Testing Equity Portfolios for Alpha Bias: An Exercise for Student Investment Funds

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ABSTRACT

We present an exercise that that guides students through the rationale and techniques for identifying and correcting for alpha bias in the reported performance of equity portfolios. The exercise is particularly relevant for Student Investment Fund programs that invest actual money, as the historical performance of the class portfolio can be used in the activity, which creates an additional level of engagement for students. Students learn why portfolios that emphasize small-capitalization and/or value stocks tend to display a positive alpha bias (overstating performance), and why portfolios that emphasize large-capitalization and/or growth stocks tend to display a negative alpha bias (understating performance).

Introduction

We develop an exercise that guides students through the rationale and techniques for identifying, quantifying and correcting for alpha bias in the reported performance of a portfolio of equities. Measurement of portfolio alpha — the excess return earned over and above a market benchmark — is a timely topic. A recent article in *The Economist* (2008) referred to the quest to accurately define alpha as "… a looming challenge for the money management industry." The exercise we present is particularly relevant for Student Investment Fund (SIF) programs that invest actual money, as the historical performance of the class portfolio can be used in the activity, which creates an additional level of engagement for students.

The SIF approach to teaching investments has become increasingly popular in recent years. In 1990, Lawrence (1990) identified 22 Student Investment Funds at United States universities. Neely and Cooley (2004) report that this number had grown to over 100 by 2004, and in 2008 the Redefining Investment Strategy Education (R.I.S.E.) conference hosted by the University of Dayton reported over 200 such programs. These programs are important to Business Schools in their quest to attract top students and engage alumni in fund-raising activities. Many programs publish sophisticated investments newsletters (Cox and Goff, 2006) and are supported by significant investments in financial services labs featuring subscriptions to professional databases such as Bloomberg and Thomson Financial.

Student Investment Fund classes are usually elite courses requiring above-average levels of effort and engagement by both students and instructors. Admission is sometimes competitive, requiring an application that is reviewed by the supervising faculty member and/or other enrolled students. Students that self-select into these courses are often targeting careers in investment management. A successful SIF track record creates a positive impression for prospective students and alumni. The topic of accurately measuring alpha is relevant for students and instructors in SIF courses, as there is often implicit pressure for these programs to report investment results that "beat the market" (positive alphas above a declared benchmark).

Moreover, the use of applied exercises that feature experiential learning and emphasize the creation of outputs that meet real-world standards are becoming increasingly important as business schools work to overcome their reputation for "**…** graduating students who are ill-equipped to wrangle with complex issues" (Bennis and O'Toole, 2005). Developing an exercise that addresses the subtleties of reporting portfolio performance is therefore appropriate for advanced courses that seek to provide students with experiences that reflect real-world standards as closely as possible.

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In our experience as consultants, speakers at global money management conferences and directors of SIF programs at our respective universities, we have a witnessed a remarkable increase in investor sophistication and competitive standards for money managers over the last decade. In particular, pension and endowment officers are increasingly interested in hiring managers who are willing to negotiate pay-for-performance fees rather than those who charge fixed fees. Performance fees are usually linked to some measure of alpha (or the related concept of the information ratio; see Grinold, 1989). Therefore, there is a lot riding on how alpha is measured, including managers' ability to declare success or failure (beating or not beating a benchmark), and the level of performance fees they can charge clients.

In the sections that follow we describe the nature of alpha bias and explain why it is an important consideration in portfolio performance attribution. These sections are written as instructor lecture notes and, at the instructor's discretion, can be photocopied and distributed directly to students. We then present an empirical exercise (with data and a solution key provided in a supplementary spreadsheet) that describes the steps necessary to detect and adjust equity portfolio performance for alpha bias. The upshot of the exercise is that students will learn, conceptually and quantitatively, why portfolios that emphasize small-capitalization and/or value stocks tend to display a positive alpha bias (performance is overstated) when benchmarked to a "plain-vanilla" index like the Russell 1000, and portfolios that emphasize large-capitalization and/or growth stocks tend to display a negative alpha bias (performance is understated) when measured against a standard market index.

