JOURNAL OF ECONOMICS and FINANCE EDUCATION

JEFE

AEF
ACADEMY of ECONOMICS and FINANCE

Volume 15 WINTER 2016 Number 1

Academy of Economics and Finance

Bootstrap Simulation with Spreadsheet Application

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Abstract

This study provides an easy and effective way to simulate distributions of future stock price and return. Using a bootstrapping approach for simulation, we generate one thousand different scenarios for Google's price after one year and the corresponding percentage return. The simulated return distribution provides a comprehensive risk-return profile that includes probabilities associated with achieving a specific return in these uncertain times. We explain and create an excel template showing the bootstrapping simulation that can be readily used in finance classrooms. Using the same methodology, students can conduct their own simulations of different assets and compare their risk-return tradeoffs.

Introduction

If investors knew with certainty that equity investments would earn a stable rate of return year after year, and that interest and inflation rates would remain unchanged in the future, financial planning would be predictable and uncomplicated. Investors would need to estimate their future retirement cash needs to attain their goals and then calculate the required contributions to secure that portfolio. Unfortunately, investors cannot accurately predict the future return rate on equity investments, inflation rates, or interest rates. However, most financial planners, when computing the necessary contributions to attain the required retirement portfolio, assume that future returns will follow the same average as the past. These are very risky assumptions, as these rates will certainly vary from year to year, thereby affecting the final value of the retirement portfolio.

The last ten years have shown that returns on equity and debt instruments are very volatile and extremely risky. One common way to estimate risk where the population distribution is known is Monte Carlo simulation. However, a relatively robust approach based on the concept of bootstrapping can be used to assess uncertainty in future investment returns. In the bootstrapping simulation method, each observation has equal probability of being included in the simulated sample. Essentially bootstrapping is sampling with replacement and simulates future investment returns by assuming that the future will be comparable to the past. One of the major benefits of simulation is that it provides an ending distribution of outcomes as opposed to a single value.

The stock prices of Google Inc. are simulated by assuming that each month's percentage change in price is equally likely to be one of the last 60 months' percentage changes in value. One thousand scenarios for Google's price for one year and the corresponding percentage returns are generated using an Excel© spreadsheet. Bootstrap sampling statistics are computed and interpreted. A simulated distribution enables an investor to associate probability with achieving a specific return in these uncertain times. Bootstrapping allows investors to easily generate distribution of the future value of their investments. A very significant advantage of bootstrapping is that the analysis can be adjusted to reflect variability in future returns.

Use of spreadsheet application in finance is common and very popular. For example, spreadsheets have been used to (1) evaluate the performance of protective puts (Yip, 2009), (2) analyze the investment style of portfolios (Atkinson and Choi, 2001), (3) conduct scenario analysis (Stretcher and McLain, 2010), and (4) determine option pricing based on stochastic calculus (Arnold and Henry, 2003). The finance education literature has established the effectiveness of spreadsheet in the classrooms (see Chandler and Marriott, 1994; Kline and Janicki, 2003; Marriott, 1992; Cagle, Glasgo, and Hyland, 2010). We contribute to this literature by showing an easy and effective way to simulate distributions of future stock price and return. This paper will stimulate interest in students and facilitate learning of important theory and concepts. Students can conduct their own simulations of different assets and compare their risk-return tradeoffs. Besides, this technique will also be very useful for naïve investors who do not have the resources to

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conduct financial analysis using sophisticated financial modeling. This technique, based on a very popular spreadsheet program, gives small investors a simple and powerful tool to conduct their own analysis.

Data

The historical monthly adjusted closing prices for Google Inc. (Ticker Symbol: GOOG) are used for the period January 2006 - December 2010 to calculate sixty monthly returns. Users may choose any company of their interest. We choose Google because it is relatively a new company with less than seven years of return data. The decision of number of months to include and how far one should go to draw observations for future return sequences depends on the future and past economic conditions. Volatility of stock returns changes with macroeconomic volatility, economic activity, and stock trading activity. Since the assumption of this simulation is that return-generating process in the future is similar to that in the past, any deviation from such assumption should be considered while interpreting the results. Alternatively, users may choose a different time period that is reflective of the future returns. We use the past 60 monthly returns to predict the one-year return distribution for Google.

Test for Normality

It is commonly assumed in finance that stock return follows normal distribution. A useful first step is to test the normality of stock returns. In this section, we use Jarque-Bera test to examine the goodness-of-fit measure of stock return's departure from normal distribution. Jarque-Bera test statistic (*JB*) is given as:

$$JB = n\left(\frac{S^2}{6} + \frac{(K-3)^2}{24}\right)$$

where n is the sample size, *S* is a measure of skewness, and *K* is a measure of kurtosis. *JB* follows an asymptotic chi-square distribution with two degrees of freedom (χ_2^2). We test the following null hypothesis:

H_0: S=0 and K=3 i.e. stock returns are from a normal distribution.

In case of our example, Google, *JB* = 21.02, which rejects the null at conventional level of significance.

Methodology[2]

In this section, we illustrate sequential steps to simulate the future returns.

Data Collection: The daily, monthly, and annual data of historical stock prices of publicly traded companies are freely available on many popular financial websites. In this study, we collect monthly adjusted closing price of Google Inc. from Yahoo Finance. The monthly adjusted closing price is used to calculate monthly returns as follows:

$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

where r_t is return during month *t*, P_t, P_{t-1} are the adjusted closing prices in months *t* and *t-1* respectively. Exhibit 1 show the partial data of 60 months returns. Each month's return is called a scenario. For example, scenario 8 in the given exhibit corresponds to the return on Google in May 2010. Scenario numbering should start with 1 to number of months included in the simulation. In our example, we number scenarios from 1 to 60. This, as will be explained in the next step, ensures that each observation has the same probability to be included in the sample.

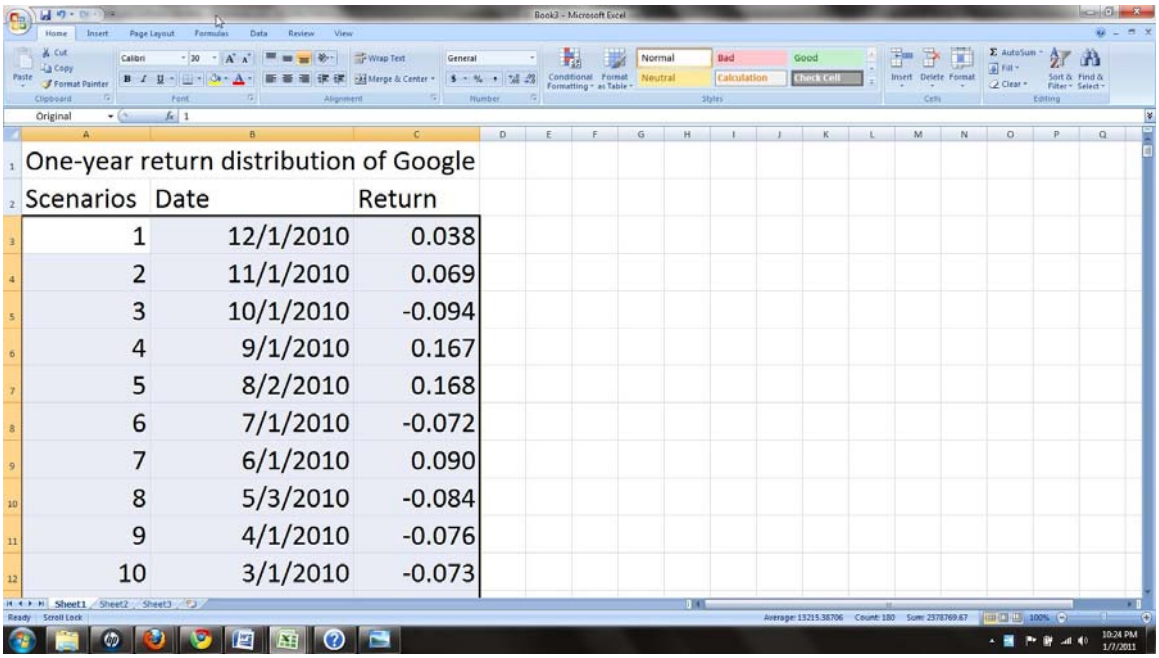
Generate 12 monthly returns selected randomly from a pool of the 60 historical returns: To predict a one-year return, we need twelve monthly returns randomly selected from the pool of our 60 returns. We use the excel function, RANDBETWEEN (1, 60)[3], to generate random number from 1 to 60 for each of the 12 months. This procedure will randomly select one of the 60 scenarios for each month. Since each scenario has an equal chance to be selected for each month, this is random sampling with replacement. For example, in exhibit 2, in month 1 we pick scenario 39 because RANDBETWEEN (1, 60) generated the number 39 in cell G3.

[2] The excel template of this simulation is available at www.ucs.louisiana.edu/~smr8609/bootstrap_simulation.html

[3] RANDBETWEEN(1, 60) is used because we employed 60 past returns. Users should modify this function based on the number of returns used by them.

Use VLOOKUP function to get returns associated with these scenarios: The formula, =VLOOKUP(G3, original, 3), in cell H3 retrieves return (-0.020) associated with scenario 39 and places it in H3.[4] This formula is copied in cell H4:H14 to generate returns associated with the remaining eleven scenarios. The closing price of December 2010 is our starting price. Based on scenarios selected for each month, we calculate the month-end price. The end price of each month becomes the start price of next month. The end price of month 12 is the year-end price. Once we have the year start and end prices, we can calculate the annual return.

Exhibit 1



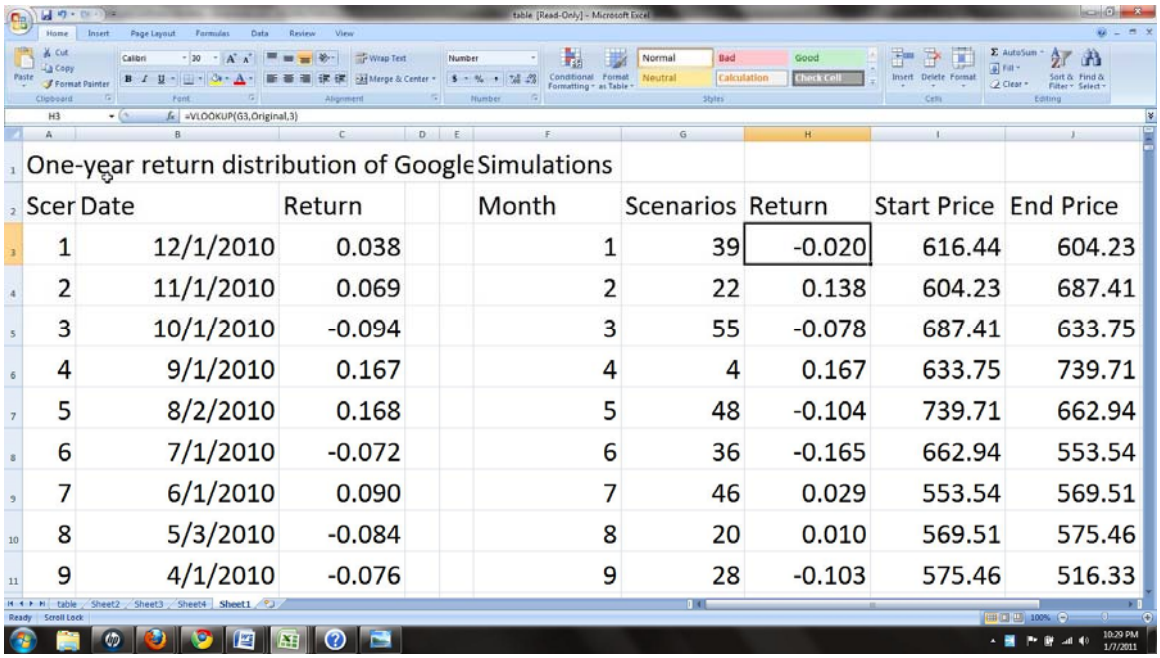
One-year return distribution of Google

Scenarios	Date	Return
1	12/1/2010	0.038
2	11/1/2010	0.069
3	10/1/2010	-0.094
4	9/1/2010	0.167
5	8/2/2010	0.168
6	7/1/2010	-0.072
7	6/1/2010	0.090
8	5/3/2010	-0.084
9	4/1/2010	-0.076
10	3/1/2010	-0.073

Simulate thousand year-end prices and returns: Since the start price is known here, this simulation needs to generate a distribution of year-end prices, based on which we will have one-year return distribution. To get the distribution of the year-end price (or one-year return), we conduct this simulation for 1000 times. For this, first enter the formula to show year-end price and one-year return associated with one-year price. In the exhibit 3, cell J14 (value - 417.38) is year-end price. In this case, the formula used in cell G17 is =J14. Next, calculate the return in cell H17 using the formula = (G17-616.44)/616.44. This is our first simulated year-end price and one-year return. To simulate one thousand scenarios for the stock, we use the 'Data table'. To accomplish this, select the cells F17 to H1016, then select 'Data' on the menu ribbon, select what-if analysis (see exhibit 4). Once the 'Data table' is selected, a dialog box prompt asks for input row and column cell. Leave the row input cell blank, choose a blank cell as column input cell to set up a one-way data table and then click ok in the table dialog box (see exhibit 5). This will populate all the 1,000 year-end prices and corresponding returns. Users need to press F9 to rerun the simulation to get a new set of 1000 prices and returns.

