ RMRF + SMB + HML + MOM,
```

```
              data=datalist[[2]])
  pvalAVW[i] <- ncvTest(fit2)$p
  if(pvalAVW[i] < 0.05){
    nullAVW[i] <- "Reject"
  } else {nullAVW[i] <- "Accept"}
}
ncvtestpval.A <- data.frame(portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW)
rm(datalist, portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW, i, fit1, fit2)
################################################################################
### Create functions and variables for Chapter 2
################################################################################
### Create function to plot Cook's distance
CiPlotFun <- function(datalist, datalistnum, portfolio, toplot = TRUE){
    data <- datalist[[datalistnum]]
    colnum <- portfolio + 1
    N <- nrow(data)
    X <- as.matrix(data[,12:15])
    X <- cbind(as.matrix(rep(1,N)), X)
    p <- ncol(X)
    Y <- as.matrix(data[,colnum, drop=FALSE])
    betahat <- solve(t(X) %*% X) %*% t(X) %*% Y
    Yhat <- X %*% betahat
    P <- X %*% solve(t(X) %*% X) %*% t(X)
    resid <- Y - Yhat
    sigma2hat <- (t(resid) %*% resid) / (N - p)
    ti <- as.matrix(rep(1,N))
    Ci <- as.matrix(rep(1,N))
    for(j in 1:N){
        ti[j] <- resid[j] / (sqrt(sigma2hat) * sqrt(1 - P[j,j]))
        Ci[j] <- ( ((ti[j])^2) / p ) * ( P[j,j] / (1 - P[j,j]) )
    }
    calpt.find <- Ci > 1
    Month <- as.matrix(data[,1])
    Cidata <- cbind(Month, Ci)
    colnames(Cidata) <- c("Month", "Ci")
    Cidata <- as.data.frame(Cidata)
    Cidata[,1] <- as.Date(Cidata[,1])
    calpt.count <- sum(calpt.find)
    Cidata.sort <- Cidata[order(-Ci),]
    dataname <- c("(AEW)", "(AVW)")[datalistnum]
    if(toplot == TRUE){
```

```
        plot(Cidata[,"Month"], Cidata[,"Ci"],
        main = paste(dataname, "\nCook's Distance: Portfolio", portfolio,
        sep = " "),
        xlab = "Month", ylab = "Cook's Distance", col="blue")
        points(Cidata[,"Month"][calpt.find], Cidata[,"Ci"][calpt.find],
        col="red", pch=19)
    } else {
        hist(Cidata[,"Ci"], breaks = 100,
        col = "skyblue", xlab = "Cook's Distance",
        main = paste(dataname, "Histogram\nCook's Distance: Portfolio",
        portfolio, sep = " "))
    }
}
##############################################################################
### Create function to plot covariance ratio
CVRiPlotFun <- function(datalist, datalistnum, portfolio, toplot = TRUE){
    data <- datalist[[datalistnum]]
    colnum <- portfolio + 1
    N <- nrow(data)
    X <- as.matrix(data[,12:15])
    X <- cbind(as.matrix(rep(1,N)), X)
    p <- ncol(X)
    Y <- as.matrix(data[,colnum, drop=FALSE])
    betahat <- solve(t(X) %*% X) %*% t(X) %*% Y
    Yhat <- X %*% betahat
    P <- X %*% solve(t(X) %*% X) %*% t(X)
    resid <- Y - Yhat
    sigma2hat <- (t(resid) %*% resid) / (N - p)
    sigma2hat.i <- as.matrix(rep(1,N))
    for(j in 1:N){
        sigma2hat.i[j] <- (N - p)*sigma2hat/(N - p -1) -
        resid[j]^2/((N - p - 1)*(1 - P[j,j]))
    }
    CVRi <- as.matrix(rep(1,N))
    for(j in 1:N){
        CVRi[j] <- ((sigma2hat.i[j]/sigma2hat)^p) / (1 - P[j,j])
    }
    calpt.find <- abs(CVRi - 1 ) > 3*p/N
    abs.CVRi_1 <- abs(CVRi - 1 )
    calpt.crit <- 3*p/N
    Month <- as.matrix(data[,1])
```

```
    CVRidata <- data.frame(Month, CVRi, abs.CVRi_1, calpt.crit)
    CVRidata[,1] <- as.Date(CVRidata[,1])
    calpt.count <- sum(calpt.find)
    CVRidata.sort <- CVRidata[order(-abs.CVRi_1),]
    dataname <- c("(AEW)", "(AVW)")[datalistnum]
    if(toplot == TRUE){
        plot(CVRidata$Month, CVRidata$CVRi,
        main = paste(dataname, "\nCovariance Ratio: Portfolio", portfolio,
        sep = " "),
        xlab = "Month", ylab = "Covariance Ratio", col="blue")
        points(CVRidata$Month[calpt.find], CVRidata$CVRi[calpt.find], col="red",
        pch=19)
    } else {
        hist(CVRidata$CVRi, breaks = 100,
        col = "skyblue", xlab = "Covariance Ratio",
        main = paste(dataname, "Histogram\nCovariance Ratio: Portfolio",
        portfolio, sep = " "))
    }
}
##############################################################################
### Create function to combine plots of Cook's distance and covariance ratio
toplotFun <- function(datalist, portfolio, toplot = TRUE){
    if(toplot == TRUE){
        par(mfcol=c(2,2))
        for(i in 1:2){
            CiPlotFun(datalist, i, portfolio)
            CVRiPlotFun(datalist, i, portfolio)
        }
        par(mfrow=c(1,1))
    } else {
        par(mfcol=c(4,1))
        for(i in 1:2){
            CiPlotFun(datalist, i, portfolio, FALSE)
        }
        for(i in 1:2){
            CVRiPlotFun(datalist, i, portfolio, FALSE)
        }
        par(mfrow=c(1,1))
    }
}
##############################################################################
```

```
### Create function to plot MOM vs monthly portfolio returns
momreturnplotFun <- function(datalist, datalistnum, portfolio){
    data <- datalist[[datalistnum]]
    i <- c(1:7)
    i <- 130 * i
    start <- c(1, i + 1)
    end <- c(i, nrow(data))
    j <- portfolio + 1
    temp <- data[,j] + data[,16]
    ymin <- min(min(temp), min(data[,15]))
    ymax <- max(max(temp), max(data[,15]))
    titlename <- paste(c("(AEW)", "(AVW)")[datalistnum],
    "MOM & Monthly Portfolio Return: Portfolio", portfolio,
    sep = " ")
    par(mfrow=c(4,2), oma=c(3,3,4,0), mar=c(4,2,1,1), las=1, cex=0.7)
    for(k in 1:8){
        plot(data[start[k]:end[k],1], temp[start[k]:end[k]],
        xlab = "", ylab = "", ylim=c(ymin,ymax), type="l", col = "blue")
        lines(data[start[k]:end[k],1], data[start[k]:end[k],15], type="l",
        col = "red")
        legend("topleft", c("Return", "MOM"), cex=0.5, col=c("blue", "red"),
        lty=1, bty="n")
    }
    mtext("Month", 1, 1, outer=TRUE, cex = 0.75)
    mtext("MOM & Monthly Portfolio Return", 2, 1, outer=TRUE, las=0,
    cex = 0.75)
    mtext(titlename, 3, 1, outer=TRUE, cex=1)
    # Restore default clipping rect
    par(mar = c(5, 4, 4, 2) + 0.1)
    par(mfrow=c(1,1))
}
###############################################################################
### Create function to compute the Cook's distance for Influential Points
CiCalptFun <- function(data, colnum){
    N <- nrow(data)
    X <- as.matrix(data[,12:15])
    X <- cbind(as.matrix(rep(1,N)), X)
    p <- ncol(X)
    Y <- as.matrix(data[,colnum, drop=FALSE])
    betahat <- solve(t(X) %*% X) %*% t(X) %*% Y
    Yhat <- X %*% betahat
```