Defining and Estimating Alpha

Generally, the alpha (for asset or portfolio *i*) is estimated empirically via a linear regression model such as:

$$(1) \qquad R_i - r_f = \alpha + \beta_1\left(R_{F1} - r_f\right) + \beta_2\left(R_{F2} - r_f\right) + \cdots + \beta_k\left(R_{Fk} - r_f\right) + \varepsilon$$

where

- R_i is a vector (column of data) representing the last T periods of returns for portfolio *i*. (A common choice is to set T equal to 60 months of data, although daily data are often used when focusing on 6-, 12-, or 18-month periods.)
- r_f is a vector of returns on the risk free asset (typically the short term T-bill rate or the London Interbank Offer Rate, a.k.a LIBOR) for the last T periods.
- $R_{F\,k}$ is a vector of returns on risk factor k for the last T periods. Depending upon the model of risk employed (CAPM (Capital Asset Pricing Model) or otherwise), there may be only one factor, or there may be several factors. Risk factors are thought to be "systematic" in nature, meaning that virtually all assets are exposed to a relatively small number (= k) of common risk factors that, to some degree, affect all aspects of investing and doing business. Equation 1 is written in general form to account for these k factors. The CAPM has only one factor, a maximally-diversified global portfolio of risky assets. Hence, in the CAPM, the factor R_{F1} is typically written as R_{MKT}. Most models developed after the CAPM typically employ multiple risk factors (elaborated on below).
- β_k is the beta (estimated statistically) associated with the return vector of factor k. Beta measures how sensitive an asset's returns are to changes in (the returns of) factor k. The CAPM models one beta, whereas there are multiple measures of beta in multi-factor models (one for each risk factor).[2]
- ε is the residual vector, indicating deviations between the linear regression line (or response surface for multifactor models) and the actual returns of asset i. There are T ε's estimated in each regression, and they have a mean of exactly zero.

Equation 1 is a completely general form for the estimation of alpha. It allows for any number of factors and their associated betas (up to k of them). That is, equation 1 provides estimates of alpha (α) and β_1, β_2, … β_k. The alpha of portfolio i for a certain time span represents the return of the portfolio above (or

[2] Beta is not simply an asset's return volatility relative to market volatility. Beta is a scaled measure of the correlation of returns between the asset and each factor. In the single-index CAPM the scaling factor is the ratio of volatility of asset *i* to the volatility of the market: $\beta_i = [\ \sigma_i / \sigma_{MKT}\ ] \times \text{correlation}_{(i,\, MKT)}$.

below) what would be expected, given the portfolio's exposure to the risk factors. Alpha is the key metric in performance attribution. It is a measure of abnormal risk-adjusted performance of an asset, portfolio, or manager(s). A positive α indicates that the portfolio performed abnormally well, over and above a certain level of exposure to various systematic risk factors. In the investments industry, alpha is interpreted as a direct measure of investment manager skill.

Models of Risk and Expected Return — General Results

Risk models relate risk to expected returns (*ex ante*, or before-the-fact *forecasts*), which are subject to error and are therefore almost always different from realized returns (*ex post*, or after-the-fact *calculations* involving known values). One key feature of these models is that all risk is viewed as belonging to one of two categories: either (1) systematic risk or (2) non-systematic risk.[3] Within these models, expected returns increase with exposure to the systematic risk factors. These extra expected returns are known as "risk premia," and are thought to expand and contract over time.

There is no expected reward for exposure to non-systematic risk. Expected returns depend upon the magnitude of exposure to systematic risk only. Although non-systematic risk exposure can result in positive or negative returns *ex post*, the important point is that, *ex ante*, this type of risk is *expected* to provide a return of zero. Beyond these commonalities, models differ in what types of risks are considered to be systematic. Some models employ only one systematic risk factor (the CAPM), while other models employ 2, 3, 4 or more.

Once the actual return to each factor is known (from the historical period of measure, e.g., 60 months), it is possible to compute what the return on a portfolio *should have been*, given the actual factor returns and the portfolio's exposure to these factors, as measured by the factor betas. This can also be thought of as a measure of what the portfolio would have earned in the period under study if exposure to non-systematic risk had a payoff of zero.

