1. (5) You see the stock market fall by 10%, $\Delta p_t = -0.10$. Does this fact imply that expected returns rise, fall, or stay the same relative to what you expected before the shock – i.e are prices are expected to “mean revert,” continue with “momentum” or stay the same? The answer is “it depends,” so explain what else you need to know, and say how much expected returns change in a few cases. Use the VAR we developed in class, see the formula sheet for a reminder.

ANSWER: $r_{t+1} = b_r \times (d_t - p_t) + \varepsilon_{t+1}$. It depends on what happened to $d_t$. If $p$ changes with no change in $d$, it means expected returns rise by about $0.1 \times 10\% = 1\%$. If $d$ changed 10% as well, then there is no change in expected returns.

2. (20) Suppose the regressions in logs had come out instead (ignoring constants) to

$$r_{t+1} = 0.2 \times d_p + \varepsilon_{t+1}^r$$
$$d_{t+1} = 0.64 \times d_p + \varepsilon_{t+1}^d$$

a) What value do you expect for $b_d$ in

$$\Delta d_{t+1} = b_d \times d_p + \varepsilon_{t+1}^d.$$

Hint: Use the return identity $r_{t+1} \approx -\rho d_p + \Delta d_{t+1} + d_p$ (formula sheet) to connect coefficients. Give approximate answers, i.e. $0.96 \times 0.94 \approx 0.90$ is fine. Is your number the “right” sign – high prices mean higher future dividend growth?

b) What value do you expect for long-run return and dividend growth forecast coefficients,

$$\sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} = a + b_r^l \times d_p + \varepsilon_{t+1}^{r,l}.$$  
$$\sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j} = a + b_d^l \times d_p + \varepsilon_{t+1}^{d,l}.$$

c) Looking at the present value identity (formula sheet) We decided that all variation in price-dividend ratios corresponded to variation in expected returns and none to expected dividend growth. How is that conclusion altered by the fact that returns are even more predictable in this case? (Hint: think about running both sides of the present value identity on $dp_t$, and multiplying by $var(dp_t)$)

ANSWER:

a) Regressing both sides of the return identity on $dp_t$, $b_r = 1 + b_d - \rho b_{dp}$. Hence $b_d = b_r + \rho b_{dp} - 1$. In the old regression $b_d = 0.1 + 0.96 \times 0.94 - 1 = 0$. In the new regression $b_d = 0.2 + 0.96 \times 0.64 - 1 = -0.2$. Negative is the “right” sign.

b) $b_r^l = b_r (1 + \rho b_{dp} + \rho^2 b_{dp}^2 + ...) = b_r (1 - 1 - 0.96 \times 0.64) = 0.2 / (1 - 0.96 \times 0.64) = 0.2 / 0.4 = 1 / 2$. Similarly, $b_d^l = -1 / 2$.

c) Running both sides of the present value identity on $dp$, $1 = b_r^l - b_d^l$; $1 = 1 / 2 - (-1 / 2)$, We interpreted the two terms as fractions of var $dp$ explained, so with these numbers the variance of prices comes half from expected returns and half from expected dividend growth. (If you state the formula

$$var (p_t - d_t) \approx cov \left( p_t - d_t ; \sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j} \right) - cov \left( p_t - d_t ; \sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} \right)$$

27
that’s even better, but just stating the answer in terms of regression coefficients is enough.

3. (5) Fama and French ("Multifactor explanations", "Dissecting anomalies") show that portfolios of smaller stocks (low market equity) earn higher average expected returns. This fact seems to offer an amazing profit opportunity: We’ll form a holding company ("Booth Hathaway"). We’ll buy lots of small stocks and earn their high expected returns. We’ll fund the purchase by issuing stock as a single company, and our total market equity will be so large that we’ll have to pay only a small expected return to our investors. We can pay ourselves huge salaries off the difference.

How would Fama and French respond? This seems like an awfully “inefficient” conclusion!

ANSWER: The new company would inherit the beta of small stocks, and, since expected returns are really a function of beta, not of market cap, our company would have to pay the expected return of small stocks. (For this answer it really doesn’t matter whether market beta is enough, or whether small firm beta gets a special premium. The point is that expected return is really a function of beta, not of size, and size is only coincidentally correlated with beta in the other firms.)