```
    P <- X %*% solve(t(X) %*% X) %*% t(X)
    resid <- Y - Yhat
    sigma2hat <- (t(resid) %*% resid) / (N - p)
    ti <- as.matrix(rep(1,N))
    Ci <- as.matrix(rep(1,N))
    for(j in 1:N){
        ti[j] <- resid[j] / (sqrt(sigma2hat) * sqrt(1 - P[j,j]))
        Ci[j] <- ( ((ti[j])^2) / p ) * ( P[j,j] / (1 - P[j,j]) )
    }
    calpt.find <- Ci > 1
    Month <- as.matrix(data[,1])
    Cidata <- cbind(Month, Ci)
    colnames(Cidata) <- c("Month", "Ci")
    Cidata <- as.data.frame(Cidata)
    Cidata[,1] <- as.Date(Cidata[,1])
    calpt.count <- sum(calpt.find)
    Cidata.sort <- Cidata[order(-Ci),]
    if(calpt.count == 0){
        return(NULL)
    } else {
        return(Cidata.sort[1:calpt.count,])
    }
}
##############################################################################
### Create function to compute the covariance ratios for Influential Points
CVRiCalptFun <- function(data, colnum){
    N <- nrow(data)
    X <- as.matrix(data[,12:15])
    X <- cbind(as.matrix(rep(1,N)), X)
    p <- ncol(X)
    Y <- as.matrix(data[,colnum, drop=FALSE])
    betahat <- solve(t(X) %*% X) %*% t(X) %*% Y
    Yhat <- X %*% betahat
    P <- X %*% solve(t(X) %*% X) %*% t(X)
    resid <- Y - Yhat
    sigma2hat <- (t(resid) %*% resid) / (N - p)
    sigma2hat.i <- as.matrix(rep(1,N))
    for(j in 1:N){
        sigma2hat.i[j] <- (N - p)*sigma2hat/(N - p -1) -
        resid[j]^2/((N - p - 1)*(1 - P[j,j]))
    }
```

```
    CVRi <- as.matrix(rep(1,N))
    for(j in 1:N){
        CVRi[j] <- ((sigma2hat.i[j]/sigma2hat)^p) / (1 - P[j,j])
    }
    calpt.find <- abs(CVRi - 1 ) > 3*p/N
    abs.CVRi_1 <- abs(CVRi - 1 )
    calpt.crit <- 3*p/N
    Month <- as.matrix(data[,1])
    CVRidata <- data.frame(Month, CVRi, abs.CVRi_1, calpt.crit)
    CVRidata[,1] <- as.Date(CVRidata[,1])
    calpt.count <- sum(calpt.find)
    CVRidata.sort <- CVRidata[order(-abs.CVRi_1),]
    if(calpt.count == 0){
        return(NULL)
    } else {
        return(CVRidata.sort[1:calpt.count,])
    }
}
##############################################################################
### Create function to compute influence measures of influential observations
exclusioninfoFun <- function(data, portfolio){
    Ci <- as.list(c(1:10))
    CVARi <- as.list(c(1:10))
    for(i in 1:10){
        if(is.null(CiCalptFun(data, i+1)) == TRUE){
            Ci[[i]] <- "None"
        } else {
            Ci[[i]] <- CiCalptFun(data, i+1)
        }
        if(is.null(CVRiCalptFun(data, i+1)) == TRUE){
            CVARi[[i]] <- "None"
        } else {
            CVARi[[i]] <- CVRiCalptFun(data, i+1)
        }
    }
    exclusion.info <- list("Cook's Distance" = Ci[[portfolio]],
    "Covariance Ratio" = CVARi[[portfolio]])
    return(exclusion.info)
}
##############################################################################
### Create functions and variables for Chapter 3
```

```
#############################################################################
### Get the excluded months
exclusion.Be <- c()
exclusion.Bv <- c()
exclusion.Ce <- c()
exclusion.Cv <- c()
for(i in 1:10){
    exclusion.Be <- c(exclusion.Be,
    CiCalptFun(data.e, i+1)[,1])
    exclusion.Bv <- c(exclusion.Bv,
    CiCalptFun(data.v, i+1)[,1])
    exclusion.Ce <- c(exclusion.Ce,
    CVRiCalptFun(data.e, i+1)[,1])
    exclusion.Cv <- c(exclusion.Cv,
    CVRiCalptFun(data.v, i+1)[,1])
}
exclusion.Be <- as.Date(sort(unique(exclusion.Be)))
exclusion.Bv <- as.Date(sort(unique(exclusion.Bv)))
exclusion.Ce <- as.Date(sort(unique(exclusion.Ce)))
exclusion.Cv <- as.Date(sort(unique(exclusion.Cv)))
### Get the subset lists
subset.Ae <- as.list(c(1:10))
subset.Av <- as.list(c(1:10))
subset.Be <- as.list(c(1:10))
subset.Bv <- as.list(c(1:10))
subset.Ce <- as.list(c(1:10))
subset.Cv <- as.list(c(1:10))
for(i in 1:10){
    subset.Ae[[i]] <- rep(TRUE, nrow(data.e))
    subset.Av[[i]] <- rep(TRUE, nrow(data.v))
    subset.Be[[i]] <- !(data.e[,1] %in% exclusion.Be)
    subset.Bv[[i]] <- !(data.v[,1] %in% exclusion.Bv)
    subset.Ce[[i]] <- !(data.e[,1] %in% exclusion.Ce)
    subset.Cv[[i]] <- !(data.v[,1] %in% exclusion.Cv)
}
### Panel B data
  data.Be <- data.e[subset.Be[[1]],] ### AEW excess return
  data.Bv <- data.v[subset.Bv[[1]],] ### AVW excess return
  pdata.Be <- pdata.e[subset.Be[[1]],] ### AEW real return
  pdata.Bv <- pdata.v[subset.Bv[[1]],] ### AVW real return
  ### List of data
```

```
  data.Bl <- list(data.Be, data.Bv)
  pdata.Bl <- list(pdata.Be, pdata.Bv)
### Panel C data
  data.Ce <- data.e[subset.Ce[[1]],] ### AEW excess return
  data.Cv <- data.v[subset.Cv[[1]],] ### AVW excess return
  pdata.Ce <- pdata.e[subset.Ce[[1]],] ### AEW real return
  pdata.Cv <- pdata.v[subset.Cv[[1]],] ### AVW real return
  ### List of data
  data.Cl <- list(data.Ce, data.Cv)
  pdata.Cl <- list(pdata.Ce, pdata.Cv)
##############################################################################
### Create function to compute the statistics
olsFun <- function(data, portfolio){
  varindex <- portfolio + 1
  fit <- lm(data[,varindex] ~ RMRF + SMB + HML + MOM, data=data)
  varnames <- c("Intercept", "RMRF", "SMB", "HML", "MOM")
  beta <- matrix(NA, 1, 5)
  beta[1,] <- fit$coefficients
  colnames(beta) <- varnames
  beta.t <- matrix(NA, 1, 5)
  beta.t[1,] <- coeftest(fit)[,"t value"]
  colnames(beta.t) <- varnames
  beta.NWt <- matrix(NA, 1, 5)
  beta.NWt[1,] <- coeftest(fit, NeweyWest(fit))[,"t value"]
  colnames(beta.NWt) <- varnames
  return(list("Beta" = beta, "Beta t-statistic" = beta.t,
              "Beta Newey-West t-statistic" = beta.NWt))
}
##############################################################################
### Create function to generate the panel summary
panelsummaryFun <- function(data, subset){
    panel.sum <- olsFun(data[subset[[1]], ], 1)
    for(i in 2:10){
        stats.temp <- olsFun(data[subset[[i]], ], i)
        for(j in 1:3){
            panel.sum[[j]] <- rbind(panel.sum[[j]], stats.temp[[j]])
        }
    }
    Portfolio <- 1:10
    for(j in 1:3){
        panel.sum[[j]] <- cbind(Portfolio, panel.sum[[j]])
```