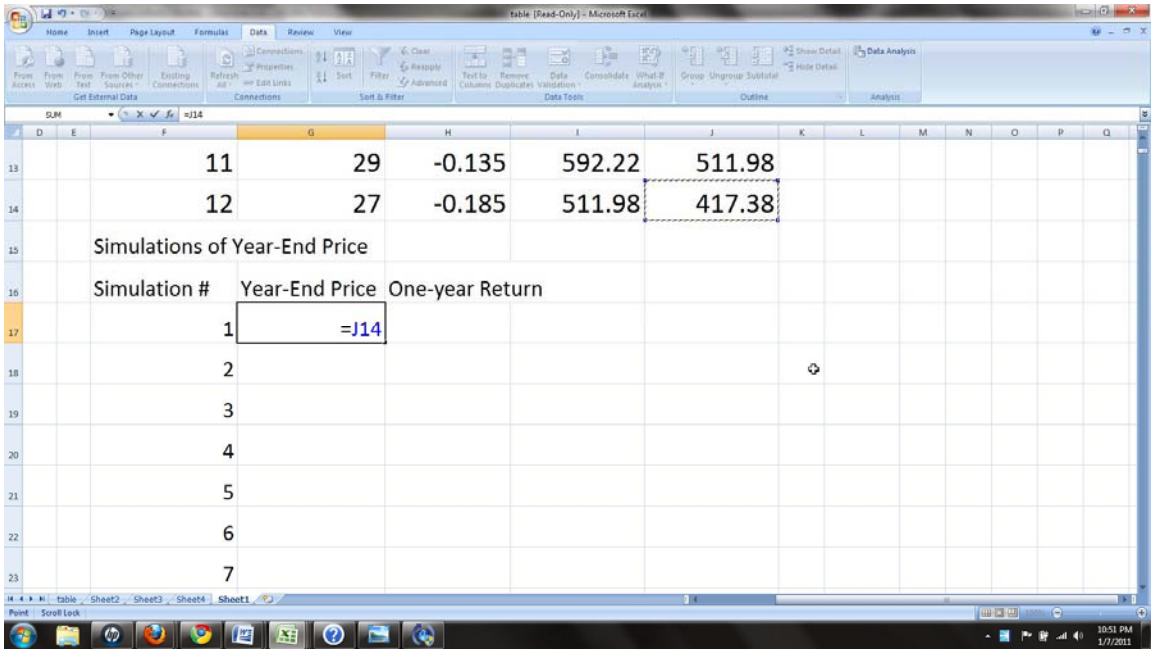
[4] Array A3:C62 is named as 'Original'. VLOOKUP(G3, Original, 3) looks for a match of value stored in cell G3 (value, in this case stored in G3 is 39) in the leftmost column of table 'Original', and then retrieves and places the value stored in column 3 of table 'Original' in cell H3.

Exhibit 2



	A	B	C	D	E	F	G	H	I	J
1	One-year return distribution of Google Simulations									
2	Scer	Date	Return			Month	Scenarios	Return	Start Price	End Price
3	1	12/1/2010	0.038			1	39	-0.020	616.44	604.23
4	2	11/1/2010	0.069			2	22	0.138	604.23	687.41
5	3	10/1/2010	-0.094			3	55	-0.078	687.41	633.75
6	4	9/1/2010	0.167			4	4	0.167	633.75	739.71
7	5	8/2/2010	0.168			5	48	-0.104	739.71	662.94
8	6	7/1/2010	-0.072			6	36	-0.165	662.94	553.54
9	7	6/1/2010	0.090			7	46	0.029	553.54	569.51
10	8	5/3/2010	-0.084			8	20	0.010	569.51	575.46
11	9	4/1/2010	-0.076			9	28	-0.103	575.46	516.33

Exhibit 3



	F	G	H	I	J
13	11	29	-0.135	592.22	511.98
14	12	27	-0.185	511.98	417.38
15	Simulations of Year-End Price				
16	Simulation #	Year-End Price	One-year Return		
17	1	=J14			
18	2				
19	3				
20	4				
21	5				
22	6				
23	7				

Exhibit 4

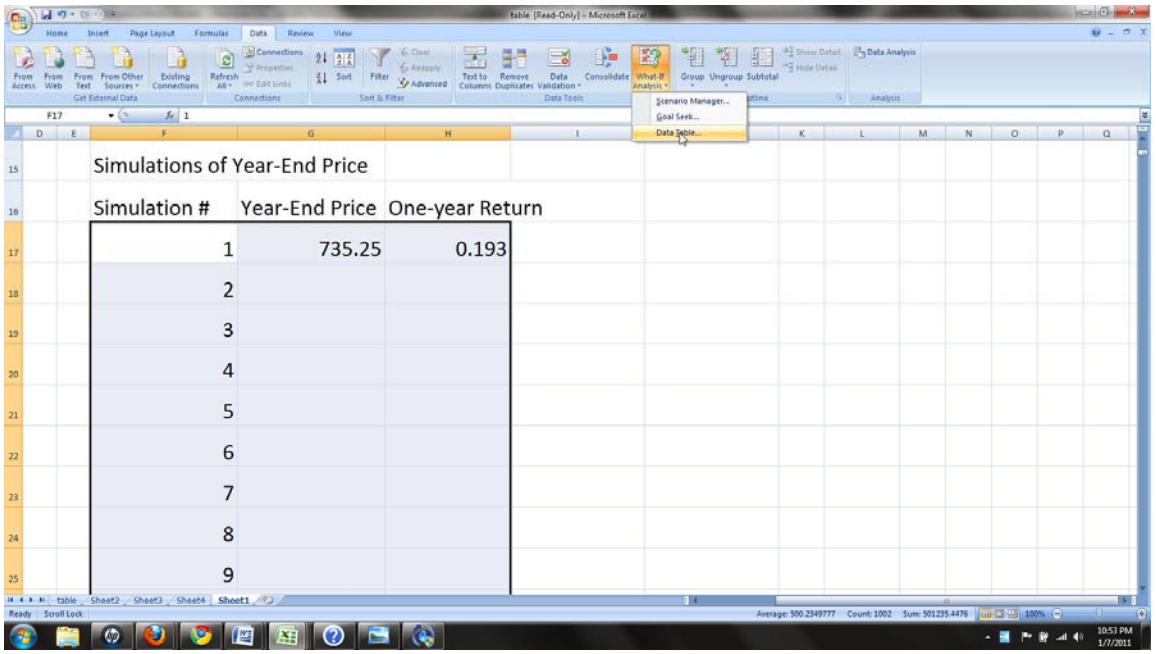
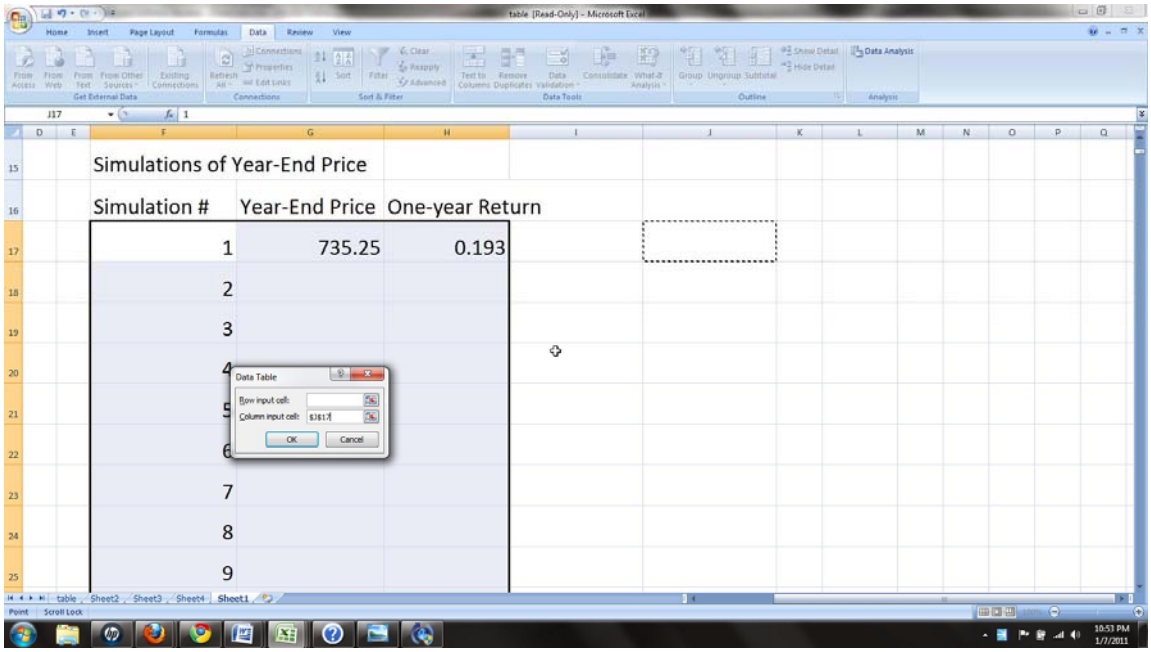


Exhibit 5

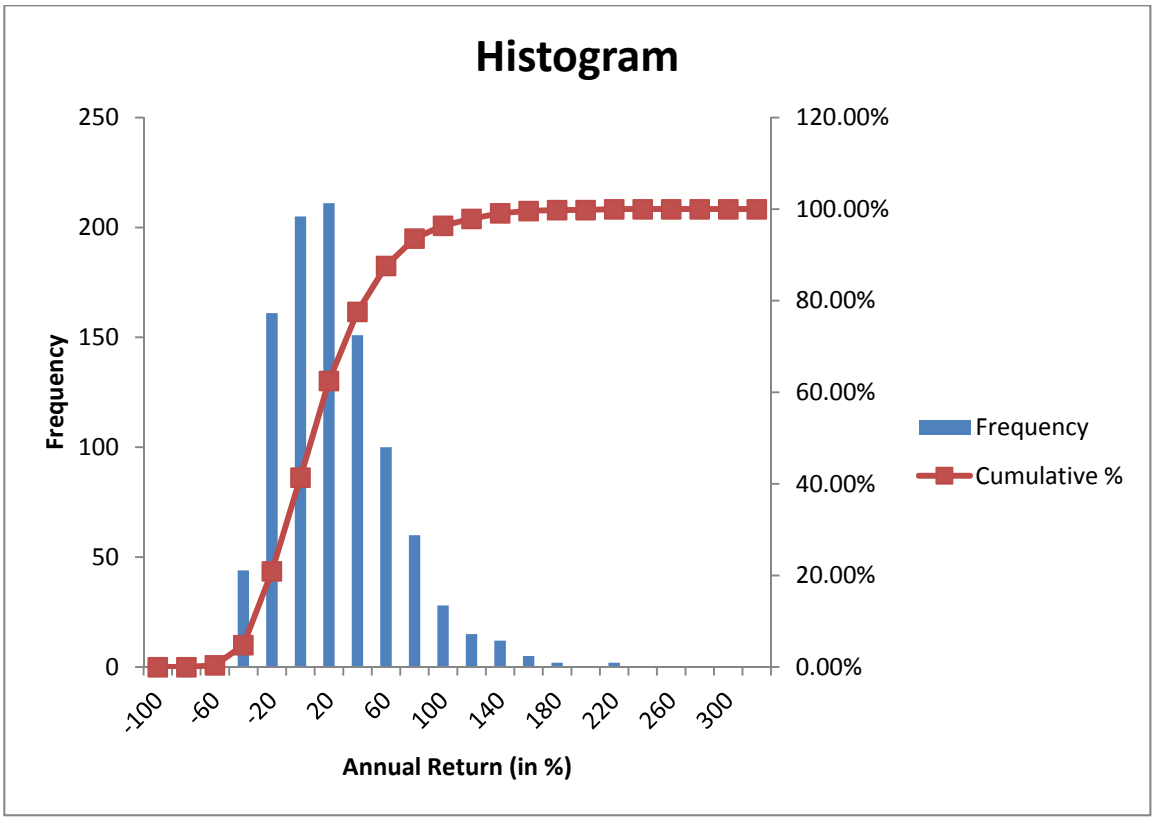


Results

We analyze the simulated one-year returns of Google Inc. The histogram and descriptive statistics based on 1000 simulated returns are shown in figure 1 and table 1.

The histogram and cumulative probability distribution may be used to find probabilities associated with one-year return. Histogram is a graphical representation that depicts the distribution of the data. It is clear from histogram shown in figure 1 that the one-year expected return distribution is right skewed.

Figure 1: Histogram and Cumulative Probability Distribution of Simulated Returns



The descriptive statistics in table 1 suggest that the expected return on Google for next year is 13.72%. The stock's standard deviation is 40.70% indicating high variability and risk. Averages and standard deviations of raw monthly returns should be interpreted with caution. Nevertheless, these simple statistics still reveal much about the nature of returns of GOOG. Stocks with higher volatility (i.e., standard deviation) such as GOOG, provide higher average returns, supporting the idea that there is risk-return tradeoff. The range of returns is from -69% to 215%. The kurtosis and skewness figures reveal that the distribution of stock returns is not normal and skewed to right.

