UNIVERSITY OF CHICAGO
Booth School of Business

Bus 35120 – Portfolio Management Prof. Lubos Pastor

# Assignment #3

Due: April 14 by 8:15am

*Be as clear and brief as possible.*

**A. CASE STUDY:** "Harvard Management Company and Inflation-Protected Bonds." Read the case study and answer the following questions.

1. Questions on Treasury Inflation-Protected Securities (TIPS).
   (a) How are TIPS different from regular Treasury bonds?
   (b) How can we combine TIPS with Treasuries to make bets on future inflation?
2. Questions on HMC's portfolio.
   (a) How does HMC develop its capital market assumptions? To what extent does HMC use historical data? What is HMC's view of the U.S. equity premium?
   (b) Should HMC invest in TIPS? If so, how much? If not, why?

Be prepared to discuss the case in class.

**B. DATA ANALYSIS.** This assignment studies the costs and benefits of market timing.[1]

A portfolio manager named Claire Voyant, who claims to be able to time the market, offers to manage your portfolio by optimally switching between stocks and T-bills. Her track record indicates 60% accuracy in predicting whether annual equity returns will exceed T-bill returns. Will you hire her? You turn to data to help you decide.

Download the 1926-2016 annual stock market and T-bill returns from WRDS.[2] After logging in to WRDS, select Get Data, CRSP, Annual Update, Index/Stock File Indexes, Market Cap-Annual, and download the full history of annual NYSE/AMEX/NASDAQ value-weighted market returns (including distributions; VWRETD). Then go back to Annual Update, move on to Index/Treasury and Inflation, and download the entire history of annual returns on the 30-day Treasury bill (T30RET). Delete the text labels (lines that include "caldt vwretd" and "caldt t30ret") and the missing year-1925 observations from the output files. Save the files as "VWMKT_26_16.txt" and "TB_26_16.txt"). These files should be easily readable by MATLAB.

[1] A MATLAB program that can help you produce the solutions can be downloaded from Canvas. Save this program into your current directory and run it by typing "*hwk3_solutions*" at the command line.

[2] wrds.wharton.upenn.edu. I announced the username and password in class at the beginning of the quarter. If you have any difficulty in accessing WRDS, please contact Computing Services/HelpDesk.

1. **Relative performance of stocks and T-bills.**
   (a) Historically, how often have stock returns exceeded T-bill returns? In light of this evidence, how impressive is Claire's forecasting accuracy?[3]
   (b) What would be your terminal wealth at the end of the sample if you invested \$1 in the stock market at the beginning of the sample, reinvested all dividends, and made no further changes to your investment? What would be your terminal wealth if you invested in the T-bill instead?
2. **Perfect vs. random market timing.**
   (a) Evaluate the benefits of *perfect* market timing. Suppose that, at the end of each year, Claire's crystal ball reveals which of the two assets will yield a higher return over the following year, and she always invests 100% in the outperforming asset. What terminal wealth is implied by this (sadly, unrealistic) strategy? What are the strategy's average return and Sharpe ratio? How do they compare to the market's average return and Sharpe ratio?[4]
   (b) Evaluate the benefits of *random* market timing. Suppose that Claire's track record is simply due to luck, and she allocates your funds completely at random (i.e., half the time she holds the market, and half the time she holds the T-bill). Simulate 1,000 possible realizations of Claire's portfolio returns over the full sample, by randomly resampling Claire's returns from the historical stock and T-bill returns. Plot the histogram of the average returns and Sharpe ratios from these simulations. What are the expected return and the expected Sharpe ratio of Claire's strategy? In the same histogram, plot also the average return and the Sharpe ratio of the stock-only portfolio.[5]
3. **Benefits of imperfect market timing.**
   (a) Suppose now that Claire is indeed right 60% of the time. Simulate 1,000 possible realizations of Claire's portfolio returns, again by resampling.[6] Prepare the histogram and the summary statistics in the same way as in question 2b. Explain the difference between the results for Claire's strategy and for the stock market portfolio.
   (b) Now suppose that Claire charges 2% per year for her services. (Another perspective is that the average annual trading cost implied by the market timing strategy is 2%.) Recalculate the expected return and Sharpe ratio from the 60% strategy. Does the fee change your willingness to hire Claire to manage your money?[7]

[3] *Matlab hint:* If $x$ and $y$ are columns of equal size, $x < y$ returns a column of zeros and ones, with ones for those elements of $x$ and $y$ for which the condition $x < y$ is satisfied. Try $sum(x < y)$.

[4] *Hint:* Recall from Investments that the Sharpe ratio of a given portfolio is the ratio of the portfolio's expected return in excess of the riskfree rate and the portfolio's standard deviation of excess returns.

