Assignment 1
Due: 11.4.2013
[at start of class #3]

Topics:
- No arbitrage
- Consumption Smoothing
- Foundations of NPV
- Getting Familiar with Finance

NOTES

• This assignment covers material we discuss in our first two meetings (Question 1 is meeting 1; Question 2, 3 and 4 are meeting 2).

• If (when!) you spot any typos (apologies in advance!), please let me know and I will relay the information to the class via the blackboard site / twitter page.

• If you are having difficulty with the analysis, also feel free to contact me. In particular, if you are spinning and uncertain where to start, contact me. The assignments cover material we have done and foreshadow things we will do. They are designed to help us learn and are not meant as “review” or “testing.” Part of the learning includes discussions with your colleagues, TA’s, and me. To contact me, E-mail is often effective since organizing your thoughts into a question is often halfway to the solution. However, feel free to stop by or call, if that is more convenient or you prefer.

• You may hand in the assignments individually or in groups. A group size of about three or four seems best. However, you are welcome to choose any size group you like (larger or smaller is fine; groups spanning sections are also fine). There is also no need to stay in the same group for each assignment. When you turn in your group’s assignment, just list all the group members on the first page. (If you do work in a group, please submit just one assignment per group. There is no need for the extra paper or grading.) However, it is not an effective
strategy to just “divide the work.” Work together on each problem and you will learn more effectively

- The assignment is due at the start of class. (In the case of cross-section groups, the assignment is due at the start of class for group member in earliest section.)

- Spending a few minutes to ensure your work is presented in a concise and readable fashion is appreciated. It is also good practice since communicating your analysis is a big part of what you will (soon) be doing. I posted a few thoughts on presentation on the blackboard site (under Assignments)

- Printing and bringing the assignment to class is fine. Submitting things via blackboard is fine too. However, please submit a PDF (and not Word/Excel files).

- Wow, that is a lot of pre-amble, on to the questions!

**QUESTION 1 – ROIC**

In class we looked at AEO and ANF when we calculated ROIC and other ratios. The financial statements for that calculation (in **xls spreadsheet**) are posted on the blackboard. Included are also the financial statements for GPS The Gap.

(The question asks you to do calculations for GPS. But this is Excel. So get the formulas working on one company for one year and then copy across and you can do all years; all companies.)

For GPS, calculate:
(a) Calculate profit margins.
= “NOPAT” / sales
NOPAT is net operating profit after tax.
[As if interest expense and interest income are zero. This requires you to approximate the tax expense.]

(b) Calculate Return on Invested Capital (ROIC)
= “NOPAT” / invested capital
= “NOPAT” / operating assets

NOPAT is net operating profit after tax. Invested Capital and operating assets are identical, they are just different ways to calculate the same thing.
(c) Break the ROIC into its two components Capital Efficiency and Operating Efficiency.

\[
\text{ROIC} = \left( \frac{\text{NOPAT}}{\text{Sales}} \right) \times \left( \frac{\text{Sales}}{\text{Capital}} \right)
\]

= [Operating Efficiency] x [Capital Efficiency]

(d) In these calculations, have we measured things accurately? We have used the financial statements (via historic cost accounting). Have we correctly measured Operating Efficiency and Capital Efficiency? (Ponder this question for as long as you like. However, your answer can be just a few sentences.)

**Question 2 – NPV / Replication / Risk**


It sounds like these cars are still more than a year away from commercial reality. But we can set that aside and work with the following scenario.

General Motors “Auto”-Mobile Car Division has developed an autonomous drive system for cars. The research and testing are all done. What remains to be done is re-fitting the factory so manufacturing can occur. This will cost $5.8 million (all paid now; date 0). This investment will allow production of cars next year. The sales of these cars will produce a cash flow that is $5.6572 million if the economy is in a recession and $7.8104 million if we are in a boom. (And for simplicity, here, these are the only cash-flows of the project. We will soon look at longer lived projects).

A one-year US Treasury Bill costs $98.00 now and pays $100.00 in one year (an interest rate of 2.041%). The S&P 500 Index costs $1745.70 now and in one year will be $1636.07 next year in a recession and $2136.07 if the economy is booming. (This is a simple financial model of things, but you can check that the equity premium, the return on the S&P above the bond rate, implied by these values is 6%. We will talk about this number later in the course.)
[You can do all these parts at once. I have listed these separately just to help with the steps.]

a. What are the payoff relevant states?
b. List the cash-flows to the project [a table like we did in class is helpful]
c. List the cash-flows to the two financial securities.
d. Find a portfolio of financial securities that has identical payoffs to the project [Let \( x = \) number of shares of S&P index, \( y = \) number of bonds. This is a system of 2 linear equations and 2 unknowns]
e. What is the Net Present Value of the project?
f. Should we accept the project?
g. Why?
h. How risky is this project? (Look at the replicating portfolio; how risky is that?)

