UNIVERSITY OF CHICAGO
Booth School of Business

Bus 35120 – Portfolio Management Prof. Lubos Pastor

# Assignment #8
Solutions

**B.** 1. **Performance Evaluation and Market Timing.**

(a) First, we construct the fund's returns using the fund's holdings and the returns on the market and the T-bill.

i. The fund's unconditional alpha estimate is -0.00024 per month ($t = -0.28$), or -0.29% per year. Its unconditional beta estimate is 0.7.

ii. No. The negative alpha suggests that the fund underperforms the market, after adjusting for beta risk.

(b) The fund's return in month $t$ can be written as

$$R_{P,t} \;=\; w_t R_{m,t} + (1 - w_t) R_{f,t},$$

which can be rewritten as

$$R_{P,t} - R_{f,t} \;=\; w_t (R_{m,t} - R_{f,t}).$$

Compare this equation to the conditional market model regression:

$$R_{P,t} - R_{f,t} \;=\; \alpha_t + \beta_t (R_{m,t} - R_{f,t}) + \epsilon_t.$$

Hence, this fund's conditional alpha and beta at time $t$ are always

$$\begin{aligned} \alpha_t &= 0 \\ \beta_t &= w_t. \end{aligned}$$

No need to estimate anything! The conditional alpha and beta are known without error, given the fund's holdings.

(c) i. Yes. The Treynor-Mazuy gamma estimate is $1.31 > 0$, which is significantly positive ($t = 6.1$). The fund seems able to increase its exposure to the market (at the expense of its T-bill holdings) before the market rises, and decrease its exposure to the market before the market falls (relative to the T-bill).

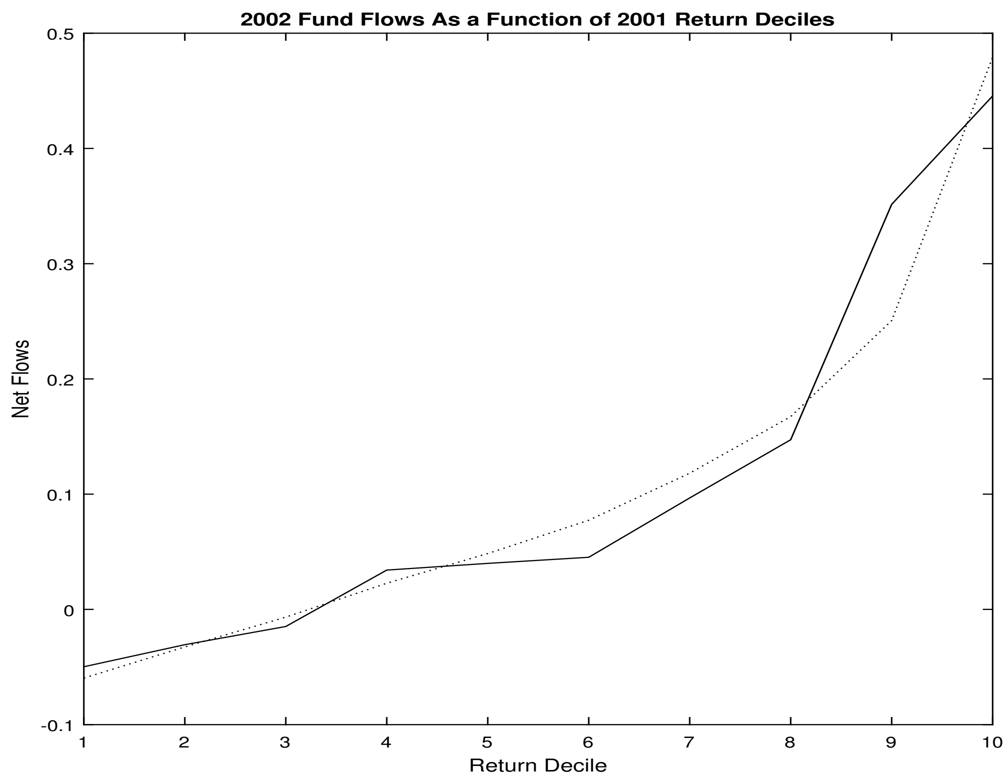
ii. Yes. The Henriksson-Merton gamma estimate is $0.17 > 0$, which is significantly positive ($t = 2.9$).

iii. Yes, but only insignificantly. We have $GT = 0.0003$ ($t = 0.2$). The GT approach is more powerful when the fund invests in more than just one risky asset.