```
    }
    return(panel.sum)
}
################################################################################
### Generate summary for each panel
### AEW
panelAe.summary <- panelsummaryFun(data.e, subset.Ae)
panelBe.summary <- panelsummaryFun(data.e, subset.Be)
panelCe.summary <- panelsummaryFun(data.e, subset.Ce)
### AVW
panelAv.summary <- panelsummaryFun(data.v, subset.Av)
panelBv.summary <- panelsummaryFun(data.v, subset.Bv)
panelCv.summary <- panelsummaryFun(data.v, subset.Cv)
################################################################################
### (AEW) Beta
### Panel A
beta.Ae <- panelAe.summary[[1]]
### Panel B
beta.Be <- panelBe.summary[[1]]
### Percentage change from panel A to panel B
beta.ABe <- ((panelBe.summary[[1]] - panelAe.summary[[1]]) /
panelAe.summary[[1]]) * 100
beta.ABe[,1] <- 1:10
################################################################################
### (AVW) Beta
### Panel A
beta.Av <- panelAv.summary[[1]]
### Panel B
beta.Bv <- panelBv.summary[[1]]
### Percentage change from panel A to panel B
beta.ABv <- ((panelBv.summary[[1]] - panelAv.summary[[1]]) /
panelAv.summary[[1]]) * 100
beta.ABv[,1] <- 1:10
################################################################################
### (AEW) Beta t-statistic
### Panel A
beta_t.Ae <- panelAe.summary[[2]]
### Panel C
beta_t.Ce <- panelCe.summary[[2]]
### Percentage change from panel A to panel C
beta_t.ACe <- ((panelCe.summary[[2]] - panelAe.summary[[2]]) /
```

```
panelAe.summary[[2]]) * 100
beta_t.ACe[,1] <- 1:10
##############################################################################
### (AEW) Beta Newey-West t-statistic
### Panel A
beta_nwt.Ae <- panelAe.summary[[3]]
### Panel C
beta_nwt.Ce <- panelCe.summary[[3]]
### Percentage change from panel A to panel C
beta_nwt.ACe <- ((panelCe.summary[[3]] - panelAe.summary[[3]]) /
panelAe.summary[[3]]) * 100
beta_nwt.ACe[,1] <- 1:10
##############################################################################
### (AVW) Beta t-statistic
### Panel A
beta_t.Av <- panelAv.summary[[2]]
### Panel C
beta_t.Cv <- panelCv.summary[[2]]
### Percentage change from panel A to panel C
beta_t.ACv <- ((panelCv.summary[[2]] - panelAv.summary[[2]]) /
panelAv.summary[[2]]) * 100
beta_t.ACv[,1] <- 1:10
##############################################################################
### (AVW) Beta Newey-West t-statistic
### Panel A
beta_nwt.Av <- panelAv.summary[[3]]
### Panel C
beta_nwt.Cv <- panelCv.summary[[3]]
### Percentage change from panel A to panel C
beta_nwt.ACv <- ((panelCv.summary[[3]] - panelAv.summary[[3]]) /
panelAv.summary[[3]]) * 100
beta_nwt.ACv[,1] <- 1:10
##############################################################################
### Examine the OLS assumptions for panels B and C
### Panel B
### Compute the p-Values of Lilliefors test for normality
normtestpval.B <- normtestpvalFun(data.Bl)
### Compute the p-values of non-constant variance score test
datalist <- data.Bl
portfolio <- 1:10
pvalAEW <- c(NA, 10)
```

```
pvalAVW <- c(NA, 10)
nullAEW <- c(NA, 10)
nullAVW <- c(NA, 10)
for(i in 1:10){
  fit1 <- lm(datalist[[1]][,i+1] ~ RMRF + SMB + HML + MOM,
             data=datalist[[1]])
  pvalAEW[i] <- ncvTest(fit1)$p
  if(pvalAEW[i] < 0.05){
    nullAEW[i] <- "Reject"
  } else {nullAEW[i] <- "Accept"}
  fit2 <- lm(datalist[[2]][,i+1] ~ RMRF + SMB + HML + MOM,
             data=datalist[[2]])
  pvalAVW[i] <- ncvTest(fit2)$p
  if(pvalAVW[i] < 0.05){
    nullAVW[i] <- "Reject"
  } else {nullAVW[i] <- "Accept"}
}
ncvtestpval.B <- data.frame(portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW)
rm(datalist, portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW, i, fit1, fit2)
### Panel C
### Compute the p-Values of Lilliefors test for normality
normtestpval.C <-normtestpvalFun(data.Cl)
### Compute the p-values of non-constant variance score test
datalist <- data.Cl
portfolio <- 1:10
pvalAEW <- c(NA, 10)
pvalAVW <- c(NA, 10)
nullAEW <- c(NA, 10)
nullAVW <- c(NA, 10)
for(i in 1:10){
  fit1 <- lm(datalist[[1]][,i+1] ~ RMRF + SMB + HML + MOM,
             data=datalist[[1]])
  pvalAEW[i] <- ncvTest(fit1)$p
  if(pvalAEW[i] < 0.05){
    nullAEW[i] <- "Reject"
  } else {nullAEW[i] <- "Accept"}
  fit2 <- lm(datalist[[2]][,i+1] ~ RMRF + SMB + HML + MOM,
             data=datalist[[2]])
  pvalAVW[i] <- ncvTest(fit2)$p
  if(pvalAVW[i] < 0.05){
    nullAVW[i] <- "Reject"
```

```
  } else {nullAVW[i] <- "Accept"}
}
ncvtestpval.C <- data.frame(portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW)
rm(datalist, portfolio, pvalAEW, pvalAVW, nullAEW, nullAVW, i, fit1, fit2)
###############################################################################
### Create functions and variables for Chapter 4
###############################################################################
### Create function to compute mean and sd of monthly portfolio return
statFun <- function(pdata, subset){
    statsummary <- matrix(NA, 10, 3)
    rownames(statsummary) <- rep("", 10)
    colnames(statsummary) <- c("Portfolio", "Mean", "SD")
    statsummary[,1] <- 1:10
    for(i in 1:10){
        statsummary[i,2] <- mean(pdata[subset[[i]], i+1])
        statsummary[i,3] <- sd(pdata[subset[[i]], i+1])
    }
    return(statsummary)
}
###############################################################################
### (AEW) Mean and sd of return
### Panel A
meansd.Ae <- statFun(pdata.e, subset.Ae)
### Panel B
meansd.Be <- statFun(pdata.e, subset.Be)
### Panel C
meansd.Ce <- statFun(pdata.e, subset.Ce)
### Percentage change from panel A to panel B
meansd.ABe <- ((meansd.Be - meansd.Ae) / meansd.Ae) * 100
meansd.ABe[,1] <- 1:10
### Percentage change from panel A to panel C
meansd.ACe <- ((meansd.Ce - meansd.Ae) / meansd.Ae) * 100
meansd.ACe[,1] <- 1:10
###############################################################################
### (AVW) Mean and sd of return
### Panel A
meansd.Av <- statFun(pdata.v, subset.Av)
### Panel B
meansd.Bv <- statFun(pdata.v, subset.Bv)
### Panel C
meansd.Cv <- statFun(pdata.v, subset.Cv)
```

```
### Percentage change from panel A to panel B
meansd.ABv <- ((meansd.Bv - meansd.Av) / meansd.Av) * 100
meansd.ABv[,1] <- 1:10
### Percentage change from panel A to panel C
meansd.ACv <- ((meansd.Cv - meansd.Av) / meansd.Av) * 100
meansd.ACv[,1] <- 1:10
##############################################################################
### Create function to compute numbers for mean-variance optimal portfolio
effpfFun <- function(pdata, mu.min, mu.max, nobs, toshorts = TRUE){
    pfoptFun <- function(mu, pdata, toshorts){
        pfmu <- matrix(colMeans(pdata[,2:11]),nrow=1)
        pfcov <- cov(pdata[,2:11])
        if(toshorts == TRUE){
            pfopt.sol <- portfolio.optim(x = pfmu, pm = mu,
            covmat = pfcov, shorts = toshorts)
        } else {
            pfopt.sol <- portfolio.optim(x = pfmu, pm = mu,
            covmat = pfcov, shorts = toshorts,
            reslow = rep(0,10), reshigh = rep(1,10))
        }
        wt <- pfopt.sol$pw
        SD <- sqrt((t(wt) %*% pfcov %*% wt)[1])
        return(c(mu, SD, wt))
    }
    mu.list <- seq(mu.min, mu.max, length.out = nobs)
    effpf <- t(sapply(mu.list, pfoptFun, pdata, toshorts))
    colnames(effpf) <- c("Mean", "SD", paste("W", 1:10, sep=""))
    rownames(effpf) <- rep("", nrow(effpf))
    return(effpf)
}
##############################################################################
### (AEW) Mean-Variance Optimal Portfolio
### Mean of each monthly portfolio return
pfmu.e <- matrix(colMeans(pdata.e[,2:11]),nrow=1)
### Max and min of the mean
pmin.e <- min(pfmu.e) + 1e-4
pmax.e <- max(pfmu.e) - 1e-4
### Mean-Variance Optimal Portfolio
effpfT.e <- effpfFun(pdata.e, 0, 0.5, 1000, TRUE)
effpfF.e <- effpfFun(pdata.e, pmin.e, pmax.e, 100, FALSE)
### Subset for nicer layout
```