4a(5) Which gets better returns going forward, stocks that had great past sales growth, or stocks of companies whose sales are going down? Are the high expected return stocks riskier, in the sense that they are more affected by market downturns? Cite evidence from a paper you read.

ANSWER: the low sales growth stocks have higher expected returns. This does not correspond to higher market betas. It does correspond to larger hml betas. Fama and French "Multifactor anomalies"

4b(5) If we form a momentum portfolio, from stocks that did well last year, are the returns on that portfolio correlated with the returns on value stocks over the next year? I.e. if value stocks go up, do momentum stocks tend to go up, down, or remain the same?

ANSWER

High momentum stocks have high h values. In “Multifactor anomalies” So momentum is negatively correlated with value.

5. (10) a) Some behavioral researchers claim that managers exploit “bubbles,” issuing stock when their stock is “overpriced,” and repurchasing when it’s “underpriced.” As a result, they say that high stock issues should forecast low returns. Leaving aside the explanations, is the fact right, or does the sign go the other way (high stock issues forecast high returns)?

b) Whatever the sign, do net stock issues add additional information about returns along with all the other forecasters?

In both cases, be specific, alluding to regression or portfolio evidence.

ANSWER FF dissecting anomalies. Yes, net issues do correspond to low returns and vice versa. Portfolios sorted by low stock issuance or repurchase have high subsequent returns and vice versa. Regressions $R_{t+1} = a + bS_t + \varepsilon_{t+1}$ work. The portfolios are net of matched size and BM stocks; the regressions include size, bm and lots of other variables, so NS is an independent forecaster.

6. (10) The graph represents consumption over time, in percent (100 x log). Use the consumption-based model to find and plot the interest rate over time, also in percent, assuming people know ahead of time where consumption is going. Use discount rate $\delta = 2\%$, and risk aversion $\gamma = 2$, and approximate as necessary to get round (integer) answers. Hint: Start by making a table of interest rates for consumption growth -1,0,1, and 2%. Make sure you put the interest rate at the right moment in time. t vs. t + 1 is vital here! What do you learn about how interest rates should move over the business cycle?
ANSWER This is from a problem set.

\[ r_t^f = \delta + \gamma E_t \Delta c_{t+1} = 2 + 2 \ast E_t \Delta c_{t+1} \]

\[
\begin{align*}
E_t \Delta c_{t+1} & \quad -1 \quad 0 \quad 1 \quad 2 \\
2 + 2 \ast E \Delta c & \quad 0 \quad 2 \quad 4 \quad 6
\end{align*}
\]

I graphed \( \Delta c_{t+1} \) in red and \( r_t^f \) in black. This is the interest rate quoted at time \( t \) for loans from \( t \) to \( t+1 \), and is conventionally dated as of time \( t \). I graphed it that way. That’s why the interest rate moves one period before the peaks of the consumption series. There’s a bit of a lesson here. See the “recession” in the second part of the plot. Interest rates move pretty much contemporaneously with the growth rate of consumption, with only the one-period advance notice. Interest rates move ahead of recessions as defined by the level of consumption. Much popular discussion confuses the level and growth views of where we are in economic cycles.
The hard part is the $t$ vs $t+1$. The interest rate at $t$ reflects consumption growth over the *next* year.

7a) (5) “The CAPM doesn’t work. You get much higher returns on small stocks than on big stocks.” Is this correct?

ANSWER: a) Two mistakes: i) higher average returns by themselves don’t mean anything, the question is whether they are matched by higher betas. ii) Actually, small stock average returns are matched by higher CAPM betas, as we saw in class

7b) (5) A friend brings in the following table of results

<table>
<thead>
<tr>
<th>$\hat{\gamma}$</th>
<th>$\hat{\lambda}$</th>
<th>$\sigma(\hat{\gamma})$</th>
<th>$\sigma(\hat{\lambda})$</th>
<th>$\sqrt{\frac{1}{25} \sum \alpha_i^2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.38</td>
<td>-0.57</td>
<td>0.40</td>
<td>0.19</td>
<td>0.15</td>
</tr>
</tbody>
</table>

CAPM, 1947-2010, FF 25 size and B/M portfolios. Estimate of $E(R^{e_i}) = \gamma + \lambda \beta_i + \alpha_i$, $i = 1, 2, \ldots, 25$ by cross-sectional regression.