[5] *Matlab hint:* To loop over years, you can use the *for* command. The *rand* command can help with generating random numbers. Commands *hist* and *hold* might help in producing the plot.

[6] *Matlab hint:* To let Claire do something with probability $p$, let her do so when $rand < p$.

[7] *Hint:* There is no need to simulate returns again – you can use the returns simulated in part 3a.

4. **Imperfect market timing with different forecasting accuracies.**
   What if Claire's accuracy is higher or lower than 60%? Answer question 3 for a range of different accuracies. Plot Claire's expected return and Sharpe ratio as a function of accuracy. What is the minimum level of accuracy required for expected return and Sharpe ratio to exceed their counterparts attained by stock-only strategy? Consider two cases, with and without the 2% management fee.[8]

## C. EXAM-LIKE QUESTIONS.

1. Suppose that the stock index return in each month is either 5% or -2% with equal probabilities, and that the risk-free asset (cash) returns 1%. A manager attempting to predict the market changes his stock/cash mix to either 70/30 or 30/70 every month, depending on his prediction.
   (a) What is the Sharpe ratio of the manager's portfolio if she possesses no market timing ability?
   (b) Explain how, without any timing ability, you can construct a portfolio with the same standard deviation but a higher expected return than this manager's portfolio. What is the Sharpe ratio of your portfolio?
2. Consider a portfolio whose continuously compounded return is normally distributed, with a mean of 10% and standard deviation of 20% per year.
   (a) What is the probability that, over a 10-year horizon, this portfolio will underperform a riskless investment whose continuously compounded return is 4%?
   (b) What is the cost of perfect insurance against such a shortfall?
   (c) How do the answers change when the horizon increases to 20 years?
   (d) In practice, the portfolio's 10% expected return is not known with certainty. Suppose your beliefs about this expected return are centered on 10%, with 3% standard deviation. How does this uncertainty about expected return affect the probability of underperformance computed in part (a)? How does it affect the cost of insurance computed in part (b)?
3. Comment on this quote from Butler and Domian's article in Journal of Portfolio Management, Spring 1991, page 44: "Capital market efficiency requires that equity returns be independently distributed over time." Use at most 60 words.
4. (Not graded, but I ask that you write down your thoughts nonetheless.) Read the article on the following page (Washington Post, May 28, 2014). Is this pure data mining, or can you think of an economic explanation for why the Harvard MBA indicator forecasts stock market returns? If we did the same analysis for Booth grads, do you think we would find a similar result?

[8] *Hint:* To limit the computing time, use the same set of random variable draws for all accuracy levels.

**Want to spot the next bubble? Look at where Harvard grads work.**
By Matt O'Brien, Washington Post Wonkblog

May 28, 2014

Everybody wants to know what the next bubble is, and there's an easy way to tell: Just watch where Harvard grads are going. Then short the hell out of that.

It's called the Harvard M.B.A. Indicator—though it applies to undergrads, too—and it's one part psychology, another part economics. The idea is simple enough: It's a bad sign when more Harvard grads go to Wall Street.

Harvard is a magnet for Organization Kids who excel at coloring between the lines. After graduation, they want to do something prestigious, something remunerative, but mostly, as Kevin Roose points out, something that gives them new lines to color between. That might be Silicon Valley, or it might be Teach for America—or it might be Wall Street, if, that is, the getting looks good.

And the getting looks best right before a crash. Which is when, the argument goes, the Harvard M.B.A. Indicator hits its highest levels, like it did in 1987, in 2000-2002, and in 2005-2008. See, as economist Hyman Minsky explained, financial stability is destabilizing. The longer markets are calm, the more people plan on them staying that way. People take bigger risks and take on bigger debt because it doesn't seem like anything can go wrong—until it does, and all this leverage turns small losses into big ones due to forced selling from margin calls.

But this era of complacency can last a long time. And it's when Wall Street exerts its strongest gravitational pull on Harvard kids. The money keeps getting better and better, and it looks like it always will. All they have to do is follow the Excel-filled road laid out before them.

That's why the more Harvard grads that head for Wall Street, the worse a sign it is for markets. It usually means that the irrational exuberance is about to give way to rational panic.

The good news now, though, is that Harvard kids aren't flocking back to Wall Street in anywhere near the numbers that they did before the financial crisis. As you can see in the chart below from the Harvard Crimson, "only" 31 percent of seniors will be working in finance or consulting next year; down from a high of 47 percent in 2007.

But the better news is that this share has flatlined around 30 percent the past few years despite buoyant markets. That's partly because post-bailout Wall Street doesn't have the same cultural cachet it once did. And partly because tech looks just as, if not more, lucrative. Which is another way of saying that for all Dodd-Frank doesn't do—and that's a lot—it has, together with higher capital requirements, made big banks a little less profitable.

The Harvard Indicator isn't blinking crimson just yet. ♠