```
min_x.e <- min(effpfT.e[,2], effpfF.e[,2])
max_x.e <- max(effpfF.e[,2])
effpfT.e <- effpfT.e[effpfT.e[,2] <= max_x.e,]
##############################################################################
### (AVW) Mean-Variance Optimal Portfolio
### Mean of each monthly portfolio return
pfmu.v <- matrix(colMeans(pdata.v[,2:11]),nrow=1)
### Max and min of the mean
pmin.v <- min(pfmu.v) + 1e-4
pmax.v <- max(pfmu.v) - 1e-4
### Mean-Variance Optimal Portfolio
effpfT.v <- effpfFun(pdata.v, 0, 0.5, 1000, TRUE)
effpfF.v <- effpfFun(pdata.v, pmin.v, pmax.v, 100, FALSE)
### Subset for nicer layout
min_x.v <- min(effpfT.v[,2], effpfF.v[,2])
max_x.v <- max(effpfF.v[,2])
effpfT.v <- effpfT.v[effpfT.v[,2] <= max_x.v,]
##############################################################################
### (Shorts Allowed) Mean-Variance Optimal Portfolio: AEW vs AVW
pmin <- 0
pmax <- 0.03
effpf.e <- effpfFun(pdata.e, pmin, pmax, 31, TRUE)
effpf.v <- effpfFun(pdata.v, pmin, pmax, 31, TRUE)
min_x.ev <- min(effpf.e[,2], effpf.v[,2])
max_x.ev <- max(effpf.e[,2], effpf.v[,2])
##############################################################################
### The End of R codes for functions and variables
##############################################################################
##############################################################################
### The Beginning of R codes for Chapter
##############################################################################
### Chapter 1: Introduction
##############################################################################
### OLS Assumptions
### Residual Plots
### (e.g. AEW Portfolio 2)
residplotFun(data.l, 1, 2)
### P-Values of Lilliefors Test for Normality
normtestpval.A
### Mean of Residuals
meanresid.A
```

```
### P-values of Non-constant Variance Score Test
ncvtestpval.A
###############################################################################
### Chapter 2: Identification of Influential Observation
###############################################################################
### Results from Cook's Distance and Covariance Ratio
### Plot of Cook's Distance and Covariance Ratio
### (e.g. Portfolio 2)
toplotFun(data.l, 2, TRUE)
### Histogram of Cook's Distance and Covariance Ratio
### (e.g. Portfolio 2)
toplotFun(data.l, 2, FALSE)
### Plot of MOM vs Monthly Portfolio Return
### (e.g. AEW Portfolio 2)
momreturnplotFun(data.l, 1, 2)
###############################################################################
### Chapter 3: Influence of Influential Observation
###############################################################################
### (AEW) Plots of Beta
par(mfrow=c(3,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta.Ae[,2], beta.Be[,2])
max_y <- max(beta.Ae[,2], beta.Be[,2])
plot(beta.Ae[,1], beta.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Intercept",
main = "(AEW) Intercept")
axis(1, at=1:10, lab=1:10)
lines(beta.Be[,1], beta.Be[,2], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Ae[,3], beta.Be[,3])
max_y <- max(beta.Ae[,3], beta.Be[,3])
plot(beta.Ae[,1], beta.Ae[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(RMRF)",
main = "(AEW) Beta of RMRF")
axis(1, at=1:10, lab=1:10)
lines(beta.Be[,1], beta.Be[,3], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Ae[,4], beta.Be[,4])
```

```
max_y <- max(beta.Ae[,4], beta.Be[,4])
plot(beta.Ae[,1], beta.Ae[,4], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(SMB)",
main = "(AEW) Beta of SMB")
axis(1, at=1:10, lab=1:10)
lines(beta.Be[,1], beta.Be[,4], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Ae[,5], beta.Be[,5])
max_y <- max(beta.Ae[,5], beta.Be[,5])
plot(beta.Ae[,1], beta.Ae[,5], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(HML)",
main = "(AEW) Beta of HML")
axis(1, at=1:10, lab=1:10)
lines(beta.Be[,1], beta.Be[,5], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Ae[,6], beta.Be[,6])
max_y <- max(beta.Ae[,6], beta.Be[,6])
plot(beta.Ae[,1], beta.Ae[,6], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(MOM)",
main = "(AEW) Beta of MOM")
axis(1, at=1:10, lab=1:10)
lines(beta.Be[,1], beta.Be[,6], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.ABe[,2:6])
max_y <- max(beta.ABe[,2:6])
plot(beta.ABe[,1], beta.ABe[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AEW) % Change from Panel A to Panel B")
axis(1, at=1:10, lab=1:10)
lines(beta.ABe[,1], beta.ABe[,3], type="o", col="green")
lines(beta.ABe[,1], beta.ABe[,4], type="o", col="blue")
lines(beta.ABe[,1], beta.ABe[,5], type="o", col="purple")
lines(beta.ABe[,1], beta.ABe[,6], type="o", col="brown")
lines(1:10, rep(0, 10), lty = 3)
legend(10.5, max_y,
c("Intercept", "Beta(RMRF)", "Beta(SMB)", "Beta(HML)", "Beta(MOM)"),
cex=0.6, col=c("red", "green", "blue", "purple", "brown"),
lty=1, bty="n")
```

```
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
##############################################################################
### (AVW) Plots of Beta
par(mfrow=c(3,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta.Av[,2], beta.Bv[,2])
max_y <- max(beta.Av[,2], beta.Bv[,2])
plot(beta.Av[,1], beta.Av[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Intercept",
main = "(AVW) Intercept")
axis(1, at=1:10, lab=1:10)
lines(beta.Bv[,1], beta.Bv[,2], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Av[,3], beta.Bv[,3])
max_y <- max(beta.Av[,3], beta.Bv[,3])
plot(beta.Av[,1], beta.Av[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(RMRF)",
main = "(AVW) Beta of RMRF")
axis(1, at=1:10, lab=1:10)
lines(beta.Bv[,1], beta.Bv[,3], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Av[,4], beta.Bv[,4])
max_y <- max(beta.Av[,4], beta.Bv[,4])
plot(beta.Av[,1], beta.Av[,4], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(SMB)",
main = "(AVW) Beta of SMB")
axis(1, at=1:10, lab=1:10)
lines(beta.Bv[,1], beta.Bv[,4], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Av[,5], beta.Bv[,5])
max_y <- max(beta.Av[,5], beta.Bv[,5])
plot(beta.Av[,1], beta.Av[,5], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(HML)",
main = "(AVW) Beta of HML")
axis(1, at=1:10, lab=1:10)
```