(d) When a fund engages in market timing, it is not sufficient (in fact, it can be misleading) to look only at the fund's usual alpha estimate when evaluating a manager's skill. Market timing implies time-varying beta, so the usual market model regression used to estimate alpha is misspecified. For the fund analyzed here, the alpha estimate is negative, suggesting no skill, but a closer look reveals zero conditional alpha and strong market timing ability.

2. **Estimating the Performance-Flow Relation.**

(a) i. Yes. Figure 1 (solid line) reveals a convex relation between the 2001 fund decile returns and 2002 net fund flows.




ii. Yes. Since the estimate of $c$ is significantly positive, the results do support a convex pattern.

| | $a$ | $b$ | $c$ |
|---|---|---|---|
| Estimate | 0.1919 | 1.3100 | 1.7038 |
| $t$-statistic | 10.3983 | 9.7304 | 3.4092 |

iii. See Figure 1 (dotted line).

iv. The main problem is that the standard regression assumption of uncorrelated error terms (recall your stats course) is violated. Fund flows tend to be correlated across funds (and hence also across fund deciles). For example, after years in which the market does well, most funds experience inflows of capital, and the right-hand side variables does not fully capture this comovement. Also, the flows to the worst and the best performers may well be negatively correlated because investors tend to withdraw money from the former and invest in the latter. Thus, the standard OLS assumptions are violated and the OLS standard errors are unreliable. To circumvent the problem, we use the Fama-MacBeth approach later in this assignment.

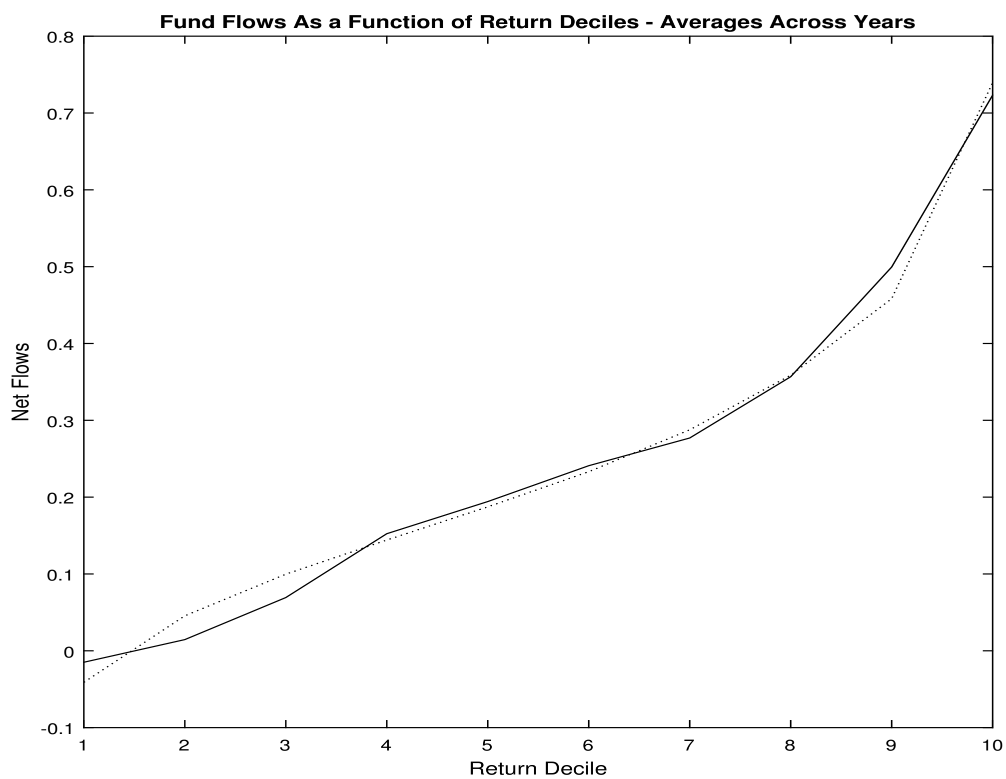
Another issue is that we have only 10 observations in the regression, which makes the estimation imprecise (but note that we found statistical significance despite this imprecision).