You ask for a graph and he produces the following graph of $E(R^{e_i})$ (vertical axis) vs. predicted mean return, $\gamma + \lambda \beta_i$ (horizontal axis). Ok, he says, it’s not perfect, but it’s not a total disaster either.

![Graph](image)

Did something go wrong here? Can you suggest a better procedure?

ANSWER: This is from a problem set. This is the cross sectional regression with a free constant. Note the constant is huge and the market premium is negative. The actual performance of this model is awful A graph like the following is an ideal answer, average returns vs betas,
A time series regression or including the factor portfolios (including rf) as test assets are ways to fix this.

8. a) (5) A mutual fund manager complains, "Carhart’s results are bogus. He sorted mutual funds by their one-year past returns. Everyone knows that’s mostly luck. He should have looked at funds based on 5 year performance averages, like Morningstar does. Then he would have seen some alphas!" How would Carhart respond?

ANSWER: Carhart also sorted funds on 5 year formation, and found even less result there than with sorts based on one-year performance.

8. b) (5) Berk argues that there can be alpha even if mutual fund returns to investors do not persist over time, and that flows following past returns are not irrational. Which of the following considerations is key to this argument, and explain why. (Focus on the right one, briefly comment on the wrong ones).

a) Managers can only achieve alpha up to a certain scale

b) Managers raise their fees (as a percent of assets under management) if they do well

c) Momentum in underlying stocks explains the appearance of persistent returns

persistent returns

ANSWER:

a is the right answer. As funds rush in, returns to investors decline. It’s important that b does not happen, otherwise we wouldn’t need new funds to give more money to the managers. c is irrelevant, that was Carhart’s point not Berk and Green’s.

9) (10) Below, find an excerpt from Fama and French’s Table Mutual Funds 3

a) What is the key assumption under “simulated?”

b) What does 1.68 mean? What does 2.04 mean?

c) How does this table address the claim, “the only reason you see some funds with really good performance is that they got lucky?”

d) What do -1.71 and -2.19 mean? Is this normal, or a puzzle?

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Simulated</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>-1.71</td>
<td>-2.19</td>
</tr>
<tr>
<td>50</td>
<td>-0.01</td>
<td>-0.06</td>
</tr>
<tr>
<td>90</td>
<td>1.30</td>
<td>1.59</td>
</tr>
<tr>
<td>91</td>
<td>1.38</td>
<td>1.68</td>
</tr>
<tr>
<td>95</td>
<td>1.68</td>
<td>2.04</td>
</tr>
</tbody>
</table>
Table 3 - Percentiles of t(\(\alpha\)) estimates for actual and simulated fund returns...[3-factor adjusted] gross fund returns....

**ANSWER**

a) The key assumption under simulated is that no funds have any alpha, positive or negative.

b) 1.68 means that if all funds really have exactly zero alpha, then we expect to see that 5% of the funds in a sample will have an alpha t statistic greater than 1.68 just due to chance. In fact, 5% of funds had a t stat greater than 2.04, and 9% had a t stat greater than 1.68. Thus there are 4% too many funds with alpha greater than 1.68 than there should be.

c) Actually, there are more funds with very large alpha than there should be just due to luck. Not many, but a small number. (4%, above)

d) 5% of funds should have performance below -1.71. In fact, 5% of funds have performance below -2.19. This is a bit puzzling – why have negative alpha when you can just buy the index? But maybe they’re just on the way out.

10. (15)

a) On the day that Palm went public, what happened to 3Com’s price?

b) Did short sales constraints mean that nobody in fact was able to short Palm stock?

c) Was Palm more or less liquid than 3Com?

d) If you want to buy Palm because you think it will go up next week, why not buy 3Com instead? After all, 3Com owns 95% of Palm so it will go up too. (Be specific about facts.)

e) What implication did Cochrane draw from this graph?