Therefore, if we have estimates of the *k* betas and the actual returns for the *k* factors over the last 60 months, the reward for systematic risk can be computed as:

$$(2) \qquad Actual\ beta\ return = \overline{r_f} + \hat{\beta}_1(\overline{R_{F1} - r_f}) + \hat{\beta}_2(\overline{R_{F2} - r_f}) + ... + \hat{\beta}_k(\overline{R_{Fk} - r_f})$$

where the $\hat{\beta}$'s are estimated via linear regression (equation 1), and are multiplied by the respective means of the actual factor returns above the risk free rate for the period of measure.[4]

Although the *expected* return for non-systematic risk exposure is zero, the *actual* non-systematic return is rarely zero. The actual return to non-systematic risk is, by definition, alpha. It is the primary measure of investment skill.[5] It is computed as:

Ex-post non-systematic return (alpha) = (actual total return) – (actual beta return),

or, equivalently:

$$(3) \qquad \alpha = \overline{R}_i - \left[\overline{r_f} + \beta_1\left(\overline{R_{F1} - r_f}\right) + \beta_2\left(\overline{R_{F2} - r_f}\right) + \cdots + \beta_k\left(\overline{R_{Fk} - r_f}\right)\right] .$$

Note that equation 3 is derived by taking the mean of equation 1. Also, all parameters (including alpha) at this stage are measured in per period terms (e.g., monthly), and can be annualized later.

A Brief History of Specific Models of Risk and Expected Return

Based on the seminal work of Sharpe (1964), Lintner (1965), and Mossin (1966]), the Capital Asset Pricing Model (CAPM) changed the way we think about risk and return forever. In any model of risk, CAPM or otherwise, total risk (defined as the variance of returns) consists of systematic and non-

[3] Both systematic and non-systematic risk are commonly referred to using other terminology as well. Systematic risk is also known as beta risk or factor risk. Non-systematic risk is also known as idiosyncratic risk, diversifiable risk, or asset-specific risk.

[4] It is especially important to subtract the risk free return in each period from both R_i and the market factor returns. Failure to do so will result in a statistical bias in alpha equal to $r_f \cdot \times (1 - \Sigma \beta_k)$.

[5] Note that if an investor has no skill in individual asset selection, but is able to time the market (when to increase or decrease exposure to various systematic factors), this ability will also manifest itself as positive alpha.

systematic risk. In the CAPM, systematic risk is related to only one factor — the global market portfolio. As described in the previous section, any increase in a portfolio's exposure to this systematic risk (measured by beta) is associated with an increase in expected return, while exposure to non-systematic risk has no effect on expected return.

The CAPM is stated formally as:

$$(4) \qquad E(R_i) = r_f + \beta\left[E\left(R_{MKT} - r_f\right)\right]$$

where E(·) denotes an expected value. The alpha and beta from the CAPM are estimated empirically via a linear regression (equation 1) as shown: [6]

$$(5) \qquad R_i - r_f = \alpha + \beta_1\left(R_{MKT} - r_f\right) + \varepsilon \ .$$

From the advent of the CAPM in 1964 until the mid-1970s, the model generated relatively little controversy. [7] For the most part, statistical tests of the CAPM were supportive of the model's prediction that non-systematic risk should not be rewarded, which is the same as saying that, on average, alpha is not statistically different from zero. The predominant view at the time was that markets were highly efficient, and it was therefore unlikely for anyone to earn alpha consistently over time. Randomness or luck was the common explanation assigned to an organization or individual who demonstrated a consistent ability to earn alpha.[8]

This view was challenged when Basu (1977) showed that, after controlling for the systematic market risk factor, portfolios of low P/E stocks outperformed portfolios of high P/E stocks. This finding ran contrary to the predictions of the CAPM. It now seemed possible that alpha could be earned consistently via skill rather than luck. Another deviation from the CAPM was uncovered in 1981 when two doctoral students, Rolf Banz and Mark Reinganum, working independently at the University of Chicago, discovered that portfolios of small capitalization stocks outperformed portfolios of large capitalization stocks, even after controlling for their exposure to the market risk factor.[9] Like Basu's P/E discovery, this finding was an anomaly from the viewpoint of the CAPM.

In the following decade, much research was aimed at better understanding the P/E and size effects. It was a time of transition, but throughout this period, although the CAPM was repeatedly challenged, it was largely left unchanged in practice.[10] That is, from 1964 to the early 1990s, systematic risk was considered to be based on only one factor — the market — while the P/E and market capitalization anomalies were largely viewed as puzzles yet to be solved. In industry, portfolio managers continued to report their results compared to market indexes such as the S&P 500, the Russell 1000, or the Russell 3000. Investors did not yet consider size and P/E (value) as systematic risk factors, so managers who emphasized small-cap and/or value stocks were allowed to report outsized positive results (and charge outsized performance fees).