```
lines(beta.Bv[,1], beta.Bv[,5], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.Av[,6], beta.Bv[,6])
max_y <- max(beta.Av[,6], beta.Bv[,6])
plot(beta.Av[,1], beta.Av[,6], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Beta(MOM)",
main = "(AVW) Beta of MOM")
axis(1, at=1:10, lab=1:10)
lines(beta.Bv[,1], beta.Bv[,6], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel B"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta.ABv[,2:6])
max_y <- max(beta.ABv[,2:6])
plot(beta.ABv[,1], beta.ABv[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AVW) % Change from Panel A to Panel B")
axis(1, at=1:10, lab=1:10)
lines(beta.ABv[,1], beta.ABv[,3], type="o", col="green")
lines(beta.ABv[,1], beta.ABv[,4], type="o", col="blue")
lines(beta.ABv[,1], beta.ABv[,5], type="o", col="purple")
lines(beta.ABv[,1], beta.ABv[,6], type="o", col="brown")
lines(1:10, rep(0, 10), lty = 3)
legend(10.5, max_y,
c("Intercept", "Beta(RMRF)", "Beta(SMB)", "Beta(HML)", "Beta(MOM)"),
cex=0.6, col=c("red", "green", "blue", "purple", "brown"),
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
################################################################################
### Plots of Intercept t-statistic
par(mfrow=c(2,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta_t.Ae[,2], beta_t.Ce[,2])
max_y <- max(beta_t.Ae[,2], beta_t.Ce[,2])
plot(beta_t.Ae[,1], beta_t.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(Intercept)",
main = "(AEW) T-Stats of Intercept")
axis(1, at=1:10, lab=1:10)
```

```
lines(beta_t.Ce[,1], beta_t.Ce[,2], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_t.Av[,2], beta_t.Cv[,2])
max_y <- max(beta_t.Av[,2], beta_t.Cv[,2])
plot(beta_t.Av[,1], beta_t.Av[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(Intercept)",
main = "(AVW) T-Stats of Intercept")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Cv[,1], beta_t.Cv[,2], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Ae[,2], beta_nwt.Ce[,2])
max_y <- max(beta_nwt.Ae[,2], beta_nwt.Ce[,2])
plot(beta_nwt.Ae[,1], beta_nwt.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(Intercept)",
main = "(AEW) NW T-Stats of Intercept")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Ce[,1], beta_nwt.Ce[,2], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Av[,2], beta_nwt.Cv[,2])
max_y <- max(beta_nwt.Av[,2], beta_nwt.Cv[,2])
plot(beta_nwt.Av[,1], beta_nwt.Av[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(Intercept)",
main = "(AVW) NW T-Stats of Intercept")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Cv[,1], beta_nwt.Cv[,2], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
################################################################################
### Plots of RMRF t-statistic
par(mfrow=c(2,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta_t.Ae[,3], beta_t.Ce[,3])
max_y <- max(beta_t.Ae[,3], beta_t.Ce[,3])
plot(beta_t.Ae[,1], beta_t.Ae[,3], type = "o", col = "blue",
```

```
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(RMRF)",
main = "(AEW) T-Stats of RMRF")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Ce[,1], beta_t.Ce[,3], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_t.Av[,3], beta_t.Cv[,3])
max_y <- max(beta_t.Av[,3], beta_t.Cv[,3])
plot(beta_t.Av[,1], beta_t.Av[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(RMRF)",
main = "(AVW) T-Stats of RMRF")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Cv[,1], beta_t.Cv[,3], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Ae[,3], beta_nwt.Ce[,3])
max_y <- max(beta_nwt.Ae[,3], beta_nwt.Ce[,3])
plot(beta_nwt.Ae[,1], beta_nwt.Ae[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(RMRF)",
main = "(AEW) NW T-Stats of RMRF")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Ce[,1], beta_nwt.Ce[,3], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Av[,3], beta_nwt.Cv[,3])
max_y <- max(beta_nwt.Av[,3], beta_nwt.Cv[,3])
plot(beta_nwt.Av[,1], beta_nwt.Av[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(RMRF)",
main = "(AVW) NW T-Stats of RMRF")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Cv[,1], beta_nwt.Cv[,3], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
################################################################################
### Plots of SMB t-statistic
par(mfrow=c(2,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
```

```
min_y <- min(beta_t.Ae[,4], beta_t.Ce[,4])
max_y <- max(beta_t.Ae[,4], beta_t.Ce[,4])
plot(beta_t.Ae[,1], beta_t.Ae[,4], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(SMB)",
main = "(AEW) T-Stats of SMB")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Ce[,1], beta_t.Ce[,4], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_t.Av[,4], beta_t.Cv[,4])
max_y <- max(beta_t.Av[,4], beta_t.Cv[,4])
plot(beta_t.Av[,1], beta_t.Av[,4], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(SMB)",
main = "(AVW) T-Stats of SMB")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Cv[,1], beta_t.Cv[,4], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Ae[,4], beta_nwt.Ce[,4])
max_y <- max(beta_nwt.Ae[,4], beta_nwt.Ce[,4])
plot(beta_nwt.Ae[,1], beta_nwt.Ae[,4], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(SMB)",
main = "(AEW) NW T-Stats of SMB")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Ce[,1], beta_nwt.Ce[,4], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Av[,4], beta_nwt.Cv[,4])
max_y <- max(beta_nwt.Av[,4], beta_nwt.Cv[,4])
plot(beta_nwt.Av[,1], beta_nwt.Av[,4], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(SMB)",
main = "(AVW) NW T-Stats of SMB")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Cv[,1], beta_nwt.Cv[,4], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
################################################################################
### Plots of HML t-statistic
```

```
par(mfrow=c(2,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta_t.Ae[,5], beta_t.Ce[,5])
max_y <- max(beta_t.Ae[,5], beta_t.Ce[,5])
plot(beta_t.Ae[,1], beta_t.Ae[,5], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(HML)",
main = "(AEW) T-Stats of HML")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Ce[,1], beta_t.Ce[,5], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_t.Av[,5], beta_t.Cv[,5])
max_y <- max(beta_t.Av[,5], beta_t.Cv[,5])
plot(beta_t.Av[,1], beta_t.Av[,5], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(HML)",
main = "(AVW) T-Stats of HML")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Cv[,1], beta_t.Cv[,5], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Ae[,5], beta_nwt.Ce[,5])
max_y <- max(beta_nwt.Ae[,5], beta_nwt.Ce[,5])
plot(beta_nwt.Ae[,1], beta_nwt.Ae[,5], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(HML)",
main = "(AEW) NW T-Stats of HML")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Ce[,1], beta_nwt.Ce[,5], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Av[,5], beta_nwt.Cv[,5])
max_y <- max(beta_nwt.Av[,5], beta_nwt.Cv[,5])
plot(beta_nwt.Av[,1], beta_nwt.Av[,5], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(HML)",
main = "(AVW) NW T-Stats of HML")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Cv[,1], beta_nwt.Cv[,5], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
```

```
par(mfrow=c(1,1))
##############################################################################
### Plots of MOM t-statistic
par(mfrow=c(2,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta_t.Ae[,6], beta_t.Ce[,6])
max_y <- max(beta_t.Ae[,6], beta_t.Ce[,6])
plot(beta_t.Ae[,1], beta_t.Ae[,6], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(MOM)",
main = "(AEW) T-Stats of MOM")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Ce[,1], beta_t.Ce[,6], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_t.Av[,6], beta_t.Cv[,6])
max_y <- max(beta_t.Av[,6], beta_t.Cv[,6])
plot(beta_t.Av[,1], beta_t.Av[,6], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "T(MOM)",
main = "(AVW) T-Stats of MOM")
axis(1, at=1:10, lab=1:10)
lines(beta_t.Cv[,1], beta_t.Cv[,6], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Ae[,6], beta_nwt.Ce[,6])
max_y <- max(beta_nwt.Ae[,6], beta_nwt.Ce[,6])
plot(beta_nwt.Ae[,1], beta_nwt.Ae[,6], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(MOM)",
main = "(AEW) NW T-Stats of MOM")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Ce[,1], beta_nwt.Ce[,6], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
lty=1, bty="n")
min_y <- min(beta_nwt.Av[,6], beta_nwt.Cv[,6])
max_y <- max(beta_nwt.Av[,6], beta_nwt.Cv[,6])
plot(beta_nwt.Av[,1], beta_nwt.Av[,6], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "NWT(MOM)",
main = "(AVW) NW T-Stats of MOM")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.Cv[,1], beta_nwt.Cv[,6], type="o", col="red")
legend(10.5, max_y, c("Panel A", "Panel C"), cex=0.6, col=c("blue", "red"),
```