One can use the simulated distribution of one-year return to assign probabilities to one's target return. For example, the probability of losing money over the next one year (i..e. the probability that one-year end price will be lower than the beginning price) is 41%. However, there is only 30% chance that loss will be greater than 10% and almost zero probability of losing more than 50% of investment in Google stocks. It is noteworthy that there is a likelihood of 46% that the stock will provide an annual yield greater than 10%. Although these results indicate that Google has high volatility with an expected yield greater than the market's historical performance, this analysis does not necessarily imply that Google was or is a poor investment choice. This same analysis may be performed on other stocks and comparisons made.

Conclusions

The use of excel is well entrenched in present finance education and practice. This paper presents the bootstrapping simulation method using spreadsheet application. Excel is the dominant spreadsheet application in the market as well as in the business classrooms. We provide a simple spreadsheet template that brings simulation concept to life. The application of this spreadsheet in classrooms will help with communicating information about adjusted closing prices, returns, risks, probability, skewness, kurtosis, etc. using real market data. Most universities and business schools operate under budget constraints, which do not allow the purchase of expensive simulation software. Working through bootstrap simulation in excel spreadsheet, a simple and inexpensive program, students can enhance their understanding of financial modeling. This exercise will increase objectivity in decision making and will result in effective and better usage of class time.

Table 1: Descriptive Statistics and Probabilities

Descriptive Statistics	
Mean	13.72
Median	7.28
Standard Deviation	40.70
Kurtosis	1.59
Skewness	1.01
Minimum	-69.10
Maximum	214.97
Probabilities	
Probability of losing money	0.41
Probability of earning return greater than 10%	0.46
Probability of earning return between 0 and 10%	0.12
Probability of losing more than 10%	0.30
Probability of losing more than 50%	0.02
Probability of losing all investment	0.00

In addition to students, individuals as well as sophisticated investors can use this method to forecast the future price trend. The user can easily adapt our simulation template for different time periods. For example, an investor interested in investing in a relatively new company (e.g. new initial public offerings) can use the limited historical data to simulate future returns. Similarly, a long-term investor can generate a distribution of terminal value of a long-term investment horizon.

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French Fried Potatoes as Lecturecraft: A Lesson on Product Homogeneity in Competition from Five Guys®

Carlos J. Asarta[1] and Franklin G. Mixon, Jr.[2]

Abstract

This study provides an interesting vignette for using the Five Guys® French fry for discussing an aspect of market structure – that of product homogeneity – in the economics principles classroom. In our view, this vignette is not only both clear and concise, it also allows for the use of humor in what is perhaps an otherwise dry lecture/discussion.

Introduction

In 2000, *The Washington Post* referred to the Five Guys® hamburger restaurant chain as "[t]he Willy Wonkas of burgercraft." In referencing the candy manufacturer in the Roald Dahl classic, *Charlie and the Chocolate Factory*, the news outlet lauds the major retailer known across the United States for mouth-watering burgers that can be served 250,000 different ways.[3] The Five Guys® brand was born in Arlington, Virginia, in 1986. Today, there are more than 1,000 restaurants in 47 states, with another 1,500 outlets in development.[4] By not employing freezers in any of its locations, only coolers, the restaurant's increasing success is owed, in part, to the fact that it uses only fresh ground beef. The popularity of Five Guys® has translated to college students across the country, as evidenced by the diffusion of the brand into many of America's well-known college towns. Table 1 shows, for example, how many of the country's iconic college towns are home to the Five Guys® brand. This particular sample of 48 towns includes Ann Arbor (Michigan), Charlottesville (Virginia), Lincoln (Nebraska), and Tuscaloosa (Alabama).

Table 1: Sample of Iconic College Towns with Five Guys® Locations[a]

Albuquerque, NM	Charlottesville, VA	Gainesville, FL	Norman, OK
Ann Arbor, MI	College Park, MD	Ithaca, NY	Reno, NV
Athens, GA	Columbia, MO	Knoxville, TN	Salt Lake City, UT
Auburn, AL	Columbia, SC	Lawrence, KS	South Bend, IN
Austin, TX	Columbus, OH	Lexington, KY	State College, PA
Baton Rouge, LA	Coral Gables, FL	Lincoln, NE	Syracuse, NY
Blacksburg, VA	Durham, NC	Logan, UT	Tempe, AZ
Bloomington, IN	East Lansing, MI	Louisville, KY	Tucson, AZ
Boise, ID	Evanston, IL	Lubbock, TX	Tuscaloosa, AL
Boulder, CO	Eugene, OR	Madison, WI	Waco, TX
Champaign, IL	Fort Worth, TX	Morgantown, WV	West Lafayette, IN
Chapel Hill, NC	Fresno, CA	New Haven, CT	Winston Salem, NC

Notes: [a] See www.fiveguys.com/en/locations/store-list.

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[3] See www.fiveguys.com/about-us.
[4] See www.fiveguys.com/about-us.

Interestingly, the French fries served by Five Guys® have achieved the same fame as the brand's burgers. A French fry's color, cut, and clarity are about as important to foodies and French fry connoisseurs as those same attributes about diamonds are to jewelers and gemologists.[5] Moreover, where gemologists are concerned with the cut of a diamond, foodies often focus on the crispness of a French fry. Also as in the case of diamonds, French fries make for a useful subject of study by economists.[6] This essay makes use of the Five Guys® French fry in developing a pedagogical vignette that, in our opinion, provides economics students with a relevant, particularly given their familiarity of the subject as evidenced in Table 1, and interesting presentation of some of the features of the microeconomic model of competition. Before turning to the details regarding how the Five Guys® French fry can be used in the classroom, we first provide a brief look at the production of russet potatoes in the United States, or, more specifically, Idaho.

Idaho® Potatoes and Five Guys® French Fries

Russet potatoes are grown in many states. However, only potatoes grown in Idaho can be called Idaho® potatoes.[7] Idaho's ideal growing conditions – rich and volcanic soil, climate, and irrigation – are what differentiate Idaho® potatoes from potatoes grown in other states.[8] A particular variety of Idaho® potato, the Russet Burbank, is often identified by French fry aficionados as the best choice for frying, seasoning, and serving with burgers or other complements. Although scientist Luther Burbank is credited with the discovery of the original seeds for the Russet Burbank, past president of the Potato Association of America, Lou Sweet, is credited with the development, in 1914, of this particular variety.[9] While Idaho growers have successfully produced many varieties of Idaho® potatoes, the Russet Burbank has been their greatest commercial success.[10]

The Russet Burbank is a late-maturing variety of potato that requires a 140- to 150-day growing season.[11] Its exterior skin is relatively thin and light brown in color. Its exterior shape is oval and slightly flattened, with few shallow eyes.[12] The interior is off-white to ivory in color, and moderately dense.[13] When prepared, the Russet Burbank generally has a distinctive, earthy potato flavor. The high solid (starch) yields a grainy texture and slightly chewy skin that bakes up dry and fluffy, and fries crisp and golden brown.[14] The aforementioned facets of the Russet Burbank provide the foundation for high-quality French fries, and, as such, account for the fact that it is the potato of choice for Five Guys®, Steak Escape®, and other food retailers that prepare freshly-cut fries.[15] The section of this study that follows provides an interesting vignette for using the Five Guys® French fry for discussing an aspect of market structure – that of product homogeneity – in the economics principles classroom. In our view, this vignette is not only both clear and concise, it also allows for the use of humor in what is perhaps an otherwise dry lecture/discussion.

Bringing Five Guys® French Fries to the Classroom

Authors of principles of economics textbooks differ in some of the approaches they use to present certain economics topics. For example, some authors use inflation in the y-axis to discuss the aggregate demand and aggregate supply model (Frank and Bernanke, 2012), while others use the price level for the same purposes (Mankiw, 2014). Yet, when it comes to discussing the characteristics and functioning of competitive markets, the pedagogical approaches are uniform across products. This is true for textbooks written in the 1960's (McConnell, 1960), in the 1990's (Mankiw, 1998) or even today (Asarta and Butters, 2016).

We see Five Guys® French fries' use of Russet Burbank potatoes as a perfect and relevant example for discussing competitive markets in the classroom. Agricultural examples are often employed in principles of economics textbooks

[5] These attributes relate to a French fry's thickness, freshness, seasoning and preparation style, and serving style.
[6] Recent studies on the economics of diamonds include Scott and Yelowitz (2010) and Lee, Caudill and Mixon (2014).
[7] See www.idahopotato.com/.
[8] See www.idahopotato.com/.
[9] See http://directory.idahopotato.com/dir_variety.php?id=1.
[10] See http://directory.idahopotato.com/dir_variety.php?id=1.
[11] See http://directory.idahopotato.com/dir_variety.php?id=1.
[12] See http://directory.idahopotato.com/dir_variety.php?id=1.
[13] See http://directory.idahopotato.com/dir_variety.php?id=1.
[14] See http://directory.idahopotato.com/dir_variety.php?id=1.
[15] http://idahopotato.com/dr-potato/181.

to present these types of markets because, once a specific agricultural good is chosen, all producers of it sell a homogenous product. As such, the market for Russet Burbank potatoes can be described as one where:

- There are large numbers of buyers and sellers in the market. Those market participants determine the market price and quantities of Russet Burbank potatoes exchanged.
- There is a homogenous product. The Russet Burbank potatoes offered by each seller in Idaho are perfect replacements for one another.
- The sellers are price takers. These farmers will have to sell their potatoes at the price determined in the overall market for Russet Burbank potatoes.
- It is relatively easy to enter and exit the market. It would not be particularly difficult for a farmer to stop producing Russet Burbank potatoes and start producing a different type of potato (i.e., red or white potatoes), or a completely different type of agricultural product.

The usefulness of the Five Guys® French fries story in the economics classroom comes from the company's tradition of recognizing the Idaho® potato farmers who supply it with Russet Burbank potatoes. As Taylor (2011) indicates, the names of the growers who supply the potatoes for frying are "prominently displayed on signs in Five Guys® restaurants." These signs are typically located adjacent to the ordering counter, where Five Guys® patrons are certain to notice them.[16] Figure 1 presents a representative image, taken by the second author of this article on a recent trip to the restaurant, of one of these signs. As depicted there, Parkinson Farms of Saint Anthony, Idaho, is a supplier of Idaho® Russet Burbank potatoes to the Five Guys® chain.[17] Of course, none of the customers who visited Five Guys® at the same time as this study's second author (or on any other occasion) would recognize, without the counter-side notification, the source of the potatoes through consumption (tasting) of the fries on that occasion. Nor would they be able to distinguish the Parkinson Farms potatoes from those of any other Russet Burbank farmer in Idaho. This is the reality of a homogeneous good in the microeconomics sense. It is that reality that makes this vignette such an effective one for economics students.

Figure 1: Example Source of Five Guys® Potatoes

Finally, the vignette, as used by the authors, also allows the instructor to interject a bit of humor into the lecture, itself a subject of research in economic education (e.g., McEachern, 1990; Bauman, 2003; Welker, 2007). Bauman (2014, p. 112) brings the first and third of the aforementioned references in his own essay on the use of humor in economics when he states,

[16] By all accounts, these signs serve as an homage to Idaho® potato farmers.
[17] Parkinson Farm, which was established in 1937, occupies about 7,200 acres of land just east of Saint Anthony, Idaho, in view of the Grand Teton Mountains of Wyoming and along the rim of Teton River Canyon (www.parkinsonseedfarm.com/).

> "In his 'Introduction' to the inaugural issue of *The Teaching Economist*, McEachern (1990) implores economics instructors to make good use of humor when exposing students to economics. According to McEachern (1990, p. 5), '[i]f you have a sense of humor, don't be afraid to use it . . . [t]he use of humor does not mean telling jokes or trying to go for big laughs, but seeing the humor in simple things and putting a humorous twist on the material.' More recently, Welker (2007) adds, '[a]ll the talk about economics being the "dismal science" is totally wrong. In fact, this subject is [funnier] than people know! . . . [s]o, add humor to your list of tools in your attempt to make economics stick with your students.'"

Similarly, Ongan (2010) includes the use of humor by economics instructors, along with the utilization of literature, theatre, and cinema, as alternatives to more traditional presentation practices in economic education in order to make economics more enjoyable, understandable, and appealing to college students. In terms of the Five Guys® vignette described above, the authors find it useful to interject a comment, such as the following, into the classroom discussion:

> "When you go to Five Guys® and you see that the French fries are cut from Parkinson Farm potatoes, you *have to* order them."

Students typically chuckle at the implication that fries cut from Parkinson Farms potatoes are somehow better (-tasting) than those made from any other "brand" of Russet Burbank, and that students should not pass up the opportunity to eat them when they visit the local Five Guys® restaurant. Moreover, by recognizing the humor in the above comment, students provide the instructor with immediate feedback that they "get" the notion of product homogeneity in the context of competitive markets.

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A Faculty-Driven Approach to Starting and Operating a Student Managed Investment Fund

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Abstract

Student managed investment funds have proven to be very strong learning experiences that bridge the gap between class-room finance knowledge and hands-on application of financial theories and tools. Though more widely utilized now than in the past, there are still many schools that do not offer such a program for students. This paper describes the approach utilized at one school to start, evolve, and operate a student managed investment fund. The experience gained from over twenty years of developing a program and experimenting with various approaches can be useful to faculty members and schools looking to implement such a program.

Keywords: student managed investment fund, SMIF

Introduction

Student managed investment funds, where students make investment decisions to manage real money investment portfolios, have proven to be very strong learning experiences that bridge the gap between class-room finance knowledge and hands-on application of financial theories, techniques, and tools. In most instances, these programs also provide effective opportunities to enhance student skills related to oral and written communication, critical thinking, and teamwork.