In 1993, more than ten years after the discoveries of Basu, Banz and Reinganum, Eugene Fama and Ken French published a paper that refuted the one factor structure of the CAPM in favor of a three factor model of systematic risk. The new factors (in addition to the market) were a value factor (similar in spirit to Basu's P/E ratio, but based instead on the ratio of book value of equity to stock price, a.k.a. the book-to-market ratio) and a size factor (representing the Banz and Reinganum market capitalization effect). The new model came to be known as the Fama-French Three-Factor Model. Inclusion of these two additional factors was initially controversial, as this was the first time that factors previously defined as

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[6] Equation 5 is commonly known as the market model regression.

[7] Not all of the initial reaction to the CAPM was favorable, however; e.g., see Bierwag and Grove (1965).

[8] Consider the following simple example: If 1,024 people flip a coin once a year (and flipping heads is associated with earning positive alpha), then after ten years we would expect at least one person to have flipped heads ten times in a row. If only one person in a thousand beats the market ten years in a row, the result is just as likely due to chance as skill. This one in a thousand ratio is similar to the historical performance of mutual fund managers (such as Peter Lynch, whose Magellan Fund earned positive alpha in 11 of 13 years). Managers who beat the market for extended periods of time are literally "one in a thousand" (and compensated accordingly).

[9] The finding has since come to be known as the size effect.

[10] During this period, Eugene Fama frequently commented "It takes a model to beat a model."

alpha returns were recast as beta returns.[11] Eventually, however, after numerous research papers, extensive debate, and innovations in index products such as exchange-traded funds (which significantly lowered the cost of obtaining exposure to the value and size factors), academics and (most) practitioners have accepted these factors as legitimate beta-risks.

Expressed in expectation form, the Fama-French Three Factor model is

$$E(R_i) = r_f + \beta_1 \left[E(R_{MKT}) - r_f\right] + \beta_2 \left[E(R_{SMB})\right] + \beta_3 \left[E(R_{HML})\right] \quad (6)$$

where R_{SMB} is the return to a portfolio of small cap stocks minus the return to a portfolio of large cap stocks (Small Minus Big), and R_{HML} is the return to a portfolio of high book to market stocks minus the return to a portfolio of low book to market stocks (High Minus Low).[12] The Fama-French alpha and its three betas are estimated empirically via a linear regression such as[13]

$$R_i - r_f = \alpha + \beta_1 (R_{MKT} - r_f) + \beta_2 (R_{SMB}) + \beta_3 (R_{HML}) + \varepsilon \ . \quad (7)$$

As the one-factor CAPM declined from favor and the Fama-French Three Factor Model gained acceptance, the definition of systematic risk also changed.[14] This spawned an evolution in the way we conceptualize equity expected returns, and the way we measure alpha. It is important to see that these results are not just theoretical, but affect industry practice as well. For example, it is now customary for portfolio performance to be adjusted for market risk, size (capitalization) risk, and style (value vs. growth) risk. In the sections that follow we show that failure to account for multiple systematic risk factors induces biased estimates of alpha, which in turn affects performance attribution, fees, managers' compensation, and investor perceptions of the money management industry.

How Bias in Alpha Estimations Affects Performance Attribution

Consider the measurement of alpha under both the one-factor CAPM and the Fama-French model. Following equation 3, under the CAPM, alpha is estimated as

$$\hat{\alpha}^{CAPM} = \overline{R}_i - \left[\overline{r_f} + \hat{\beta}_1^{CAPM} \times \left(\overline{R_{MKT} - r_f}\right)\right] \quad (8)$$

whereas under the Fama-French Three Factor model, alpha is estimated as

$$\hat{\alpha}^{FF3} = \overline{R}_i - \left[\overline{r_f} + \hat{\beta}_1^{FF3}\left(\overline{R_{MKT} - r_f}\right) + \hat{\beta}_2^{FF3}\left(\overline{R_{SMB}}\right) + \hat{\beta}_3^{FF3}\left(\overline{R_{HML}}\right)\right] \ . \quad (9)$$