```
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
##############################################################################
### Plots of % change in t-statistic
par(mfrow=c(2,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,5))
min_y <- min(beta_t.ACe[,2:6])
max_y <- max(beta_t.ACe[,2:6])
plot(beta_t.ACe[,1], beta_t.ACe[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AEW) % Change in T-Stats\nFrom Panel A to Panel C")
axis(1, at=1:10, lab=1:10)
lines(beta_t.ACe[,1], beta_t.ACe[,3], type="o", col="green")
lines(beta_t.ACe[,1], beta_t.ACe[,4], type="o", col="blue")
lines(beta_t.ACe[,1], beta_t.ACe[,5], type="o", col="purple")
lines(beta_t.ACe[,1], beta_t.ACe[,6], type="o", col="brown")
lines(1:10, rep(0, 10), lty = 3)
legend(10.5, max_y,
c("Intercept", "T(RMRF)", "T(SMB)", "T(HML)", "T(MOM)"),
cex=0.6, col=c("red", "green", "blue", "purple", "brown"),
lty=1, bty="n")
min_y <- min(beta_t.ACv[,2:6])
max_y <- max(beta_t.ACv[,2:6])
plot(beta_t.ACv[,1], beta_t.ACv[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AVW) % Change in T-Stats\nFrom Panel A to Panel C")
axis(1, at=1:10, lab=1:10)
lines(beta_t.ACv[,1], beta_t.ACv[,3], type="o", col="green")
lines(beta_t.ACv[,1], beta_t.ACv[,4], type="o", col="blue")
lines(beta_t.ACv[,1], beta_t.ACv[,5], type="o", col="purple")
lines(beta_t.ACv[,1], beta_t.ACv[,6], type="o", col="brown")
lines(1:10, rep(0, 10), lty = 3)
legend(10.5, max_y,
c("Intercept", "T(RMRF)", "T(SMB)", "T(HML)", "T(MOM)"),
cex=0.6, col=c("red", "green", "blue", "purple", "brown"),
lty=1, bty="n")
min_y <- min(beta_nwt.ACe[,2:6])
max_y <- max(beta_nwt.ACe[,2:6])
```

```
plot(beta_nwt.ACe[,1], beta_nwt.ACe[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AEW) % Change in NW T-Stats\nFrom Panel A to Panel C")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.ACe[,1], beta_nwt.ACe[,3], type="o", col="green")
lines(beta_nwt.ACe[,1], beta_nwt.ACe[,4], type="o", col="blue")
lines(beta_nwt.ACe[,1], beta_nwt.ACe[,5], type="o", col="purple")
lines(beta_nwt.ACe[,1], beta_nwt.ACe[,6], type="o", col="brown")
lines(1:10, rep(0, 10), lty = 3)
legend(10.5, max_y,
c("Intercept", "NWT(RMRF)", "NWT(SMB)", "NWT(HML)", "NWT(MOM)"),
cex=0.6, col=c("red", "green", "blue", "purple", "brown"),
lty=1, bty="n")
min_y <- min(beta_nwt.ACv[,2:6])
max_y <- max(beta_nwt.ACv[,2:6])
plot(beta_nwt.ACv[,1], beta_nwt.ACv[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AVW) % Change in NW T-Stats\nFrom Panel A to Panel C")
axis(1, at=1:10, lab=1:10)
lines(beta_nwt.ACv[,1], beta_nwt.ACv[,3], type="o", col="green")
lines(beta_nwt.ACv[,1], beta_nwt.ACv[,4], type="o", col="blue")
lines(beta_nwt.ACv[,1], beta_nwt.ACv[,5], type="o", col="purple")
lines(beta_nwt.ACv[,1], beta_nwt.ACv[,6], type="o", col="brown")
lines(1:10, rep(0, 10), lty = 3)
legend(10.5, max_y,
c("Intercept", "NWT(RMRF)", "NWT(SMB)", "NWT(HML)", "NWT(MOM)"),
cex=0.6, col=c("red", "green", "blue", "purple", "brown"),
lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
##############################################################################
### OLS Assumptions
### Panel B
  ### P-Values of Lilliefors Test for Normality
  normtestpval.B
  ### P-values of Non-constant Variance Score Test
  ncvtestpval.B
### Panel C
  ### P-Values of Lilliefors Test for Normality
  normtestpval.C
```

```
  ### P-values of Non-constant Variance Score Test
  ncvtestpval.C
##############################################################################
### Chapter 4: Portfolio Optimization
##############################################################################
### Mean and SD of Monthly Portfolio Returns
### Plots of Mean and SD
### Fill by column
par(mfcol=c(3,2))
### Expand right side of clipping rect to make room for the legend
par(xpd = T, mar = par()$mar + c(0,0,0,3))
min_y <- min(meansd.Ae[,2], meansd.Be[,2], meansd.Ce[,2])
max_y <- max(meansd.Ae[,2], meansd.Be[,2], meansd.Ce[,2])
plot(meansd.Ae[,1], meansd.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Mean",
main = "(AEW) Mean of Monthly Portfolio Return")
axis(1, at=1:10, lab=1:10)
lines(meansd.Be[,1], meansd.Be[,2], type="o", col="red")
lines(meansd.Ce[,1], meansd.Ce[,2], type="o", col="green")
legend(10.5, max_y, c("Panel A", "Panel B", "Panel C"), cex=0.6,
col=c("blue", "red", "green"), lty=1, bty="n")
min_y <- min(meansd.Ae[,3], meansd.Be[,3], meansd.Ce[,3])
max_y <- max(meansd.Ae[,3], meansd.Be[,3], meansd.Ce[,3])
plot(meansd.Ae[,1], meansd.Ae[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "SD",
main = "(AEW) SD of Monthly Portfolio Return")
axis(1, at=1:10, lab=1:10)
lines(meansd.Be[,1], meansd.Be[,3], type="o", col="red")
lines(meansd.Ce[,1], meansd.Ce[,3], type="o", col="green")
legend(10.5, max_y, c("Panel A", "Panel B", "Panel C"), cex=0.6,
col=c("blue", "red", "green"), lty=1, bty="n")
min_y <- min(meansd.ABe[,2:3], meansd.ACe[,2:3])
max_y <- max(meansd.ABe[,2:3], meansd.ACe[,2:3])
plot(meansd.ABe[,1], meansd.ABe[,2], type = "o", col = "skyblue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AEW) % Change from Panel A to Panels B & C")
axis(1, at=1:10, lab=1:10)
lines(meansd.ACe[,1], meansd.ACe[,2], type="o", col="orange")
lines(meansd.ABe[,1], meansd.ABe[,3], type="o", col="purple")
lines(meansd.ACe[,1], meansd.ACe[,3], type="o", col="brown")
legend(10.5, max_y, c("Mean (B)", "Mean (C)", "SD (B)", "SD (C)"), cex=0.6,
```