**Question 3 – Ethics in Finance?**

Background See:

The Case Against Corporate Social Responsibility
By Aneel Karnani, Wall Street Journal 8/23/2010

“Corporate Social Responsibility” is a much-debated topic these days. You can go to many corporate websites and see their annual “corporate social responsibility” report that documents the company’s environmental and social impact. (GM has a whole website on sustainability [http://bit.ly/17fbi7m](http://bit.ly/17fbi7m))

Take a look back at question 2:
- Where does “safety” or “pollution” show up in these calculations.
- Where should it show up?

[This is an open-ended set of questions. For the assignment, aim for just a brief paragraph.]

**Question 4 – Bonds and Cash Flows**
The purpose of this question is to highlight the mechanics of valuation-by-replication. It is the same technique you used in Question 2. We will talk about “rates” and “yields” later. For now, focus on cash-flows and prices.

The following table lists bonds and current prices. The bonds listed are Treasury bonds issued by the U.S. Government and are risk-free.

<table>
<thead>
<tr>
<th>BOND</th>
<th>Coupon</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months</td>
<td>8%</td>
<td>103.376</td>
</tr>
<tr>
<td>12 months</td>
<td>2%</td>
<td>99.974</td>
</tr>
<tr>
<td>18 months</td>
<td>6%</td>
<td>104.802</td>
</tr>
<tr>
<td>24 months</td>
<td>4%</td>
<td>101.748</td>
</tr>
</tbody>
</table>

These bonds pay coupons semi-annually. Coupons are periodic interest payments. We will spend some more time talking about bonds next week. For now, all you need to do is think of these bonds as a series of cash flows. For example, bond C has cash-flows of -104.802 today (i.e., it costs you money if you buy the bond), $3 at 6 months (1/2 of 6% of $100 face value), $3 at 12 months, and $103 at maturity which is at 18 months (principle and interest are paid at maturity). Work with cash-flows and not “rates of return” or “yields.”

a. List the cash-flows to the four bonds. (Bond C was described above)

<table>
<thead>
<tr>
<th>BOND</th>
<th>Coupon</th>
<th>Price</th>
<th>Cash Flow (date in years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months</td>
<td>8%</td>
<td>103.376</td>
<td>Today 0.5 1.0 1.5 2.0</td>
</tr>
<tr>
<td>12 months</td>
<td>2%</td>
<td>99.974</td>
<td>(104.802) 3 3 103</td>
</tr>
<tr>
<td>18 months</td>
<td>6%</td>
<td>104.802</td>
<td>104.802 3 3 103</td>
</tr>
<tr>
<td>24 months</td>
<td>4%</td>
<td>101.748</td>
<td>104.802 3 3 103</td>
</tr>
</tbody>
</table>

b. Using “no arbitrage” or “the law of one price,” calculate the price of a “zero bond.” A “zero bond” is a bond that has just one payment at a specified date.

<table>
<thead>
<tr>
<th>maturity</th>
<th>Cash Flow (date in years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months</td>
<td>0.5 Today 0.5 1.0 1.5 2.0</td>
</tr>
<tr>
<td>12 months</td>
<td>1.0 Today 0.5 1.0 1.5 2.0</td>
</tr>
<tr>
<td>18 months</td>
<td>1.5 Today 0.5 1.0 1.5 2.0</td>
</tr>
<tr>
<td>24 months</td>
<td>2.0 Today 0.5 1.0 1.5 2.0</td>
</tr>
</tbody>
</table>
- For each Z or “zero” you will need to solve a system of equations. There are 4 unknowns (the quantity of bond A, B, C, D you need to replicate the zero payoff) and 4 equations (there are four time periods or four cash-flows)
- To solve a system of 4 linear equations and 4 unknowns you can use Excel or do it by hand. It turns out this is fairly easy to solve by hand. For example, for Z1, you really only need bond A.
- It is easiest to solve for the zero prices one at a time. But if you are the sort of person who lives in linear algebra, you can formulate and solve this in matrix notation (and Matlab if you like.)
- For your information, the prices of these bonds you calculate are helpful when we look at the term structure of interest rates. Sometimes, they are referred to as “discount factors”.

c. You notice bond E. It has a price of $120, a coupon rate of 10% ($5 each six months) and a two-year maturity (like bond D). There is arbitrage. Find it! (and show the cash-flows from a portfolio that captures it).

d. For this assignment, we modeled the bonds as risk-free. How is that assumption reflected in the cash flow description (in part a)? And, (ever so briefly), is this a good assumption in this setting? (Recall the recent discussion on the debt ceiling!)