The growth in student managed investment funds (SMIFs) over the past 25 years has been dramatic. Although a handful of funds have been in existence for a longer time, a survey by Lawrence (1990) found that only approximately 25 such funds/programs were in existence in 1990 in U.S. colleges and universities. A follow-up survey and study by Lawrence (2008) almost 20 years later identified 289 SMIFs in the U.S. and 25 at colleges and universities outside of the U.S., for a total of 314 funds.

Even with this growth, there are obviously still many hundreds of colleges and universities that do not have a program of this type for their students. Despite several articles that describe how some specific funds were established and how they work (e.g., Block and French (1991), Johnson, Alexander and Allen (1996), and Kahl (1997), and the Lawrence (2008) article that provides a great overview of the number and size of SMIF programs, differences in their structure and operation, and examples of unique aspects of various programs, the authors of this study still are frequently contacted by faculty members from other universities with questions about how to start, grow and/or operate a SMIF program. Conversations with faculty members at other schools that have SMIF programs have allowed us to see that there are many different variations in how programs have been started and operated and there is clearly a need for more dialog and information sharing in this area.

The purpose of this paper is to provide a summary of how the SMIF program was started at our university, how it has evolved significantly over time, and how it currently operates after incorporating almost 20 years of experience and numerous experiments to try to improve it. Also, our experience may be useful for faculty members at schools that don't have broad support or obvious resources for establishing a SMIF program, as our own program was started with virtually no initial support from colleagues, administrators, alumni, or the university's foundation. It is our belief that the strength of the learning experience that can be provided by a well-designed SMIF program is so significant that any school without such an opportunity for students should seek to find a way to develop one.

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Starting as an Investment Club

The comprehensive SMIF survey and study by Lawrence (2008) notes that the vast majority of SMIFs receive start-up funds from university endowments, private or corporate donations, or some combination of these. Twenty-eight percent (28%) of funds got all of their initial capital from their university endowment, and another twenty-three percent (23%) were funded by a single large donor. Almost all of the others were funded with some combination of these and/or from multiple smaller donors.

Our experience was rather different, as we first initiated a student managed investing experience in the form of a student investment club. We did not particularly set out to get started in this manner, but in the mid-1990s with far fewer examples of successful SMIFs, the efforts of two relatively new assistant professors to convince our university foundation, at a regional public university, to provide start-up funds for a student managed investment fund were entirely unsuccessful. A few alumni and potential donors seemed to think the idea was interesting, but no one stepped up to provide actual funds for our endeavor.

Thus, in the fall of 1994, we started a student investment club as an official student organization in our college of business. We could find virtually no evidence of other active student investment clubs in the country at that time, so we did not have a specific model to follow. Only after we had actually been operating for a couple of years did we learn of one other university student investment club at Bucknell University.

Most investment clubs have rather stable membership and are usually organized by individual investors that have at least moderate amounts of money to invest. We were dealing with a membership that we knew would be rapidly turning over as students graduated and most of our students were not likely to have sizable amounts of money to invest. Despite this, the interest on the part of students was strong and we started out with a group of about 25 members willing to invest $50 to $100 per student. Similar to many other investment clubs, our student investment club was organized as a partnership. In addition, we designed it to allow students to leave their money in the club after they graduated as well as allowing a few non-voting supporters, such as a few faculty members and some alumni, to invest in the club. This structure enabled the portfolio to grow beyond what would have been possible if only current students were allowed to invest funds, but it was still a very small beginning with only a couple of thousand dollars.

Even with a small capital base, the number of partners in the club over time created significant problems with recordkeeping and tax filings. In addition, most of the individual investments were very small ($50 to $100), and even with some participants donating their investment to the club upon graduation, the size of the portfolio remained relatively small and limited the ability to fully diversify the investments.

One of the most noticeable positive results of students investing real money, even in these small amounts, was the way their attitude and approach to investment decision making changed. We had both previously utilized investment simulation exercises in classes and as many professors have noted, a simulation environment may often lead to rapid trading, seeking out risky or momentum driven stocks, and seeking to "beat" classmates in a short-term investing game. We had both tried approaches to minimize these issues in a simulation, such as requiring a certain degree of portfolio diversification, requiring written journals to document the rationale behind trades, setting a limit on the total volume of trading in a semester, and several other methods to attempt to encourage a longer-term fundamental view. Regardless, in a one semester time period, with no impact that extends beyond the end of the semester, and the use of simulated money, it is difficult to get students to treat a simulation exercise with the seriousness that would be desired.

From the very beginning of the real money investment club however, it was striking how different the student approach became. Students were generally more conservative than we had anticipated, asked many more questions about how to analyze companies and about economic factors that were relevant, and seemed to transform almost overnight from hot stock day traders into reasonably careful financial fiduciaries. Thus, even with the limited size of our fund and minimal support from other sources, we were quickly convinced that a real money investment management fund could be one of the most valuable learning experiences that could be provided to finance students.

As an investment club operated as a student organization, our initial student managed portfolio was not linked to any academic class. Thus, it offered students no academic credit for their involvement, and as club advisors our efforts did not count towards part of our teaching load. As a club, any student could participate and there was a wide dispersion of knowledge and effort from student members. As previously noted, membership turnover, record keeping, and tax reporting to members also proved to be drawbacks of the investment club structure. Despite these numerous drawbacks, direct observation of the powerful learning mechanism provided by managing a real money investment portfolio provided the motivation for us to find a way to evolve the club into a more manageable and meaningful structure.

The size and structure of our investment club was different from most other SMIFs at that time, but to function well we still needed to be effectively organized, have clearly defined roles for club leaders and members, have specific rules and regulations about making investments, and place the burden of decision making on the student members.

Many changes have taken place over the years as we evolved to a more traditional SMIF, but many of the original organizational decisions that had to be made to establish a viable investment club have served as the general basis for our operational approach even today. Regardless of the size or structure of a student fund, it is important for any SMIF start-up to take the time to carefully develop a structure, procedures, and policies that will ensure a professional approach to running the program.

After several years of actual operation, even on a small scale, we had accumulated strong favorable feedback from students involved in the club, examples of impressive analytical work from some of the stronger students, and investment returns that exceeded average market returns. We now had something more concrete to "sell." We decided to convert the investment club into a more traditional student managed investment fund. A majority of the investment club members agreed to donate their funds to the new fund structure. In addition, one of our colleagues, a long-time successful professor that was nearing retirement, was sold on the value of the educational experience and made a couple of donations to the fund. Equally important, he allowed the fund to be named for him and thus provided additional name recognition and a fund-raising stimulus for us. Within a couple of years, the fund grew to approximately $75,000 of funds to invest.

Knowing that some schools have SMIFs that contain millions of dollars, it might seem that a fund of less than $100,000 is almost inconsequential. Nothing could be further from the truth. Our experience over time has convinced us that the educational value of the entire SMIF experience can be almost the same, regardless of the size of the fund. With a wealth of data and information that is available at low cost and with transactions costs that are very modest, an efficient and effective SMIF can be operated without having to have a very large scale.

Original Course Structure for Our Student Managed Investment Fund

When we made the conversion from a student investment club that was an extra-curricular club in the college of business to a student managed investment fund, we felt it was desirable to make the fund part of an academic class that students would take for credit. Although approximately 30% of SMIFs at U.S. universities are operated as extra-curricular activities or organizations, our experience with a club led us to believe that a good number of the concerns that we had identified with a club structure (limited teaching opportunity, student involvement that sometimes decreased over time, minimal recognition of faculty workload involved, and a wide variety of student preparation for analysis and investing) could be better addressed by incorporating the fund as part of a formal class.

When we began teaching the course that was linked to managing the investment fund, we used a senior-level investment management course that was already in the curriculum for the finance major. It had previously been a traditional one semester lecture type class that covered primarily security analysis and portfolio management, and placed approximately equal emphasis on theory and practice. This three semester hour course was transformed to be spread over two semesters and to be focused on the hands-on experience of managing the real money investment portfolio. Students were assigned a grade of "incomplete" at the end of the first semester and the course grade was awarded at the end of the second semester. We required the two-semester sequence because we strongly believed that students needed more time than is afforded in one semester to fully grasp the concepts we hoped to cover. In addition, we felt that having a little more time would encourage the students to take a longer-term perspective in their investment decision making.

The only finance prerequisites for the course were an introduction to finance course and a survey of investments course. At first, a cohort of students entered the class only in the fall semester and finished the class at the end of the following spring semester. This makes for much easier management of what is taught in the class and when it is taught, but since it was a new approach to have a senior-level class spread across the entire academic year and we had not had a great deal of lead time to promote the class, this initial class had relatively small enrollment.

After the first year, we tried an approach where we allowed students to enter the investment management course during either the spring or fall semester. This flexibility made it easier to fit in with the other scheduling needs of students. That is, students could enter the course when it best fit their program of studies and it was not as restrictive as is the cohort type course sequence that was originally, and is currently being, used. There was typically a roughly even mix of first semester and second semester students in the class. In addition to better flexibility for students, this structure offered several other benefits.

- There was more on-going continuity across multiple student investment groups since each semester there were always some students that had some historical knowledge of what had been happening in the fund and why/how prior decisions had been made.
- It provided more of an opportunity for students to learn from each other. Second semester students could mentor first semester students, work together on how to monitor and analyze investments, and move some of the collaborative learning out of class time.

- It made it easier to allow students to make significant investment decisions at any time during the course since there were always seasoned participants in the class, even on the first day of each semester.
- Finally, it provided some level of portfolio oversight during the summer months. Students that entered the class in the spring semester and completed it in the fall semester were given some responsibility for monitoring economic and investment activities over the summer months.

The primary drawback of letting students overlap each other with this course structure was developing and delivering effective teaching sessions to a mix of students at different knowledge levels. Some basic material had to be repeated each semester, some topics were broken into segments so that part could be taught when students had minimal investment knowledge (during the first part of their first semester) and then added to as their knowledge expanded (somewhere near the end of the first semester or beginning of the second semester), and some topics were covered via external readings or exercises that students covered on their own when they were prepared for the material. A majority of class time was spent on discussions of what was currently going on in the economy and markets in general, and with our investments in particular. Students prepared stock analyses to present in class and investment decisions were debated and voted on. It made for a lively, timely, and dynamic class that was certainly worthwhile, but it lacked the ability to truly teach investment management at a level that was as in-depth and comprehensive as we desired. Another aspect of the disadvantage of this course structure was that allowing only three semester hours for the course did not allow sufficient class time to cover the materials that we believed should be covered for a high level analytical course that we envisioned. Although the course required more work than other courses at the same level, we felt there was a limit to how much we could ask of students if they were only receiving three hours credit. After a couple of years of experience with the course in this format, we began considering other options.

Current Course Structure

The current course structure is designed to overcome the problems of the original course structures. A second course in investment management was added to the finance curriculum and the students selected to manage the student investment fund must take a two-course sequence that begins in the fall semester and ends in the spring semester. The students in the program are in a cohort and all move through the program simultaneously.

The course structure currently used gives more time in class to cover the lessons that students need in order to analyze stocks and manage the portfolio. All students entering the program have similar background knowledge in finance and investments and learn together throughout the year. This structure makes easier for the faculty to teach than did the original course structure and provides a richer and more in-depth learning experience for the students. The downside of this structure is that there is no continuity of membership from spring semester to fall semester.

Our Current Student-Managed Investment Program

We recognize that very few of our students will ever work in the investments field; therefore, we stress that the primary objective of the investment program for students to learn how to do fundamental financial analysis and to apply that knowledge to select stocks and manage the investment fund. The skills and knowledge gained by students can be applied in a wide variety of finance careers.

The Investment Group

Students in the investments program are considered part of an "Investment Group" that is unofficially named in honor of the largest donor to the investment fund. It is stressed upon the group members that they have a fiduciary duty to manage the fund to the best of their ability. Students take membership in the Investment Group very seriously and take great pride in being a member of the group. In a sense the students take ownership in the program and they know that they are responsible for the success of the program and for carrying on the traditions of the program. Typically the group members become a tight-knit group and operate as a team.

Selecting Students for the Investment Group

Although students officially enter the program in the fall semester, their involvement begins in the previous spring semester when they apply to be a member of the Investment Group. Applications are due at the beginning of March and the applications are screened by faculty to eliminate applicants with weak academic credentials. The remaining applicants are interviewed late in March by faculty members and by the current student members of the Investment Group. The members of the Investment Group like to be involved in the process because it gives them an opportunity to have an impact on the continued success of the program. Given the current structure of the MBA program at our university, it is not possible for MBA students to participate in the investment program. Therefore, for the past several years the Investment Group has been comprised solely of undergraduate students.

The application and interview process is intended to identify students that have
a high level of academic ability,
a good work ethic,
a strong desire to learn how to do financial analysis and security analysis,
a demonstrated interest in investments, and
the ability to function as part of a team.

Typically, twelve students are selected to join the Investment Group and the average GPA of the group is usually around 3.5. There have been a couple of years when there were a large number of outstanding applicants and the group size was increased. The disadvantage of a larger group is the group dynamic changes and the group does not function as well as a team.

Once the new Investment Group members are selected, they are invited to sit in on the Investment Group meeting (classes) for the remainder of the spring semester. This gives the new group members an opportunity to see how the group functions and help better prepare them to take over the management of the investment fund.