If there are actually three systematic risk factors that drive expected returns (equation 9), but the measurement of alpha for an actively-managed equity portfolio is conducted according to the one-factor CAPM (equation 8), a bias will be induced in the estimation of alpha. The bias is equal to:

$$\textit{Alpha Bias} = \textit{False Alpha} - \textit{True Alpha} = \alpha^{CAPM} - \alpha^{FF3} \text{, or}$$

$$\textit{Alpha Bias} = \left[\left(\beta_1^{FF3} - \beta_1^{CAPM}\right) \times \left(\overline{R_{MKT} - r_f}\right)\right] + \left[\beta_2^{FF3} \times \left(\overline{R_{SMB}}\right)\right] + \left[\beta_3^{FF3} \times \left(\overline{R_{HML}}\right)\right] . \quad (10)$$

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[11] Money managers have a rational incentive to resist re-classifying alpha returns as beta returns, as this reduces the abnormal return they can report to investors (and the fees they can charge based on their reported outperformance).

[12] There is no risk free rate subtracted from the SMB or HML portfolios because the factor returns are constructed from the difference between two portfolios (each with a risk free rate subtracted) and in the differencing process, the risk free rates cancel out.

[13] Historic returns for all three factors are available at Ken French's web site: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html

[14] Carhart (1997) suggests that a fourth factor (price momentum) should also be considered as a systematic influence. This model, known as the Fama-French/Carhart Four Factor model, remains somewhat controversial. The focus of this paper is limited to the Fama French Three Factor model. Risk consulting firms such as Barra and Axioma employ numerous risk factors (including, but not limited to, SMB, HML and momentum). The additional risk factors are employed not necessarily for their systematic characteristics, but rather because some industries are exposed to specific risks, and asset managers are interested in measuring these risks.

The following discussion will focus on the potential bias from the second two terms in Equation 10, related to estimation of the betas on the size and value factors.[15] It is well-known that small-cap stocks tend to outperform large-cap stocks. The alpha of a portfolio with a small-cap emphasis will be overstated (positive alpha bias) if alpha is calculated using a one-factor CAPM. The CAPM-measured alpha is too large because some of the additional return earned from exposure to the systematic size factor (from overweighting small-cap stocks) is bundled into the measurement of alpha.

Alternatively, portfolios emphasizing large-cap stocks typically suffer from the opposite problem. In this case CAPM-measured alphas are often negatively biased, because below-average exposure to small-cap risk *reduces* the expected risk premium. If a portfolio with a large-cap emphasis outperforms relative to these lower return expectations, managers should be credited with earning a *higher* alpha.

It is also well-known that over long periods value portfolios (with high book-to-market ratios) tend to outperform growth portfolios (low book-to-market ratios). For portfolios with a value emphasis, a CAPM alpha will be positively biased because it includes the value risk premium (the extra return earned from overweighting value stocks). In the Fama-French Three-Factor Model, the value premium is included in the beta component of returns. Alternatively, for portfolios emphasizing growth (low book to market ratios), the bias will be negative, as less exposure to the value risk factor decreases the portfolio's expected return. Collectively, these effects imply that small-cap value portfolios will be esusceptible to positive alpha bias, while large-cap growth portfolios will be susceptible to negative alpha bias.

Intuitively, the alpha bias arises from Fama-French beta returns being incorrectly included in (or subtracted from) a CAPM-based alpha. Inaccurately measuring the alpha and beta components of returns in this manner is sometimes referred to as "dirty alpha" or "alpha contamination." The alpha is contaminated because it is an inaccurate measure of performance and manager skill. Notice how critical it is to properly measure alpha, as pay-for-performance agreements usually base managers' fees on the amount of alpha they generate. Failure to measure alpha accurately can result in managers charging too much (if they fail to account for exposure to small-cap and/or value stocks) or too little (if they fail to account for exposure to large-cap and/or growth stocks).

An Exercise in Measuring Alpha Bias

Data for this exercise are provided in the first worksheet in the Alpha-Bias-Regression.xls spreadsheet. We are using a dataset from Ken French's online library (URL provided in our references). The data consist of 60 months (2003-2007) of returns from a small-cap value portfolio (SCV) and a large-cap growth portfolio (LCG). (A longer time series of various portfolio returns and the Fama-French monthly risk factors are also provided on subsequent worksheets.) There is also data for the risk-free rate of interest and returns on the systematic risk factors Mkt-RF (market return in excess of the risk-free rate), SMB (for small minus big, computed as the returns of small-cap portfolio minus large-cap (or "big") portfolio returns, known as the size premium), and HML (high minus low, computed as the returns of a high book-to-market portfolio minus the returns of a low book-to-market portfolio, known as the value premium). The exercise requires students to estimate various linear regression models and interpret the regression outputs.