![Graph of Dollar volume on NYSE, NASDAQ and NASDAQ Tech with SIC code 737. Series are normalized to 100 on Jan 1 1998.](image)

**ANSWER**

a) Fell, from 95 to 81.

b) No, at the peak palm was 147% shorted

c) Fun question. Bid ask was larger, but turnover vastly more. We discussed and decided there was more demand to trade, despite higher costs, so less liquid. Mentioning the fact of high turnover and high bid ask spread is the key answer.
e) The volume here is visually nearly identical to a price graph. “overpricing” comes with massive trading volume.

11. (10) a) A broker-dealer lost money and is running short of cash. Why does it not just issue more equity?

b) Derivatives are exempt from bankruptcy – they get paid first. Why does this make sense? Since the firm typically is running a matched book, with no overall derivative exposure, why does it case a problem in bankruptcy?

c) Why does it hurt the bank if you pull securities of your brokerage account? After all, they’re just executing trades for a fee; the securities you own are yours. Missing a few weeks of fee income isn’t going to make them bankrupt.

d) Why, according to Gorton and Metrick, did a run at Lehman spark a crisis, but a run at MF Global did not?

ANSWER

a) Debt overhang. Having lost money, the debt is trading below par. New equity first bails out that debt before making profits.

b) It makes sense to keep them from running. However, they get the right to replace their contracts, so the firm pays the bid ask spread on the whole book.

c) They are rehypothecated, and used by the firm as collateral for its own trading.

d) Gorton and Metric’s big point is that the problem is “systemic runs” when the “system” is insolvent. This happens when losses at one institution spark an e coli outbreak, people become worried about other institutions or assets. MF global was transparently a bet on Greece, and since nobody learned anything about Greece or other investment banks from its failure, it didn’t cause any systemic problems. n outbreak you avoid the whole salad bar.

12. (15) The price of one, two and three year bonds is $p_0^{(1)} = -0.05$, $p_0^{(2)} = -0.15$, $p_0^{(3)} = -0.30$

a) Find today’s yields and forward rates

b) Plot the expected evolution of these bonds’ prices over time, according to the expectations hypothesis.

c) Plot the expected evolution of these bonds’ prices for the first year, according to the Fama Bliss regressions, specializing all the coefficients to 1 and 0 as appropriate.
Answer: This includes a 4 year bond that I deleted from the question.

\begin{align*}
y^{(1)} &= 0.05 \\
y^{(2)} &= 0.075 \\
y^{(3)} &= 0.10
\end{align*}

\begin{align*}
f^{(2)} &= 0.10 \\
f^{(3)} &= 0.15
\end{align*}

I drew expectations just by having each line rise at the same rate as the one year rate that year. (green)

for FB, \( r_{t+1}^{(n)} = 0 + 1(f_i^{(n)} - y_t^{(1)}) \) as plotted
12. (5) Cochrane and Piazzesi run regressions

\[ r x_{t+1}^{(n)} = a_n + \beta_n,1 \gamma_1^{(1)} + \beta_n,2 \gamma_2^{(2)} + \beta_n,3 \gamma_3^{(3)} + \beta_n,4 \gamma_4^{(4)} + \beta_n,5 \gamma_5^{(5)} + \varepsilon_{t+1} \]

They find betas in a tent shape across the right hand variables. What pattern do they find in these betas across maturity \( n \)? Write an equation that captures this pattern.

ANSWER: They found that the betas have the same shape for each maturity, just scaled up. So, they obey

\[ r x_{t+1}^{(n)} = a_n + b_n \left( \gamma_1^{(1)} \gamma_t^{(1)} + \gamma_2^{(2)} \gamma_t^{(2)} + \gamma_3^{(3)} \gamma_t^{(3)} + \gamma_4^{(4)} \gamma_t^{(4)} + \gamma_5^{(5)} \gamma_t^{(5)} \right) + \varepsilon_{t+1} \]

13. (15) Suppose the one-year rate is an MA(1),

\[ y_{t+1} = \varepsilon_t + \varepsilon_{t-1} \]

\( E_t(\varepsilon_{t+1}) = 0; E(\varepsilon_t) = 0 \) as usual. Form a term-structure model, by supposing that the expectations hypothesis holds. (You’re looking for yields and forward rates of all maturities as a function of two “factors” \( \varepsilon_t \) and \( \varepsilon_{t-1} \).)

a) Find forward rates (at time \( t \), for maturity 2,3,4,...\( n \))

b) Find yields (at time \( t \), for maturity 2,3,4,...\( n \)).

c) plot the yield and forward curves on a day in which \( \varepsilon_t = 1; \varepsilon_{t-1} = 1 \).