(b) i. Yes and yes. The Fama-MacBeth estimates of $a$, $b$, and $c$ are:

| | $a$ | $b$ | $c$ |
|---|---|---|---|
| Fama-MacBeth estimate | 0.0458 | 1.5511 | 4.5152 |
| Fama-MacBeth $t$-statistic | 0.9541 | 3.4855 | 2.2899 |

Since the estimate of $b$ is significantly positive, the performance-flow relation is significantly positive. Since the estimate of $c$ is significantly positive, the convexity pattern is statistically significant.

ii. Yes. Figure 2 reveals a convex relation between one year's fund return deciles and the following year's net fund flows, averaged across all 10 years in the sample.




(c) i. If investing your own money, you would choose A, which is safer than B and has a higher expected return at the same time. In fact, the expected return of B is negative.

ii. As a manager of somebody else's money, you would choose B because it provides you with higher expected compensation.
Under investment A, the fund will grow from \$100 million to \$101 million because A's return is 1%. Using this return and the Fama-MacBeth estimates, expected net flow at the year-end is

$$\hat{a} + \hat{b} \times 0.01 + \hat{c} \times 0.01^2 = 0.0618.$$

Thus, the expected size of the fund at the year-end is

$$100 \times (1 + 0.01) \times (1 + 0.0618) = 107.24,$$

and the expected compensation is roughly \$1.07 million.
Under investment B, there are two possibilities. If the return is -25%, the fund size changes to \$75 million, and the subsequent net flow is

$$\hat{a}+\hat{b}\times(-0.25)+\hat{c}\times(-0.25)^2 = -0.0598 \quad \text{(i.e., 5.98\% of your capital is withdrawn)}$$

The expected size of the fund is

$$100 \times (1 - 0.25) \times (1 - 0.0598) = 70.5150,$$

and your compensation is \$705,150.
If the return is +25%, the fund size increases to \$125 million thanks to the return. Moreover, the expected net flow is now higher thanks to the high return:

$$\hat{a} + \hat{b} \times 0.25 + \hat{c} \times 0.25^2 = 0.7158,$$

so that the final size of the fund is

$$100 \times (1 + 0.25) \times (1 + 0.7158) = 214.4750,$$

and your compensation is \$2,144,750.
Your expected compensation from choosing investment B is $0.6 * \$705,150 + 0.4 * \$2,144,750 = 1.280990$ million dollars, which is more than the \$1.0724 million expected from choosing investment A.

iii. The choices are different. As a money manager, you rationally choose the investment that maximizes your expected compensation (rather than the well-being of the fund's investors). This is the so-called agency problem – the incentives of the manager (agent) are not perfectly aligned with those of the fund investors who hired the manager (principal). The manager's incentives are such that s/he wants to gamble, due to the convex pattern examined here.
In practice, this problem is partially resolved by giving the manager a fixed-term employment contract. If the manager significantly underperforms the benchmark, s/he is often fired. Such career concerns help alleviate the gambling problem.

(d) First, we established empirically that there is an increasing and convex relation between fund returns and subsequent fund flows. Then we found that a fund manager may choose a risky investment with a negative expected return over a safe investment with a positive expected return. This bizarre result is due to the fact that the manager is managing somebody else's money, and s/he cares only about his/her compensation. A convex performance-flow relation implies that fund managers have an incentive to gamble. Due to the convexity, the potential gain if the gamble pays off is larger than the potential loss if the gamble fails. (This is the same intuition as for why the value of an option increases when the volatility of the underlying asset increases.) Indeed, there is evidence that managers who are lagging behind halfway through the year do gamble in this way (Brown, Harlow, and Starks, 1996, Journal of Finance).

## C. EXAM-LIKE QUESTIONS.

1. (a) Peter Lynch's $\hat{\alpha}$ has a $t$ distribution with 154 degrees of freedom. The probability of observing a $t$-statistic larger than 5.69 is $1 - tcdf(5.69, 154) = 0.0000031\%$. Roughly one in 32,121,000; that is a tiny probability!

   (b) The probability that at least one manager earns a bigger alpha is equal to one minus the probability that not even one manager earns such a large alpha: $1 - (1 - 0.000000031)^{10000} = 0.00031 = 0.031\%$. Still tiny.

   (c) The answer is $1 - (1 - 0.000000031)^{20000} = 0.00061981 = 0.062\%$.

   (d) Even with 20,000 managers (that is a lot!), the probability of matching or improving on Peter Lynch's performance is only 0.062%. Lynch's performance is highly unlikely to be only due to luck.