Summer Assignments

Students selected to be part of the Investment Group are given three assignments to complete during the summer prior to starting the first investment management class in the fall semester. The first assignment is to read an investment book. The book assigned is a popular book on investing and not a textbook. The purpose behind this assignment is to give students some practical insight into selecting and analyzing stocks. The book currently used is *One Up on Wall Street* by Peter Lynch.

Students are also assigned stocks in the investment fund to track and study during the summer. The purpose of this assignment is to make certain that, beginning on the first day of classes in the fall semester, the students are at least somewhat prepared to discuss the stocks that are held in the portfolio. Students will continue to track the assigned stocks throughout the year (or until the stocks are sold).

The final summer work assignment is to learn the basics of financial statement modeling. Students are given access to online training materials provided by Wall Street Prep (www.wallstreetprep.com). These training materials are widely used by major investment banking firms and student access is paid for with earnings from the investment fund or from private contributions given in support of the Investment Group. During the summer students build a model for one of the companies that they are following by applying the lessons from the online training. The purpose of the summer modeling assignment is for the students to learn the basics of modeling. At this point, before the class formally begins, the focus is more on the mechanics of modeling and less on the assumptions required to accurately forecast company financials.

The Fall Semester

We begin the fall semester with a full day event focused on professional development and team building activities. Our philosophy is that we are working with some of the top students in the finance major and we want to help these students be highly successful in the business world. It is important to ensure that these students have the business etiquette and professional skills needed to be successful.

As with most of our courses, the investment management class meets two times each week. We add an extra hour to each class meeting to give sufficient class time to discuss the stocks in the portfolio and for lectures. We typically refer to these as meetings rather than classes to try to instill the feel of a business environment. The meetings begin with a review of the stocks in the portfolio. There are at least two students assigned to each stock in the portfolio and

they discuss the latest news about the stocks and indicate whether they have concerns about continuing to hold the stock in the portfolio. There are often questions from other students and the discussions around the stocks often take longer than expected.

The students entering the program in the fall inherit the portfolio of stocks left by the previous Investment Group. They have been researching the stocks over the summer and are prepared to discuss the stocks at the first class meeting. The Investment Group can decide at any time to sell a stock in the portfolio; however, they are not allowed to buy stocks until they thoroughly research the stock, write an analyst report on the stock, and present their recommendation to the Group and that does not happen until the end of the fall semester.

The primary focus of the fall semester is to learn how to do in-depth fundamental security analysis. Within the first two weeks of the fall semester the students must select a company to analyze for the semester. The students are required to find a company that they think is a good investment and that is relatively easy to analyze. They are advised to:

avoid companies with products or services they you do not understand,
avoid companies that have numerous lines of business,
avoid financial firms (REITs, banks, insurance companies),
find a company with relatively simple and straight-forward financial statements,
avoid companies that have recently had a merger or other significant event, and
avoid foreign-based companies (even if the stock trades on a U.S. exchange).

Through assigned readings and lectures the students learn about security analysis and then apply what they learn to their selected company. They have a series of required assignments and must submit reports for each assignment. The topics covered in the reports include industry analysis, qualitative company analysis, and financial statement/ratio analysis. The students use the information gathered through these assignments to build a model to forecast the company's financial statements and value the company.

The final assignment for the fall semester is to take all of the knowledge and information they have gained throughout the semester and write a detailed security analyst report on their company. The recommendation for the report can be buy, hold, or sell and the students present their report to the Investment Group. After the presentations are completed the group can decide whether to buy any of the stocks recommended by group members.

During the fall semester students are given training on how to make an effective presentation and are given an opportunity to do a non-graded practice presentation where feedback is given. Implementing the practice presentation greatly improved the quality of the end-of-semester security analysis presentations.

Another major activity of the fall semester is a trip to New York City that is typically scheduled for the end of September. This trip gives students an opportunity to visit investment professionals, the New York Stock Exchange, and tourist destinations in the city. The student's travel expense is heavily subsidized by earnings from the investment fund and from contributions given in support of the Investment Group. A major side benefit of the trip is that it gives the students a great opportunity to better get to know each other. Students report that the New York trip is when they really start feeling comfortable with each other and feel they can begin functioning better as a team. As a result, the trip has been moved earlier in the semester than when the Investment Group was initiated and officer elections are delayed until after returning from New York.

In the fall semester a team of students from the Investment Group are selected to participate in the CFA Research Challenge.[3] The local level of competition has been hosted in our state for the past six years and for four of the six years, teams from our university have won the competition and have advanced to compete in the Americas Regional competition. Our teams are comprised of undergraduate students and have competed very well against teams of students from other universities, including teams from some of the top MBA programs in the country. We believe that the intense focus of the Investment Group on learning fundamental security analysis and the training and preparation for presentations are major contributing to the success of the teams competing in the Research Challenge.

The Spring Semester

In the spring students apply what they learned in the fall to the management of the portfolio. They are required to prepare and present three reports during the semester:

Each student must present a sell recommendation on a stock that is currently in the portfolio. Even if they do not agree with the recommendation they are making, they must present an argument as to why the stock should be sold.

[3] Information on the CFA Research Challenge is available on the CFA Institute website (http://www.cfainstitute.org/COMMUNITY/CHALLENGE/Pages/index.aspx).

The sell recommendations help to ensure that an in-depth analysis is conducted on most of the stocks held in the portfolio. The recommendation is delivered by oral presentation and does not require a written report.

Each student must present a buy recommendation on a stock. For this report and presentation the students are permitted to rely heavily on the professional analysts and can bring in information from Value Line, Morningstar, and sell-side analyst reports. The reports prepared by students are more informal than the reports prepared in the fall semester. This report and presentation gives an opportunity for students to consider investments in companies that are more difficult to analyze (e.g., financial firms and foreign companies)

Students are placed in groups and the groups must do a full analyst report providing a buy recommendation on a stock. To support their analyst report they must build a model to forecast the financial statements of the company and must include a valuation based both on multiples and discounted cash flows. This report is typically presented near the end of the semester and brings together everything they learned about fundamental analysis throughout their year in the Investment Group.

In addition to continuing with the security analysis in the spring semester, students learn about portfolio management topics including asset allocation, risk and return measures, and managing risk.

In March, the students in the Investment Group assist in selecting the members of the next group. The students review applicants and conduct interviews. They then share their opinions with the faculty member in charge. The final decision on who to invite to join the Investment Group is the responsibility of the faculty member.

The spring schedule allows free time to bring in speakers. Speakers are invited from a variety of finance fields and typically include a fixed-income portfolio manager, a partner in a major private equity firm, an expert on technical analysis, and other finance professionals.

The final responsibility of the Investment Group at the end of the spring semester is to position the portfolio for the summer and ensure they are leaving it in good shape for the next semester. The Investment Group does not meet during the summer; therefore, the portfolio is left unmanaged during the summer. Some groups have tried using stop-loss orders to provide some downside protection during the summer; however, that practice has not worked very well as temporary drops in the price of some of the stocks led to the stock being sold locking in a loss that would have been avoided if the stop-loss orders had not been in place.

Beyond The Program Structure, What Has Worked Well?

Giving the group a name was very helpful. The group name gives it identity. Students are not just members of a class that manages a portfolio; they are members of an Investment Group that has a growing reputation. This sense of ownership also helps to generate support from alumni of the group. Many alumni keep track of what is currently happening with the Investment Group and with the stock portfolio. And, we frequently receive financial support from Investment Group alumni and from their parents. The name also helps give the group recognition with alumni and advisory boards. Finally, the reputation of the group is recognized by several companies that recruit on campus and members of the Investment Group have an advantage, especially during the initial screening of résumés.

One of the responsibilities of the group is to write a monthly newsletter that is distributed via email to group alumni and other supporters. The newsletter helps to keep alumni, supporters, and others who are interested in the group informed about the activities of the group. It also provides another opportunity for students to develop business writing skills and the motivation that comes from knowing their work will be read by a substantial audience of business professionals and university supporters.

Another method of connecting with supporters is having the students make presentations to external groups such as various campus advisory boards. The members of these advisory boards like to interact with students and they like to hear about the investing activities of the group. The students like the exposure they receive through these presentations and like to talk about their work. The external presentations typically occur near the end of the spring semester.

Three years ago we were fortunate to have a retired investment professional volunteer his time to work with the faculty member teaching the investment management classes. The faculty member still has primary responsibility for the classes and the retiree assists by attending most meetings and helping with other activities. The retiree also serves as a mentor and role model for the students. The students see how much effort he puts into the course as a volunteer and that helps to motivate the students to do more and to work harder.

Managing funds that we raised specifically for the student investment fund rather than managing funds allocated by the University Foundation also has some benefits. We do not have to report to the Foundation and, since the money belongs to our department, we have more freedom and flexibility in spending the portfolio earnings. All spending

must still be in compliance with University guidelines, but we do not have to ask for the money and do not have to seek prior approval for spending.

The New York trip has been one of the extra-curricular activities that has proven to be well worth the time and effort. Planning the trip and traveling with the students takes a lot of the faculty member's time, but the benefits to the students make the trip worthwhile. We highly recommend some type of professional trip as an opportunity to build greater camaraderie among the student group and to expose students to the environment and expectations of working professionals in the investment industry. Both are valuable aspects of generating the atmosphere that we seek to develop in our SMIF.

Additional Benefits of the Program

The students involved in the Investment Group are clearly the primary beneficiaries of the program, but there are also other benefits. For example, the success of the Investment Group as a whole and the success of the Investment Group students participating in the CFA Research Challenge has provided a lot of positive publicity for our College. We are at a point where we have a lot of positive momentum and that is helping in fund raising for the College. For example, due to a benefactor seeing a presentation made by students in the group, funding has been provided to pay for our Bloomberg terminal for several years.

The operating fund and the returns from the portfolio also provide benefits to the faculty member teaching the Investment Group and to the Department. The faculty member has funds available that can be used to pay travel expenses for investments-related conferences and for other activities related to the Investment Group. Funds are also used to support some Department activities. For example, alumni luncheons and alumni receptions have been funded by the investment program funds. In return, the students in the Investment Group are invited to attend these functions and can benefit from the networking opportunities.

Conclusion

Despite following a circuitous path to the development of a student managed investment fund, the authors are convinced that the unique and powerful educational experience provided to finance students via a SMIF is something that should be considered by faculty members at schools that have not yet developed such a program. Hopefully, the evolution of our efforts in developing a SMIF will provide useful insight and ideas to others that may contemplate such a program. Also, it may help others to see that there is not a single or obvious path to follow.

We would advise others to avoid the investment club model if possible. Although we learned a lot by going that route, in our opinion it has far more weaknesses than a program that is part of a class and a program that has funds to invest from a source other than the members. While it can be nice if one has access to a very large donation to start with, or a university foundation that will provide a substantial amount of money to be managed by students, a successful program does not require hundreds of thousands, or millions, of dollars. Our own early experience and feedback from colleagues at other schools indicates that a program can be started with as little as a few thousand dollars. More is generally better, but one should not feel that it is necessary to have a million dollars to make a program meaningful and worthwhile for students.

Finally, faculty members considering starting a student managed investment fund needs to consider that it is a time consuming process and it would be useful to ensure that they have the support of other department faculty members, the Department Chair, Dean and the University Administration. Although we started the original investment club when we were assistant professors and with little support at our university, we would generally not recommend this activity for non-tenured faculty. The time and effort involved can be substantial, but seeing the growth, development and success of the students participating in the Investment Program has been very rewarding to us as educators.

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A Classroom Property Title Experiment

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Abstract

Economists such as de Soto (2000) posit that property titles are among the institutions that enhance human well-being. This paper presents a classroom property title exercise in which students may uncover for themselves the potential benefits of property titling on residential investment incentives. Players are faced with a series of rounds in which they must choose to build a low quality or high quality dwelling. Players are initially titleless squatters, but some property titles are randomly distributed between rounds. In each round, players receive a payoff from their housing investment but untitled properties also run the risk of confiscation.

Introduction

Institutions, according to Douglass North (1991, p. 97), are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange.

Property titling has been cited as an institution conducive to beneficial economic outcomes (de Soto 2000).[2] For example, studies find strong evidence that property titles increase residential investment. Examining a property titling program in Peru, Field (2005) finds housing investment in urban slums increased with the strengthening of property rights. Similarly, Galiani and Schargrodsky (2010) analyze a natural experiment occurring in Argentina and conclude that titles led to greater housing investment.[3] Because of titles' potential role as an institution conducive to economic development, the economics of property titling is a likely learning goal in many courses, particularly those focused on development economics.

In recent years there has been an emphasis on active learning approaches in the classroom instead of sole reliance on "chalk and talk." Indeed, there is a growing literature that suggests that these types of techniques promote deeper student learning of economic concepts (Frank 1997; Hansen et al. 2002). This paper presents an active learning exercise that instructors can use to teach their students about the economic effects of property titling on housing investment. We have used the experiment in both a development and a law and economics course, but it would also be suitable for principles-level courses that include coverage of property rights topics. For reasons we will outline below, the activity is probably most suitable for classes of fewer than 30 students unless the instructor has teaching assistants or can have a colleague assist with classroom implementation. A single 50-minute class should be sufficient to run the basic activity in class, with time remaining for follow up discussion of Field (2005) or Galiani and Schargrodsky (2010).

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[2] Implicit in our discussion of property titles is the assumption that titles are indicative of secure property rights. However, it is worth noting that property titles per se are meaningless without some public or private means of protecting against encroachment. See Kerekes and Williamson (2010) for more on this point.