```
col=c("skyblue", "orange", "purple", "brown"), lty=1, bty="n")
min_y <- min(meansd.Av[,2], meansd.Bv[,2], meansd.Cv[,2])
max_y <- max(meansd.Av[,2], meansd.Bv[,2], meansd.Cv[,2])
plot(meansd.Av[,1], meansd.Av[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "Mean",
main = "(AVW) Mean of Monthly Portfolio Return")
axis(1, at=1:10, lab=1:10)
lines(meansd.Bv[,1], meansd.Bv[,2], type="o", col="red")
lines(meansd.Cv[,1], meansd.Cv[,2], type="o", col="green")
legend(10.5, max_y, c("Panel A", "Panel B", "Panel C"), cex=0.6,
col=c("blue", "red", "green"), lty=1, bty="n")
min_y <- min(meansd.Av[,3], meansd.Bv[,3], meansd.Cv[,3])
max_y <- max(meansd.Av[,3], meansd.Bv[,3], meansd.Cv[,3])
plot(meansd.Av[,1], meansd.Av[,3], type = "o", col = "blue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "SD",
main = "(AVW) SD of Monthly Portfolio Return")
axis(1, at=1:10, lab=1:10)
lines(meansd.Bv[,1], meansd.Bv[,3], type="o", col="red")
lines(meansd.Cv[,1], meansd.Cv[,3], type="o", col="green")
legend(10.5, max_y, c("Panel A", "Panel B", "Panel C"), cex=0.6,
col=c("blue", "red", "green"), lty=1, bty="n")
min_y <- min(meansd.ABv[,2:3], meansd.ACv[,2:3])
max_y <- max(meansd.ABv[,2:3], meansd.ACv[,2:3])
plot(meansd.ABv[,1], meansd.ABv[,2], type = "o", col = "skyblue",
ylim = c(min_y,max_y), xlab = "Portfolio", ylab = "%",
main = "(AVW) % Change from Panel A to Panels B & C")
axis(1, at=1:10, lab=1:10)
lines(meansd.ACv[,1], meansd.ACv[,2], type="o", col="orange")
lines(meansd.ABv[,1], meansd.ABv[,3], type="o", col="purple")
lines(meansd.ACv[,1], meansd.ACv[,3], type="o", col="brown")
legend(10.5, max_y, c("Mean (B)", "Mean (C)", "SD (B)", "SD (C)"), cex=0.6,
col=c("skyblue", "orange", "purple", "brown"), lty=1, bty="n")
# Restore default clipping rect
par(mar = c(5, 4, 4, 2) + 0.1)
par(mfrow=c(1,1))
##############################################################################
### Plots of Mean vs SD
par(mfrow=c(3,2))
min_x <- min(meansd.Ae[,3], meansd.Be[,3], meansd.Ce[,3])
max_x <- max(meansd.Ae[,3], meansd.Be[,3], meansd.Ce[,3])
min_y <- min(meansd.Ae[,2], meansd.Be[,2], meansd.Ce[,2])
```

```
max_y <- max(meansd.Ae[,2], meansd.Be[,2], meansd.Ce[,2])
plot(meansd.Ae[,3], meansd.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlim = c(min_x,max_x),
xlab = "SD", ylab = "Mean", main = "(AEW) Mean vs SD")
lines(meansd.Be[,3], meansd.Be[,2], type="o", col="red")
lines(meansd.Ce[,3], meansd.Ce[,2], type="o", col="brown")
legend("topright", c("Panel A", "Panel B", "Panel C"), cex=0.6,
col=c("blue", "red", "brown"), lty=1, bty="n")
min_x <- min(meansd.Av[,3], meansd.Bv[,3], meansd.Cv[,3])
max_x <- max(meansd.Av[,3], meansd.Bv[,3], meansd.Cv[,3])
min_y <- min(meansd.Av[,2], meansd.Bv[,2], meansd.Cv[,2])
max_y <- max(meansd.Av[,2], meansd.Bv[,2], meansd.Cv[,2])
plot(meansd.Av[,3], meansd.Av[,2], type = "o", col = "green",
ylim = c(min_y,max_y), xlim = c(min_x,max_x),
xlab = "SD", ylab = "Mean", main = "(AVW) Mean vs SD")
lines(meansd.Bv[,3], meansd.Bv[,2], type="o", col="purple")
lines(meansd.Cv[,3], meansd.Cv[,2], type="o", col="orange")
legend("topright", c("Panel A", "Panel B", "Panel C"), cex=0.6,
col=c("green", "purple", "orange"), lty=1, bty="n")
min_x <- min(meansd.Ae[,3], meansd.Av[,3])
max_x <- max(meansd.Ae[,3], meansd.Av[,3])
min_y <- min(meansd.Ae[,2], meansd.Av[,2])
max_y <- max(meansd.Ae[,2], meansd.Av[,2])
plot(meansd.Ae[,3], meansd.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlim = c(min_x,max_x),
xlab = "SD", ylab = "Mean", main = "(Panel A) Mean vs SD")
lines(meansd.Av[,3], meansd.Av[,2], type="o", col="green")
legend("topright", c("AEW", "AVW"), cex=0.6, col=c("blue", "green"),
lty=1, bty="n")
min_x <- min(meansd.Be[,3], meansd.Bv[,3])
max_x <- max(meansd.Be[,3], meansd.Bv[,3])
min_y <- min(meansd.Be[,2], meansd.Bv[,2])
max_y <- max(meansd.Be[,2], meansd.Bv[,2])
plot(meansd.Be[,3], meansd.Be[,2], type = "o", col = "red",
ylim = c(min_y,max_y), xlim = c(min_x,max_x),
xlab = "SD", ylab = "Mean", main = "(Panel B) Mean vs SD")
lines(meansd.Bv[,3], meansd.Bv[,2], type="o", col="purple")
legend("topright", c("AEW", "AVW"), cex=0.6, col=c("red", "purple"),
lty=1, bty="n")
min_x <- min(meansd.Ce[,3], meansd.Cv[,3])
max_x <- max(meansd.Ce[,3], meansd.Cv[,3])
```

```
min_y <- min(meansd.Ce[,2], meansd.Cv[,2])
max_y <- max(meansd.Ce[,2], meansd.Cv[,2])
plot(meansd.Ce[,3], meansd.Ce[,2], type = "o", col = "brown",
ylim = c(min_y,max_y), xlim = c(min_x,max_x),
xlab = "SD", ylab = "Mean", main = "(Panel C) Mean vs SD")
lines(meansd.Cv[,3], meansd.Cv[,2], type="o", col="orange")
legend("topright", c("AEW", "AVW"), cex=0.6, col=c("brown", "orange"),
lty=1, bty="n")
min_x <- min(meansd.Ae[,3], meansd.Av[,3],
meansd.Be[,3], meansd.Bv[,3],
meansd.Ce[,3], meansd.Cv[,3])
max_x <- max(meansd.Ae[,3], meansd.Av[,3],
meansd.Be[,3], meansd.Bv[,3],
meansd.Ce[,3], meansd.Cv[,3])
min_y <- min(meansd.Ae[,2], meansd.Av[,2],
meansd.Be[,2], meansd.Bv[,2],
meansd.Ce[,2], meansd.Cv[,2])
max_y <- max(meansd.Ae[,2], meansd.Av[,2],
meansd.Be[,2], meansd.Bv[,2],
meansd.Ce[,2], meansd.Cv[,2])
plot(meansd.Ae[,3], meansd.Ae[,2], type = "o", col = "blue",
ylim = c(min_y,max_y), xlim = c(min_x,max_x),
xlab = "SD", ylab = "Mean", main = "Mean vs SD")
lines(meansd.Av[,3], meansd.Av[,2], type="o", col="green")
lines(meansd.Be[,3], meansd.Be[,2], type = "o", col = "red")
lines(meansd.Bv[,3], meansd.Bv[,2], type="o", col="purple")
lines(meansd.Ce[,3], meansd.Ce[,2], type = "o", col = "brown")
lines(meansd.Cv[,3], meansd.Cv[,2], type="o", col="orange")
legend("topright",
c("AEW (A)", "AVW (A)", "AEW (B)", "AVW (B)", "AEW (C)", "AVW (C)"),
cex=0.6,
col=c("blue", "green", "red", "purple", "brown", "orange"),
lty=1, bty="n")
par(mfrow=c(1,1))
###############################################################################
### Mean-Variance Optimal Portfolio
par(mfrow=c(3,1))
### (AEW) Mean-Variance Optimal Portfolio
plot(effpfT.e[,2], effpfT.e[,1], type = "o", col = "red",
     xlim = c(min_x.e,max_x.e), xlab = "Standard Deviation",
     ylab = "Expected Monthly Return",
```