2. (a) The maximum annual fee is the fund's annual alpha before fees. (Customers holding the market are willing to buy the fund as long as the fund's after-fee alpha is nonnegative, so the minimum after-fee alpha is zero.) The fund's monthly alpha is $E(r_F^e) - \beta_F E(r_M^e) = 1.8\% - 2.1(0.8\%) = 0.12\%$, so the annual alpha is $12 \times 0.12\% = 1.44\%$. The maximum annual fee is thus 1.44%.

   (b) Since the coefficient on the squared market term is positive, the fund appears to have market timing ability. To be more certain, we should see if the estimate is statistically significant (impossible given the information provided).

   (c) The $t$-statistic on the mean is the ratio of the sample average and the estimated standard error:

   $$t = \frac{0.018}{0.1/\sqrt{60}} = 1.3943 < 2.$$

   Hence, the fund's mean return is not significantly different from zero at the 5% confidence level.

   (d) The correlation can be computed as

   $$\rho_{FM} = \frac{\sigma_{FM}}{\sigma_F \sigma_M} = \beta_F \frac{\sigma_M}{\sigma_F} = 0.84.$$

(e) Assuming that you can invest in a risk-free T-bill as well, you want to pick the one with the higher Sharpe ratio. The fund's Sharpe ratio is $0.018/0.1 = 0.18$. The market's Sharpe ratio is $0.008/0.04 = 0.2$. Choose the market.

(f) Recall the formula

$$S^2_{M+F} = S^2_M + \frac{\alpha^2}{\sigma^2_\epsilon}.$$

The fund's residual variance is

$$\sigma^2_\epsilon = \sigma^2_F - \beta^2\sigma^2_M = 0.1^2 - 2.1^2 0.04^2 = 0.0029.$$

Therefore,

$$S^2_{M+F} = 0.04 + \frac{0.0012^2}{0.0029} = 0.0405,$$

and $S_{M+F} = 0.2012$. A tiny improvement in the Sharpe ratio. The fund's alpha is relatively small and the residual variance is relatively large; the low information ratio translates into a low improvement in the Sharpe ratio.

3. Returns on funds that are truly large-cap value should covary with the returns on the big stock portfolio ("B" in Fama-French's SMB) and the value stock portfolio ("H" in Fama-French's HML). In the context of the Fama-French regressions, we would expect the fund's $SMB$ beta to be significantly negative and the $HML$ beta to be significantly positive.

4. This seemingly simple question is a bit tricky. The traditional "textbook" answer is that this is a true statement – a skilled manager should deliver persistently high risk-adjusted returns, period after period.

   However, Berk and Green (Journal of Political Economy, 2004) show that this need not be the case. They analyze a model in which rational investors compete with each other for superior returns, and there are decreasing returns to scale in managerial ability. (That is, a manager who can profitably invest the first \$100m may not be able to profitably invest the following \$100m as well, because profitable opportunities (if any) exist on a limited scale. This is very realistic.) In this world, a fund that did well in the past attracts new money as investors infer that this fund manager is likely to be skilled. The new money flows into the fund up to the point at which the fund's ability to generate abnormal returns is depleted. As a result, this fund that did well in the past will not outperform its benchmarks in the future. (Note that the fund manager will be rewarded for her skill nonetheless, because she gets paid a fraction of assets under management, and assets grow after good past performance.) When we observe a high return (or alpha) for a given manager, all we can conclude is that this fund will grow larger; we can say nothing about future performance.

   The statement is true, though, if the skilled manager manages a fund that is closed to new investment. In that case, high performance cannot be followed by money inflows, so it should persist.

5. True. Past performance strongly predicts fund flows, but the predictive power of fund flows for future returns is much weaker.

6. The article directly characterizes Peter Lynch as a value investor, and indirectly as not a momentum investor. Regressing Magellan's returns during Peter Lynch's leadership (May 1977 - May 1990) on the Fama-French and momentum benchmark paints a different story (play with *magellan.m*). Lynch had only an insignificant exposure to value stocks (his HML beta has a $t$-stat of 0.5), while his exposure to momentum was highly significant (his WML beta has a $t$-stat of 3.9).

   Based on this evidence, it seems fair to characterize Lynch as a momentum investor. He is known for buying up-and-coming stocks, which may well qualify as recent winners. Is he a value investor? His HML beta does not indicate so, but the concept of 'value' is often considered broader than just a high book-to-market ratio. In some sense, any investor who buys stocks whose value subsequently goes up is a value investor. In this course, we'll stick to the more specific (and more narrow) definition of value, according to which Lynch was not a value investor.