[3] The literature is somewhat mixed with respect to other potential benefits of property titling. For example, Field (2007) finds a positive impact of property titles on household labor supply, with substitution away from child labor toward the adults in a household. Additionally, Allendorf (2007) suggests that land ownership by women is positively related to measures of women's empowerment and a decreased likelihood of children in the household to be severely underweight. With respect to environmental considerations, Ali et al. (2014) find that a land tenure regularization program in Rwanda had a large effect on investment and maintenance of soil conservation measures. On the other hand, there is some evidence that the benefits of property titling may differentially accrue to wealthy households due to liquidity constraints (Carter and Olinto 2003).

Setup of the Experiment

Each student participant begins with an initial endowment of $1 (in quarters) to purchase housing. In each round of the game, students can choose to build a primitive dwelling (referred to as a "shack") for 1 quarter or a more substantial dwelling (referred to as a "house") for 2 quarters, but they must build a place to live (no homelessness or moving back in with their parents!). Students are told the game will involve multiple periods but are not told a specific number.[4]

As in the Argentinian episode chronicled by Galiani and Schargrodsky (2010),[5] students start out as squatters who do not have a formal title to their chosen dwelling in the first round of the game. Since property rights are insecure without a land title, there is a probability each round that students' dwellings will be confiscated by the government or the rightful land owner. In each period, the payoff to a dwelling is determined by a coin toss. With equal probability, students have their dwelling confiscated or receive a payoff of equal to their housing investment (25 cents for shack dwellers, 50 cents for house dwellers).[6] Hence, potential returns on the housing investment are shown in Figure 1:

Figure 1

Probability	Return
50%	0, Lose Dwelling
50%	1x Investment

At the beginning of each round, students can "upgrade" to a house from a shack by paying the additional $0.25 cost, but they may not "downgrade" from a house to a shack (i.e., housing investments are irreversible). This allows the game to more closely mirror "real world" investment decisions. At the end of the last round, students sell back their dwellings (if they have not been confiscated) for the amount paid for them.

Students keep track of investments and returns each round of the game in Table 1. (The complete student handout is shown in the Appendix, and electronic copies are available from the authors upon request.)

The activity begins with each student deciding on building a shack (at a cost of $0.25) or a house (at a cost of $0.50). The instructor walks around the room collecting the payments from students and helping them to record "shack" or "house" in the investment choice column for round one. The instructor then asks students for a show of hands about which type of dwelling they chose and records the results on a chalk or white board in the classroom. In our experience running this experiment, the majority of students choose to start with a shack rather than a house.

Once the initial housing choices are recorded, the instructor tosses a coin to determine whether students keep their dwellings or lose their investments. For some variation among the students in class, we recommend doing separate coin tosses for each student if the class is particularly small or for various sections of the classroom for larger classes (e.g., by rows in the classroom or by sides of an aisle in the classroom). If there is only one coin toss for the entire class then all students will win or all will lose in the round. Based on the outcome of the coin toss, students then record their 100% gain or loss and the instructor walks around the room again, this time paying out student winnings. There is no need to collect student losses because all participants pay for their dwellings up front; however, students who lose their dwellings in the initial round will need to purchase new ones before the second round. Also, as

[4] As noted in the "Teaching Tips" section, this helps to mitigate potential end-period behavior that would result from students anticipating the game's conclusion and modifying their behavior accordingly. It also serves to help the game seem more realistic to students.

[5] In 1981, about 1,800 families occupied a poor piece of land in the San Francisco Solano suburb of Buenos Aires. Although the occupiers did not formally own the land, they marked off parcels in hopes of avoiding a shanty town. The squatters thought the land belonged to the government but it actually belonged to several private owners. After learning that the land was privately owned, the occupiers resisted several attempts at eviction. While not all people with insecure property rights are squatters like the people studied by Galiani and Schargrodsky (2010), the events documented by Galiani and Schargrodsky are especially useful in illustrating the relationship between property titles and housing investment.

[6] The 50-50 odds of receiving a payoff or having a dwelling confiscated are chosen simply for easy of administering the experiment. Though, through repeated trials in our classes, we have found that such odds work well, instructors could easily choose to use different probabilities when running the experiment. The payoff received from owning a (non-confiscated) dwelling each period can be thought of as the consumption benefit of owning the dwelling.

mentioned above, part of the rules of the game conveyed to students is that they must make some type of housing decision (they can choose between a house and a shack, but they cannot choose homelessness on their plot of land). This is important, because it helps make sure that each student has some "skin in the game" in terms of realizing losses or gains from their investment decisions. In this experiment, choosing not to build a house or a shack would be tantamount to choosing not to play the game at all. In "real world" situations where people do not have secure property rights, choosing "not to play" is not an option, and the classroom experiment should reflect this reality.

Table 1

	Title?	Investment Choice (House or Shack)	Lose Dwelling?	Return	Total of Earnings So Far
Round 1	No				
Round 2					
Round 3					
Round 4					
Round 5					
Round 6					

Once the payouts to winners in the initial round are complete, each student receives a sealed envelope. One-fourth of the envelopes contain property titles, while the other three-fourths contain notes indicating that they did not receive titles (see the examples in Appendix Figures 2 and 3 below).[7] (Electronic copies of these are also available from the authors upon request.) This random distribution of titles is intended to resemble the natural experiment described in Galiani and Schargrodsky (2010).[8]

After the random distribution of some titles via the sealed envelopes, students must decide what sort of dwelling to purchase for round 2 for the activity. Students who lost their dwellings in the initial round must decide on investing in a shack or a house. Students who constructed shacks in the first round and did not lose them must decide to keep their shacks or upgrade (at a price of $0.25) to a house. (Recall, students who chose houses in the initial round and did not lose them may not downgrade to a shack.) Once all students have made their dwelling choice and indicated it

[7] Instructors can change the likelihood of an envelope's containing a title from one-fourth without affecting the substance of the experiment. We chose one-fourth because if one runs three rounds of the experiment, then the cumulative probability of receiving a title is roughly equal to the likelihood that Argentine squatters received titles. We choose to distribute the titles over several rounds rather than a single round because we think it helps students to see the causal effect between titles and residential investment more clearly.

[8] After unsuccessful attempts to evict the squatters, the government passed a law expropriating the occupied land from its rightful owners. The law called for the land's owners to receive monetary compensation and for the occupiers to receive titles. Eight of the thirteen owners of the land accepted the government's compensation offer and their tracts were titled over to the squatters in 1989. The other five tract owners contested the expropriation in court, and their cases got bogged down in the slow Argentinian courts. Squatters occupying the tracts being contested in court did not receive titles thereby setting up a natural experiment comparing their housing investment to that of occupiers who received titles in 1989. Galiani and Schargrodsky are careful to demonstrate that there were no systematic differences that might have affected housing investment among the squatters "treated" with titles and those who remained "untreated."

on their sheets, the instructor then asks students with and without titles to indicate their housing investment choice and records the results on the board. Note that students may now fall into four categories: people with titles who purchase houses, people with titles who choose shacks, people with no titles who choose houses, and people with no titles who choose shacks. In our experience, most of the students with land titles will choose houses while most those without titles will continue to choose shacks.

At this point, the instructor tosses the coin to determine students' returns in round two. (Again, for variation in student outcomes we recommend coin tosses for individual students or for different areas in the classroom.) As before, students without titles can reap 100% gains or losses. However, students with titles cannot lose their dwellings so they reap a 100% reward regardless of the coin toss. Once again the instructor pays out winnings based on the coin toss and asks students to record their gains/losses on their tally sheet.

At this point, another round of envelopes is distributed, with one-fourth having property titles and three-fourths containing notes saying that the recipient does not receive a title. Students must then decide on dwelling choice for round 3 with the instructor coming around the room to collect payments for new dwelling purchases or upgrades. The instructor asks for a show of hands about students' choice of housing and records the results on the board. The instructor then conducts another coin toss, pays out any student winnings, and helps students record their earnings or losses on their tally sheets.

After three rounds, approximately one half of students should have property titles. In our experience a clear trend should have emerged at this point—students with titles tend to invest in houses, while students without titles choose shacks. This result parallels Galiani and Schargrodsky's finding that people with secure titles invest in larger and more expensive houses. However, instructors do have the option of conducting additional rounds of the exercise if they think that doing so will help students see the effect of titles on housing investment.

Although we have not conducted a controlled comparison of the learning that results from the experiment by, say, having one section of a course use the experiment while another section covers the same material in a traditional lecture format, our experience with the activity has been positive. Students have indicated, both informally and on evaluations at the conclusion of the term, that they found the experiment a useful way to engage with the course material and to solidify their understanding of the implications of property rights. Moreover, a colleague at another institution has used the exercise in one of her classes, reporting it as a "powerful learning tool" because several of her students referenced the activity in answering a relevant question on their final exam.

Teaching Tips

In this section, we offer a few tips that in our experience make the activity run more smoothly. First, it is helpful to explain to students that the experiment will consist of an unknown number of rounds but that they will have the opportunity to sell back their dwelling at the end of the activity. Thus, students should have no concerns about end-period behavior. (Relatedly, the table for recording gains and losses should have several more rows than the number of rounds that the instructor anticipates including in the game. When starting the fourth round of the activity, we once had a student proclaim in class that that round had to be last since there were no more rows on the sheet.)

Second, paying out student winnings and taking student payments for dwellings is somewhat time intensive for the instructor so, as noted above, the exercise probably works best in classes smaller than 30. In order to expedite matters, instructors might want to have a teaching assistant or a colleague help with the activity. Alternatively, instructors might have their students play in groups rather than as individuals. On the other hand, having fewer than 10 participants (or groups) may make it difficult to see the pattern of behavior in response to receiving a property title.

Third, in our experience the cost of the activity is about $2 per student. An alternative that would reduce the cost would be running the experiment using dimes rather than quarters (an initial endowment of four dimes with shacks costing $0.10 and houses costing $0.20). Another option is to frame returns in terms of extra credit points, and use "tokens' that students can redeem for small amounts of points on an upcoming assignment or exam in lieu of cash (we have found that sometimes extra credit is a particularly strong incentive!).

Conclusion

The classroom property title experiment described above provides a new method by which instructors can convey the mechanisms by which property titling affects investment. It also provides a new avenue for "active learning" in the economics classroom, which has been associated with increased student engagement and prolonged retention of higher-order economic concepts. We hope that, in doing so, this experiment will serve as a useful tool for economics educators in both introductory and advanced undergraduate classrooms.

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Appendix: Student Directions and Worksheet

You are all citizens of Econland, who have each been given an initial endowment (*E*) of 4 quarters (or $1) with which to invest in property. You can choose to build a shack for 1 quarter ($^1/_4E$), or a house for 2 quarters (½*E*), but you must build a place to live (no moving back in with your parents!).

Unfortunately, you will start out as a squatter in Econland, which means that you do not have a formal title to your chosen dwelling in the first round of the game. Since property rights are insecure in Econland, there is a probability each round that your dwelling will be confiscated by the government if you do not have a formal title. Specifically, your potential returns on your investment are as follows:

Probability	Return
50%	0, Lose Dwelling
50%	1x Investment

If you choose to do so, you can "upgrade" to a house from a shack at the beginning of each round by paying the additional ¼ *E* cost, but you may not "downgrade" once you have chosen your dwelling (i.e. – investments are irreversible). At the end of the last round, you may sell back your investment (if it has not been confiscated) for the amount that you paid for it.

Keep track of your investments and returns each round of the game below:

	Title?	Investment Choice (House or Shack)	Lose Dwelling?	Return	Total of Earnings So Far
Round 1	No				
Round 2					
Round 3					
Round 4					

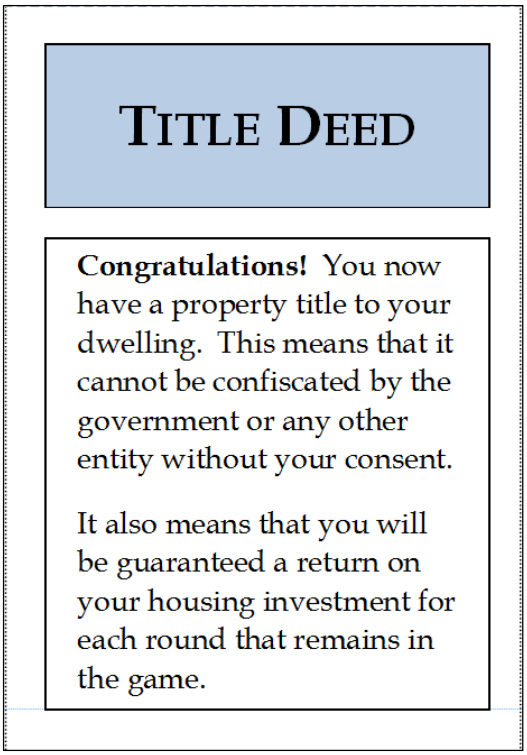
"Debriefing" Questions to Ponder:

What happened when the professor changed the "rules" of the game? How did your behavior change? Why?

Which of the session participants earned the highest returns on their investments? Why do you think that is?

What might this imply about property titles and investment, especially in developing countries?