(Hint: You may think you got it wrong because the answer is too simple. Don’t worry, it really is simple. This problem does NOT involve a lot of algebra.)

ANSWER
\(y_t^{(1)} = \varepsilon_t + \varepsilon_{t-1}\)
\(f_t^{(2)} = E_t y_{t+1}^{(1)} = \varepsilon_t\)
\(f_t^{(3)} = E_t y_{t+2}^{(1)} = 0\)
\(f_t^{(n)} = E_t y_{t+n-1}^{(1)} = 0\)

\(y_t^{(1)} = \frac{1}{2} \left( y_t^{(1)} + f_t^{(2)} \right) = \frac{1}{2} \varepsilon_t + \varepsilon_{t-1} = 1.5\)
\(y_t^{(3)} = \frac{1}{3} \left( y_t^{(1)} + f_t^{(2)} + f_t^{(3)} \right) = \frac{1}{3} \varepsilon_t + \frac{2}{3} \varepsilon_{t-1} = 1\)
\(y_t^{(n)} = \frac{1}{n} \left( y_t^{(1)} + f_t^{(2)} + f_t^{(3)} + .. + f_t^{(n)} \right) = \frac{1}{n} \varepsilon_t + \frac{2}{n} \varepsilon_{t-1} = \frac{3}{n}\)

(Optional: Factors The factors are \(\varepsilon_t\) and \(\varepsilon_{t-1}\). You can find them just by
\(\varepsilon_t = f_t^{(2)}\)
\(\varepsilon_{t-1} = y_t^{(1)} - f_t^{(2)}\).

You already have the loadings.

\[
\begin{bmatrix}
y_t^{(1)} \\
y_t^{(2)} \\
y_t^{(3)} \\
y_t^{(n)} \\
y_t \\
\end{bmatrix} = \begin{bmatrix}
1 \\
\frac{1}{2} \\
\frac{1}{3} \\
\frac{1}{4} \\
\frac{1}{5} \\
\end{bmatrix} \varepsilon_t + \begin{bmatrix}
1 \\
\frac{1}{2} \\
\frac{2}{3} \\
\frac{3}{4} \\
\frac{4}{5} \\
\end{bmatrix} \varepsilon_{t-1}
\]

14 (5) You form an optimal portfolio of the 25 Fama French size and b/m sorted returns. You use the mean-variance formula

\[
\text{“optimal”}: w = \frac{1}{\gamma} \Sigma^{-1} E(R^c)
\]

Here are the results, in percent. Did something go wrong, and if so what? Explain, using an equation or a graph.

<table>
<thead>
<tr>
<th></th>
<th>low</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>high</th>
</tr>
</thead>
<tbody>
<tr>
<td>small</td>
<td>-149</td>
<td>51</td>
<td>69</td>
<td>96</td>
<td>52</td>
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</tr>
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<tr>
<td>smb</td>
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</tr>
</tbody>
</table>

ANSWER: This happens typically. What went “wrong” was taking mean returns at face value.
15. (5) You have risk aversion $\gamma = 1$, and returns are independent over time. Your best guess is that the mean annual premium $\mu$ is 4% with volatility $\sigma = 20\%$.

a) What should your allocation to stocks be?

b) In fact you don’t really know what the mean return is. Reflecting on it, your uncertainty about the mean return $\sigma(\mu)$ is 10 percentage points, and both the actual return and your uncertainty about it are normally distributed. (Numbers are easy to calculate, not realistic.) How does this consideration change your optimal allocation to stocks?

**ANSWER**

\[
\frac{0.04}{0.2^2} = \frac{0.04}{0.04} = 1 \\
\frac{0.04}{0.2^2 + 0.1^2} = \frac{0.04}{0.04 + 0.01} = \frac{0.04}{0.05} = 0.8
\]

Verbal answers to the effect that “parameter uncertainty is extra variance and scale back the allocation to stocks” are worth some partial credit.