1. Estimate a CAPM-based regression model using SCV-RF (excess return of the small-cap value portfolio) as the dependent variable and the Mkt-RF risk factor as the independent variable (equation 5 with Mkt-RF as the market factor). Record the estimated alpha and beta and the adjusted R-square from the regression.
2. Estimate a Fama-French regression model using SCV-RF as the dependent variable and the Mkt-RF, SMB and HML risk factors as the dependent variables (equation 7). Record the estimated

[15] As shown by Equation 10, estimation of the Mkt-Rf factor using the CAPM and Fama-French models induces a third potential source of bias. If the Fama-French factors were constructed to be orthogonal to one another the estimated Mkt-Rf betas would be expected to be equal under both models. As the Fama-French factors are not constructed for strict orthogonality, however, deviations in the estimated Mkt-Rf beta factor under both models can also affect the estimated alpha. As the bias arising from estimation of the Mkt-Rf coefficient is more statistical in nature, and the potential bias associated with estimation of the SMB and HML betas results from omission or inclusion of additional systematic risk factors in the alpha model, we focus our discussion on the potential bias associated with estimation of these coefficients.

alpha, estimated betas (one for each systematic factor) and the adjusted R-square from the regression.

3. Answer the following questions based on the models you estimated in questions 1 and 2 above.

- **a.** Was the portfolio alpha higher or lower in the second model?
- **b.** Explain why the estimated alpha was different.
- **c.** What are the implications of the change in estimated alpha in terms of portfolio performance and the fees a manager could charge for this performance?
- **d.** Was the estimated beta on the Mkt-RF factor higher or lower in the second model?
- **e.** Explain why the estimated beta on the Mkt-RF factor changed.
- **f.** What do the signs and statistical significance of the Mkt-RF, SMB and HML regression coefficients imply about the SCV portfolio's exposure to the three systematic risk factors? How are these coefficients related to the change in alpha you described above?
- **g.** Was the adjusted R-square higher or lower in the second model?
- **h.** Based on the change in the adjusted R-square, which model provided a better fit for the data?

4. Estimate a CAPM-based regression model using LCG-RF (excess return of the large-cap growth portfolio) as the dependent variable and the Mkt-RF risk factor as the independent variable (equation 5 with Mkt-RF as the market factor). Record the estimated alpha and beta and the adjusted R-square from the regression.

5. Estimate a Fama-French regression model using LCG-RF as the dependent variable and the Mkt-RF, SMB and HML risk factors as the dependent variables (equation 7). Record the estimated alpha, estimated betas (one for each systematic factor) and the adjusted R-square from the regression.

6. Answer the following questions based on the models you estimated in questions 4 and 5 above.

- **a.** Was the estimated alpha higher or lower in the second model?
- **b.** Explain why the estimated alpha was different.
- **c.** What are the implications of the change in alpha in terms of portfolio performance and the fees a manager could charge for this performance?
- **d.** Was the estimated beta on the Mkt-RF factor higher or lower in the second model?
- **e.** Explain why the estimated beta on the Mkt-RF factor changed.
- **f.** What do the signs and statistical significance of the Mkt-RF, SMB and HML regression coefficients imply about the LCG portfolio's exposure to the three systematic risk factors? How are these coefficients related to the change in alpha you described above?
- **g.** Was the adjusted R-square higher or lower in the second model?
- **h.** Based on the change in the adjusted R-square, which model provided a better fit for the data?

7. Repeat the tasks described in questions 1, 2 and 3 above using the monthly excess returns from the Student Investment Fund portfolio managed at your university, and answer all conceptual questions. (Remember to subtract the monthly risk-free rate to create time series of excess returns for your portfolio returns and the market returns, but not the SMB and HML factor returns.) Since the CAPM and Fama-French factors are value-weighted, it is important to use a time series of monthly value-weighted returns for your university portfolio returns. Do the regression results suggest that your class portfolio performance has a significant alpha bias? If so, is this bias positive or negative? (Has your portfolio performance been overstated or understated?)

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