Appendix Figure 2 - Sample Title Deed Card



Appendix Figure 3 - Sample Card for No Title

Bond Duration: Constructivist Learning Using Excel

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Abstract

Duration is significant in that it summarizes a bond or a portfolio's sensitivity to interest rates. Based on the constructivist learning approach, we propose an Excel-based assignment that encourages student interaction and active learning which leads to individual discovery regarding the properties of bonds and their effects on duration. Students receive immediate feedback by constructing dynamic Excel tables and figures to calculate duration for bonds with various maturity terms, coupon rates, yields to maturity, and frequencies of coupon payments. The constructivist approach to teaching bond duration is valuable because it requires students to actively acquire and construct knowledge.

Keywords: Duration, Finance Education, Computer Modeling, Microsoft Excel©

Introduction

Macaulay (1938) developed the formula for the effective or average maturity of a bond's cash flows. He termed this concept *duration*. Macaulay's duration is the only type of formula that calculates the number of years needed to regain the investment in a bond. Macaulay's duration provides two primary benefits to investors. First, duration allows investors to compare bonds of different coupon rates and maturities. Second, portfolio managers can use the weighted average duration of a bond portfolio to quickly determine required portfolio adjustments that should be made in response to expected interest rate changes.

The duration formula allows us to calculate a measure that represents the effects of interest rate sensitivity. The major determinants of interest rate sensitivity are described by Malkiel's (1962) five bond-pricing relationships. Homer and Liebowitz (1972) added a sixth observation regarding the relationship between yield to maturity and interest rate sensitivity. The properties of duration, which are natural extensions of bond-pricing relationships (Malkiel, 1962; Homer and Liebowitz, 1972), are simply presented as figures and tables that students typically memorize. Further, the calculation of duration is often taught in traditional classroom settings with sample problems that involve shorter bond maturities in order to save class time. Realizing this limitation, we propose that educators can use Excel in an interactive lab setting. By adopting this method, students can produce for themselves the calculation of longer duration problems and the properties of duration.

This paper presents an Excel-based bond duration assignment that results in two primary educational benefits for students. First, constructivist learning is utilized by requiring the use of Excel to create a dynamic duration calculation table (Malkiel, 1962). Once the table is created, students can quickly compute the duration of bonds with different maturity dates and frequency of coupon payments, including zero coupon bonds. This technique results in a more engaging learning process for a difficult and lengthy formula. Students are taught how to use data tables to instantly observe and reflect on how differing maturity terms, coupon rates, yields to maturity, and frequencies of coupon payments affect duration. Second, this assignment enables students to learn how to use Excel more professionally. Given the competitiveness nature of the job market, students will be able to demonstrate more "hard skills" to prospective employers.

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Motivation

Studies have shown that effective learning come from interactions between the educator and the students or among the students, which involve interactive activities and assignments (Rovai, 2004; Tynjala, 1998). This approach is known as the "constructivist" learning approach where knowledge is acquired and constructed by the students, resulting in the feelings of empowerment and self-control (Boethel and Dimock, 1999; Maddux, Johnson, and Willis, 1997).

The constructivist learning approach is different from the traditional classroom setting because it encourages students to actively ask questions and seek answers. Tynjala (1998) conducted a study on the learning outcomes between a constructivist class and a traditional class, and found that the students in the constructivist class reported higher level learning outcomes. Clements and Battista (1990) proposed that constructivist leaning is different in five different ways. First, knowledge is actively created by the students. Second, students create new knowledge by reflecting on their own ideas. Third, students are only able to learn in a way that makes sense in their own world. Fourth, learning is a social process. Finally, students can use their own sense making to enable learning.

Hence, an important motivation for this spreadsheet-based assignment is that Excel enhances concept retention as an alternative and more engaging learning opportunity, thus enabling constructivist leaning. For instance, Hess (2005) advocates the "hands-on" use of spreadsheet modeling in the classroom to improve understanding, retention, and employability. Further, some surveys suggested that finance faculty and business schools are motivated to use more technology in the classroom to prepare students for the workforce (Bailey and Heck, 2002; Gitman and Vandenberg, 2003).

Prior experience using Excel-based assignments in upper-level finance course found that students understood lectures and complicated formulas better afterwards. Students also demonstrated more confidence and empowerment after completing Excel assignments. These results are consistent with those of Ghani and D'Mello (1993). This study reported student feelings of increased self-competence and self-actualization after completing an excel-based finance problem.

Another important motivation for this teaching tool is that companies expect workers to know how to use Excel and other basic digital skills (Weber, 2015). Burning Glass Technologies recently review millions of job postings and reported that sixty-seven percent of middle-skill jobs require Excel proficiency and other basic technology skills. Further, jobs that demand "basic digital skills tend to pay 13% more than jobs that require no digital chops: median pay of $22.66 per hour versus $20.14 per hour" (Weber, 2015). This is consistent with the speculation of Holden and Womack (2000) who believe that there are no current finance jobs that would not require the regular use of Excel. Angeles (2014) obtained this quote from Bob Myhal, CEO of NextHire:

"Having well-developed technical skills is no longer just a nice little add-on for job applicants. Many employers now expect candidates to demonstrate proficiency in a variety of technical areas. Currently, [one of the] most sought-after tech skills is competency with Microsoft Excel"

There is a strong need for universities to incorporate Excel in the classroom. The lack of Excel knowledge seems to affect students of all pedigrees. For example, even extremely qualified graduates who secure highly coveted jobs on Wall Street are deficient in basic spreadsheet building (Browning, 2013). Until universities offer such training, firms like Goldman Sachs and the Blackstone Group send new recruits to high cost Excel modeling and financial analysis classes from companies such as Wall Street Prep and Training the Street (Browning, 2013).

Given that investment firms highly value job candidates that can use Excel to conduct financial modeling and analyses, there is no reason why educators should not use Excel in a finance course. Specifically, we believe that using Excel to teach students bond duration will improve a student's placement opportunity in the job market. In short, Excel-based assignments encourages interactive learning and enhance a student's job skills.

Spreadsheet Construction

$$D = \frac{\sum_{n=1}^{N} n(CF_n)(1+r)^{-n}}{P_b} \quad (1)$$

Where:

CF_t = Cash Flow at time t

N = Number of Periods
r = Yield to Maturity
P_b = Bond Price

Duration calculation and duration properties are first introduced and demonstrated during a regular lecture. Exhibit 1 shows the duration questions and original data. At the top of the assignment, there are "notes" that instruct students how to interact with different cell colors in the assignment.

Exhibit 1. Duration Questions and Original Data

	B	C	D	E	F	G	H	I
1	NAME:							
2					NOTES:	Type raw data in these cells		
3		Duration Assignment				Input Excel calculations or functions in these cells		
4						Input final answer calculations in these cells		
5								
6		1. Calculate the duration of a 7%, $1,000 par bond maturing in 20 years if the yield to maturity is 6% and interest is paid semi-annually.						
7		1.a Compute the price of the bond.						
8		Instuctions : In Part 1 use nested IF functions to produce the word Annual, Semi-Annual, or Quarterly using the number of compounding periods per year. In Parts 3 through 6, use nested IF functions to compute the adjusted input number for computing the answers. In Part 7, calculate the price of the bond.						
9		1.b Create a duration table that demonstrates the calculation of the NPV portion of duration. This is the numerator in the Duration equation.						
10		Instructions: (Hint: Use the dummy variable in Column 0 to achieve the following results when needed.) In Column 2, use cell referencing to schedule the correct payments to appear for the length of the bond's adjusted maturity. In Column 3, write a formula that causes the principal repayment to occur only once, at the bond's adjusted maturity. Column 4 and 5 are self-explanatory. Finally, make sure the the Net Present Value (NPV) calculation references the entirety of Column 5.						
11		1.c Calculate the annual duration.						
12		Instructions: Make sure the you write the formula in the green answer cell that represents annual duration.						
13		2. Demonstrate the relationships between duration and maturity, coupon rate, yield to maturity, and frequency of compounding.						
14		Instructions: To create a data table, first set the top yellow cell under the word "Duration" equal to the final duration answer in Question 1.c. Then highlight this cell and the cell to the left and then downward to the bottom of the Data Table. Next, go to the "Data" tab under the "What-If Analysis drop down menu in Excel. Since only the numbers in the left column are changing, click on the "column input" choice and cell reference the original (adjusted) data item created in Question 1.a. For each part of Question 2, fill in the correct word of either "Direct" or "Inverse" on the graph based upon the relationship you observe.						
15		2.a Create a data table that demonstrates the relationship between duration and time to maturity. Show how the relationship increases at a decreasing rate using the "Delta" Column.						
16		2.b Create a data table that demonstrates the relationship between duration and coupon rate.						
17		2.c Create a data table that demonstrates the relationship between duration and yield to maturity.						
18		2.d Create a data table that demonstrates the relationship between duration and the frequency of coupon						

Students must take the numerical data from the question and type the data in the designated orange-shaded cells. Question "1.a" asks for the current price of the bond. Question "1.b" asks students to create a table that calculates the duration for either an annual, a semi-annual, or a quarterly bond that has a maximum maturity of 30 years. Question "1.c" asks students to calculate the duration for the bond mentioned in Question 1. Students must solve for parts "1.a" through "1.b" before solving Question "1.c." These separate parts allow the educator to quickly assist students by identifying a cell where a referencing or syntax error has occurred. All yellow-shaded areas must have formulas that

consist of cell references to the hard-coded numerical data. This requirement allows the final answer, "1.c," to dynamically change if the student desires to see the effect of altering the original data assumptions.

The next purpose of the assignment is that students generate the implied relationships of the properties of duration in Excel. Question 2 parts "a" through "c" address these well-known properties which are discussed in *Essentials of Investments* (Bodie, Kane, & Marcus, 2013). Question "2.d" adds an additional property related to the effect of the frequency of coupon payments on duration. First, there is a direct relationship between duration and time to maturity. All else equal, as the time to maturity increases (decreases), duration increases (decreases). Second, there is an inverse relationship between duration and the coupon rate. All else equal, as the coupon rate increases (decreases), duration decreases (increases). Third, there is an inverse relationship between duration and yield to maturity. All else equal, as the yield to maturity increases (decreases), duration decreases (increases). Finally, there is an inverse relationship between duration and the frequency of coupon payments. All else equal, as the frequency of coupon payments increases (decreases), duration decreases (increases). These relationships are summarized in Table 1.

Table 1. Properties of Duration

All else equal, if this variable is larger	Then duration is
Maturity Term	Larger
Coupon Rate	Smaller
Yield to Maturity	Smaller
Frequency of Coupon Payments	Smaller

As stated before, the Excel spreadsheet has been designed to handle annual, semi-annual, and quarterly compounding. Therefore, it is necessary to examine the details of each question to see the flexibility of the spreadsheet design. Question "1.a" instructs students to calculate the price of the semi-annual bond. Exhibit 2 demonstrates the student view of the assignment. You can see the different colored cells that help the student determine if data entry, Excel functions and formulas, or the final answer is required. Also, the final calculated duration answer will appear once students complete Questions "1.a" to "1.c" so that students receive immediate feedback when changing the bond parameters for future duration exploration.

Exhibit 2. Student View of Question "1.a"

	F	G	H	
20	Input:	Data:	Adjusted data:	Part
21	Compounding periods per			1
22	Coupon %			2
23	FV			3
24	PMT			4
25	N			5
26	I			6
27	PV			7
28	Duration		0.00	8

Exhibit 3 demonstrates the answers to Question "1.a" in the assignment. Notice that a 2 is entered in the first orange cell because the bond makes semi-annual payments. The "Adjusted data" column is needed for dynamic calculations when bond interest is compounded semi-annually or quarterly. There is also a cell that simply requires the student to enter the number "1." This cell is needed as a seed number to begin Question "2.a" which requires the student to construct a flexible duration calculation table. The green numerical cell contains the final answer for this part of the question.

Exhibit 3. Numerical Answers to Question "1.a"

	F	G	H	I
20	**Input:**	**Data:**	**Adjusted data:**	**Part**
21	**Compounding periods per year**	2	Semi-annual	1
22	**Coupon %**	7.00%	3.50%	2
23	**FV**	$1,000.00	$1,000.00	3
24	**PMT**	$70.00	$35.00	4
25	**N**	20	40	5
26	**I**	6.00%	3.00%	6
27	**PV**		**$1,115.57**	7
28	**Duration**		**11.53**	8

Exhibit 4 demonstrates the cell formulas required to answer Question "1.a." The "Data" column requires students to enter the bond's frequency of coupon payments, coupon rate, future value, payment, number of periods, and interest rate (YTM). The only exception to the "Data" column is that students must calculate the payment for the bond by multiplying the coupon rate and the par value. This is noted by the yellow cell shading. Additionally, the number of periods ("N") is restricted to accepting whole numbers between 1 and 30 due to the constraints in the duration table. Students will receive a pop-up message about this restriction. In the "Adjusted Data" column, students must then use nested Excel IF functions to calculate data that must be adjusted based upon the frequency of coupon payments entered into its corresponding orange-shaded cell. The only exception is that the par value ("FV") remains the same in both columns so the student just sets this "Data" column cell equal to the "Adjusted Data" column cell.

In Part 1, students must first enter the frequency of coupon payments per year. If the bond is annual, semi-annual, or quarterly, then the student enters "1," "2," or "4," respectively. In the "Adjusted Data" column, students will create their first nested IF functions. Students may need help with this concept at first. The nested IF functions requires students to cause Excel to display the word "Annual," Semi-annual," "Quarterly," or "error" based upon the entered frequency of coupon payments. The word "error" is programmed as a self-check measure and will show up if a student does not enter a "1," "2," or "4.