```
     main = "(AEW) Mean-Variance Optimal Portfolio")
lines(effpfF.e[,2], effpfF.e[,1], type="o", col="blue")
legend("right", c("Short Allowed", "Long Only"), cex=0.6,
col=c("red", "blue"), lty=1, bty="n")
### (AVW) Mean-Variance Optimal Portfolio
plot(effpfT.v[,2], effpfT.v[,1], type = "o", col = "red",
     xlim = c(min_x.v,max_x.v), xlab = "Standard Deviation",
     ylab = "Expected Monthly Return",
     main = "(AVW) Mean-Variance Optimal Portfolio")
lines(effpfF.v[,2], effpfF.v[,1], type="o", col="blue")
legend("right", c("Short Allowed", "Long Only"), cex=0.6,
col=c("red", "blue"), lty=1, bty="n")
### (Shorts Allowed) Mean-Variance Optimal Portfolio: AEW vs AVW
plot(effpf.e[,2], effpf.e[,1], type = "o", col = "red",
     xlim = c(min_x.ev,max_x.ev), xlab = "Standard Deviation",
     ylab = "Expected Monthly Return",
     main = "(Shorts Allowed) Mean-Variance Optimal Portfolio: AEW vs AVW")
lines(effpf.v[,2], effpf.v[,1], type="o", col="blue")
legend("right", c("AEW", "AVW"), cex=0.6,
col=c("red", "blue"), lty=1, bty="n")
par(mfrow=c(1,1))
### Mean-Variance Optimal Portfolio: Solution and Correlation
print(
xtable(effpf.e,
caption = "(AEW) Mean-Variance Optimal Portfolio: Solution",
label = "table:t4.1", digits = c(0, rep(3, 2), rep(2, 10)),
display = c('e', rep('f', 12))),
table.placement = "htbp", caption.placement = "top",
include.rownames = FALSE, latex.environment = "center")
print(
xtable(effpf.v,
caption = "(AVW) Mean-Variance Optimal Portfolio: Solution",
label = "table:t4.2", digits = c(0, rep(3, 2), rep(2, 10)),
display = c('e', rep('f', 12))),
table.placement = "htbp", caption.placement = "top",
include.rownames = FALSE, latex.environment = "center")
print(
xtable(cor(effpf.e),
caption = "(AEW) Mean-Variance Optimal Portfolio: Correlation",
label = "table:t4.3", digits = c(0, rep(1, 12)),
display = c('e', rep('f', 12))),
```

```
table.placement = "htbp", caption.placement = "top",
latex.environment = "center")
print(
xtable(cor(effpf.v),
caption = "(AVW) Mean-Variance Optimal Portfolio: Correlation",
label = "table:t4.4", digits = c(0, rep(1, 12)),
display = c('e', rep('f', 12))),
table.placement = "htbp", caption.placement = "top",
latex.environment = "center")
### Scatterplot of the Portfolio's Mean, SD, and Weight
pairs(effpfT.e, col="blue")
pairs(effpfT.v, col="blue")
##############################################################################
### Chapter 5: Conclusion
##############################################################################
### None
##############################################################################
### The End of R codes for Chapter
##############################################################################
##############################################################################
### The Beginning of R codes for Appendix
##############################################################################
### Appendix A: Residual Plots
##############################################################################
### (AEW) Portfolio 1
portfolio <- 1
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 1
portfolio <- 1
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 2
portfolio <- 2
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 2
portfolio <- 2
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 3
portfolio <- 3
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 3
portfolio <- 3
```

```
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 4
portfolio <- 4
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 4
portfolio <- 4
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 5
portfolio <- 5
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 5
portfolio <- 5
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 6
portfolio <- 6
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 6
portfolio <- 6
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 7
portfolio <- 7
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 7
portfolio <- 7
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 8
portfolio <- 8
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 8
portfolio <- 8
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 9
portfolio <- 9
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 9
portfolio <- 9
residplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 10
portfolio <- 10
residplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 10
```

```
portfolio <- 10
residplotFun(data.l, 2, portfolio)
##############################################################################
### Appendix B: Plot of Cook's Distance and Covariance ratio
##############################################################################
### Portfolio 1
toplotFun(data.l, 1, TRUE)
### Portfolio 2
toplotFun(data.l, 2, TRUE)
### Portfolio 3
toplotFun(data.l, 3, TRUE)
### Portfolio 4
toplotFun(data.l, 4, TRUE)
### Portfolio 5
toplotFun(data.l, 5, TRUE)
### Portfolio 6
toplotFun(data.l, 6, TRUE)
### Portfolio 7
toplotFun(data.l, 7, TRUE)
### Portfolio 8
toplotFun(data.l, 8, TRUE)
### Portfolio 9
toplotFun(data.l, 9, TRUE)
### Portfolio 10
toplotFun(data.l, 10, TRUE)
##############################################################################
### Appendix C: Histogram of Cook's Distance and Covariance ratio
##############################################################################
### Portfolio 1
toplotFun(data.l, 1, FALSE)
### Portfolio 2
toplotFun(data.l, 2, FALSE)
### Portfolio 3
toplotFun(data.l, 3, FALSE)
### Portfolio 4
toplotFun(data.l, 4, FALSE)
### Portfolio 5
toplotFun(data.l, 5, FALSE)
### Portfolio 6
toplotFun(data.l, 6, FALSE)
### Portfolio 7
```

```
toplotFun(data.l, 7, FALSE)
### Portfolio 8
toplotFun(data.l, 8, FALSE)
### Portfolio 9
toplotFun(data.l, 9, FALSE)
### Portfolio 10
toplotFun(data.l, 10, FALSE)
################################################################################
### Appendix D: Information for the Excluded Influential Observations
################################################################################
### (AEW) Portfolio 1
portfolio <- 1
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 1
portfolio <- 1
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 2
portfolio <- 2
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 2
portfolio <- 2
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 3
portfolio <- 3
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 3
portfolio <- 3
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 4
portfolio <- 4
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 4
portfolio <- 4
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 5
portfolio <- 5
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 5
portfolio <- 5
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 6
```

```
portfolio <- 6
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 6
portfolio <- 6
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 7
portfolio <- 7
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 7
portfolio <- 7
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 8
portfolio <- 8
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 8
portfolio <- 8
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 9
portfolio <- 9
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 9
portfolio <- 9
exclusioninfoFun(data.v, portfolio)
### (AEW) Portfolio 10
portfolio <- 10
exclusioninfoFun(data.e, portfolio)
### (AVW) Portfolio 10
portfolio <- 10
exclusioninfoFun(data.v, portfolio)
###############################################################################
### Appendix E: Excluded Months By Panel and Weighting Method
###############################################################################
list(
"Panel A's Number of Monthly Observations" = nrow(data.e),
"(AEW) Panel B's Excluded Months" = exclusion.Be,
"(AEW) Panel B's Number of Excluded Months" = length(exclusion.Be),
"(AVW) Panel B's Excluded Months" = exclusion.Bv,
"(AVW) Panel B's Number of Excluded Months" = length(exclusion.Bv),
"(AEW) Panel C's Excluded Months" =
matrix(c(as.character(exclusion.Ce), rep("",3)), ncol = 5, byrow = TRUE),
"(AEW) Panel C's Number of Excluded Months" = length(exclusion.Ce),
```

```
"(AVW) Panel C's Excluded Months" =
matrix(c(as.character(exclusion.Cv), rep("",3)), ncol = 5, byrow = TRUE),
"(AVW) Panel C's Number of Excluded Months" = length(exclusion.Cv)
)
##############################################################################
### Appendix F: Plot of MOM vs Monthly Portfolio Return
##############################################################################
### (AEW) Portfolio 1
portfolio <- 1
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 1
portfolio <- 1
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 2
portfolio <- 2
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 2
portfolio <- 2
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 3
portfolio <- 3
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 3
portfolio <- 3
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 4
portfolio <- 4
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 4
portfolio <- 4
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 5
portfolio <- 5
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 5
portfolio <- 5
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 6
portfolio <- 6
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 6
```

```
portfolio <- 6
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 7
portfolio <- 7
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 7
portfolio <- 7
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 8
portfolio <- 8
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 8
portfolio <- 8
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 9
portfolio <- 9
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 9
portfolio <- 9
momreturnplotFun(data.l, 2, portfolio)
### (AEW) Portfolio 10
portfolio <- 10
momreturnplotFun(data.l, 1, portfolio)
### (AVW) Portfolio 10
portfolio <- 10
momreturnplotFun(data.l, 2, portfolio)
###########################################################################
### The End of R codes for Appendix
###########################################################################
```

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