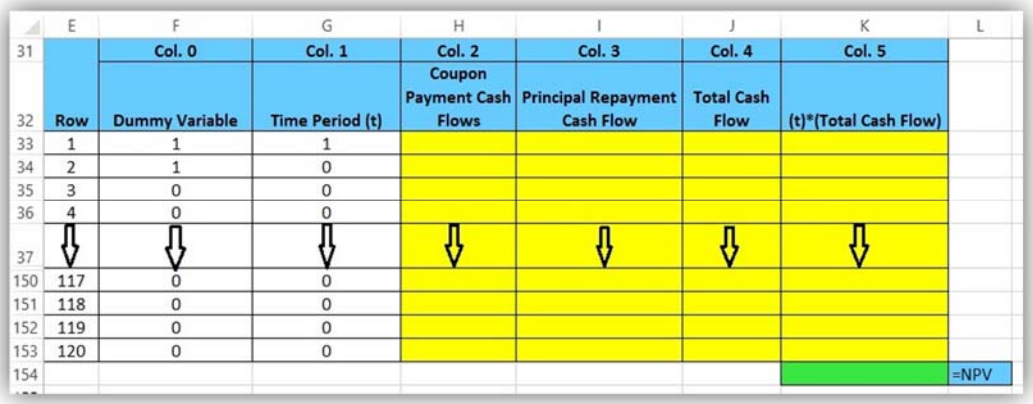
The "Adjusted Data" column also requires students to use nested IF functions to calculate any adjustments to the "Coupon %," "PMT" (coupon payment), "N" (number of compounding periods), and "I" (yield to maturity). "PMT" and "I" are adjusted using the nested IF functions by dividing the payment and yield to maturity by "2" or "4" if the coupon is paid semi-annual or quarterly, respectively. The maturity term, "N," must be adjusted by the nested IF functions by multiplying the number of compounding periods by "2" or "4" if the payment is semi-annual or quarterly, respectively. Again, the "FV" (future value) remains the same in the "Adjusted data" column. Finally, the bond price is computed in the green-shaded cell using the Excel PV function which calculates the bond's present value.

Exhibit 4. Cell Formula answers to Question "1.a"

	F	G	H	I
20	**Input:**	**Data:**	**Adjusted data:**	**Part**
21	**Compounding periods per year**	2	=IF($G$21=1,"Annual",IF($G$21=2,"Semi-annual",(IF($G$21=4,"Quarterly","error"))))	1
22	**Coupon %**	0.07	=IF($G$21=1,G22,IF($G$21=2,(G22/2),(IF($G$21=4,(G22/4),"error"))))	2
23	**FV**	1000	=G23	3
24	**PMT**	=G23*G22	=IF($G$21=1,G24,IF($G$21=2,(G24/2),(IF($G$21=4,(G24/4),"error"))))	4
25	**N**	20	=IF($G$21=1,G25,IF($G$21=2,(G25*2),(IF($G$21=4,(G25*4),"error"))))	5
26	**I**	0.06	=IF($G$21=1,G26,IF($G$21=2,(G26/2),(IF($G$21=4,(G26/4),"error"))))	6
27	**PV**		**=-PV(H26,H25,H24,H23)**	7
28	**Duration**		**=H157**	8

Question "1.b" instructs students to create a dynamic duration table. This means that students must use logic-based cell referencing to allow the parameters of Question 1 to change and calculate a 1 year annual bond duration, a quarterly 30 year bond duration, or any other combination of bond input variables. The number of rows in the duration computation table equals 120 (four times thirty years) which enables students to calculate the table's maximum duration capability (i.e., a quarterly 30 year bond). Exhibit 5 demonstrates a shortened student view of the assignment.

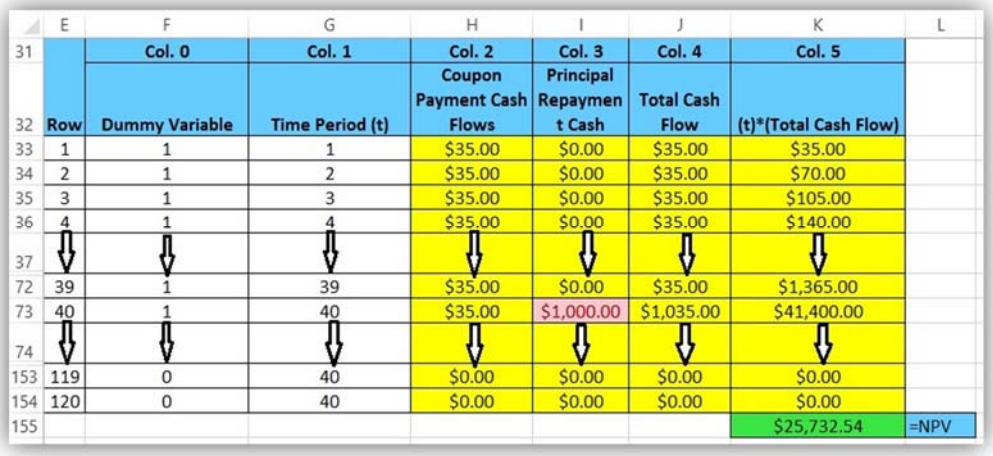
Exhibit 5. Student View of Question "1.b"



	E	F	G	H	I	J	K	L
31		Col. 0	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	
32	Row	Dummy Variable	Time Period (t)	Coupon Payment Cash Flows	Principal Repayment Cash Flow	Total Cash Flow	(t)*(Total Cash Flow)	
33	1	1	1					
34	2	1	0					
35	3	0	0					
36	4	0	0					
37	⇩	⇩	⇩	⇩	⇩	⇩	⇩	
150	117	0	0					
151	118	0	0					
152	119	0	0					
153	120	0	0					
154								=NPV

Exhibit 6 demonstrates the answers to Question "1.b" in the assignment. The green numerical cell contains the final answer for this section of the question. In Column 1 Row 40, the sequential numbering has been programmed by the instructor to stop at 40 because this example is a 20 year semi-annual bond (40 = 2 x 20). In Column 3 row 40, the principal repayment of $1,000 has been programmed by the student to populate the cell when the life of the bond is over. The cell that contains the $1,000 becomes conditionally formatted with pink shading and red text to help the student locate the occurrence. Notice that the Dummy Variable in Column 0 changed from a one to a zero. The last row, row 120, has the final NPV computed, which is needed in the numerator portion of the duration equation. Also, notice that all of the rows after row 40 have a zero in Column 5 in order to calculate the correct NPV.

Exhibit 6. Numerical Answers to Question "1.b"



	E	F	G	H	I	J	K	L
31		Col. 0	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	
32	Row	Dummy Variable	Time Period (t)	Coupon Payment Cash Flows	Principal Repayment Cash	Total Cash Flow	(t)*(Total Cash Flow)	
33	1	1	1	$35.00	$0.00	$35.00	$35.00	
34	2	1	2	$35.00	$0.00	$35.00	$70.00	
35	3	1	3	$35.00	$0.00	$35.00	$105.00	
36	4	1	4	$35.00	$0.00	$35.00	$140.00	
37	⇩	⇩	⇩	⇩	⇩	⇩	⇩	
72	39	1	39	$35.00	$0.00	$35.00	$1,365.00	
73	40	1	40	$35.00	$1,000.00	$1,035.00	$41,400.00	
74	⇩	⇩	⇩	⇩	⇩	⇩	⇩	
153	119	0	40	$0.00	$0.00	$0.00	$0.00	
154	120	0	40	$0.00	$0.00	$0.00	$0.00	
155							$25,732.54	=NPV

Exhibit 7 demonstrates the cell formulas required to answer Question "1.b." The correct cell referencing required in Question "1.b" is necessary to answer Questions "1.c" and each part of Question 2. The instructor will need to provide guidance for this table and the following questions. The instructor should provide the formulas needed for Column 0 and Column 1 so that students do not feel overwhelmed with the complexity of the table. The instructor can explain the formulas in Column 0 as follows. Column 0 represents a Dummy Variable of zero or one based upon the value in Column 1. Notice that Row 1 is set to equal the value of 1 which was entered as the seed number in Question "1.a." In Column 2 and Column 3, the Dummy Variable is used to multiply the Cash Flow or Principal Repayment by either a one or zero. The Dummy Variable turns to 0 after the table reaches the time to maturity for the bond in question. In this example, for a semiannual 20 year bond (40 semiannual periods), the dummy variable will turn to zero at Row 41, which causes the table to have zeros in Columns 2 and 3. The zeros will occur to the end of the table. Further, this creates zeros in Column 4 which cause zeros to occur in Column 5 and the correct NPV to be calculated

at the end, in Row 120. The reason why the dummy variable turns to zero at Row 41 is based upon the formulas in Column 1.

Exhibit 7. Cell Formula answers to Question "1.b"

	E	F	G	H	I	J	K	L
31		Col. 0	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	
32	Row	Dummy Variable	Time Period (t)	Payment Cash Flows	Principal Repayment Cash Flow	Total Cash Flow	(t)*(Total Cash Flow)	
33	1	1	1	=$H$24*F33	=IF(G33=$H$25,$H$23,0)*F33	=H33+I33	=G33*J33	
34	2	=IF(G34=G33,0,1)	=IF($H$25>(G33+1),G33+1,$H$25)	=$H$24*F34	=IF(G34=$H$25,$H$23,0)*F34	=H34+I34	=G34*J34	
35	3	=IF(G35=G34,0,1)	=IF($H$25>(G34+1),G34+1,$H$25)	=$H$24*F35	=IF(G35=$H$25,$H$23,0)*F35	=H35+I35	=G35*J35	
36	4	=IF(G36=G35,0,1)	=IF($H$25>(G35+1),G35+1,$H$25)	=$H$24*F36	=IF(G36=$H$25,$H$23,0)*F36	=H36+I36	=G36*J36	
151	119	=IF(G151=G150,0,1)	=IF($H$25>(G150+1),G150+1,$H$25)	=$H$24*F151	=IF(G151=$H$25,$H$23,0)*F151	=H151+I151	=G151*J151	
152	120	=IF(G152=G151,0,1)	=IF($H$25>(G151+1),G151+1,$H$25)	=$H$24*F152	=IF(G152=$H$25,$H$23,0)*F152	=H152+I152	=G152*J152	
153							=NPV(H26,K33:K152)	=NPV

The purpose of Column 1 is to create a sequence of numbers that count upwards to the time to maturity for the bond. In this example, we want this column to read: 1, 2, 3,...,38, 39, 40. After the number 40 is reached, the instructor programmed the remaining cells in Column 1 to repeat the number 40. This may seem like an undesired result, but this allows the Column 0 Dummy Variable to change from a one to a zero after Column 1 reaches 40. Column 1 states that if cell $H$25 (the adjusted N which equals 40) is greater than the previous cell plus one, then enter the value of the previous cell plus one. Otherwise the cell function enters 40 when the sequence of numbers has reached the correct value of 40. Then, notice the cell function in Column 0 which states that if the current cell value equals the previous cell value, then a zero is recorded in the cell. Otherwise, if the current cell value does not equal the previous cell value, then a 1 is recorded in the cell. This creates the desired effect of switching the dummy variable to zero when the time to maturity has been reached.

The student enters logic based cell references and functions in Columns 2 through 5 to calculate the numerator portion of the duration equation. In Column 2, the desired outcome is a column of forty $35 semiannual payments. After 40 payments have been reached, the remaining cells in the column should show a value of $0. This can be accomplished simply by cell referencing the $35 payment and multiplying it by the Column 0 dummy variable. Therefore, the payment of $35 will be recorded only for the length of the bond maturity.

In Column 3 the student needs the $1,000 repayment of principal to occur once at the time to maturity for the bond. In other words, every Row except for Row 40 needs to contain a zero. Also, we want the table to be dynamic and account for differing maturities of bonds. This is needed later in Question 2. Therefore, the student can use the IF function again. The IF function can be conditioned upon the value in Column 1. The IF function should state that if the Column 1 value is equal to the time to maturity (N = 40), then record the principal repayment of $1000, otherwise record $0. This is where the students will see that they need to multiply the results of this IF function by the Column 0 dummy variable. If they do not utilize the Column 0 dummy variable, then the $1000 principal repayment will continue to the end of the table and create the wrong answer. The reason why this occurs is due to the continuance of a "40" value in Column 1 after the maturity has been reached. This is one of the critical reasons for creating the dummy variable in Column 0. The Column 0 dummy variable can override the Column 1 maturity value if the student multiplies the dummy variable times the IF function needed in Column 3.

The calculations for Column 4, Column 5, and the Net Present Value are very straightforward. Column 4 contains the sum of Column 2 and Column 3. In other words, the students sum the semiannual bond payment column with the principal repayment column. Column 5 is equal to the time period (Column 1) multiplied by the result in Column 4. Finally, in Row 120, the students utilizes the NPV function to calculate the final number needed in the numerator of the Duration equation. The student should make sure that all of the cash flows from Column 5 are referenced as shown in Exhibit 7.

Question "1.c" instructs students to perform the final duration calculation. The following three screenshots in Exhibits 8, 9, and 10 illustrate the student view, numerical answers, and cell formulas for this question. Exhibit 8 demonstrates the student view of the assignment. The first row asks the students to calculate an unadjusted duration in the yellow cell. There is a "0" in the top left cell which is pre-referenced by the instructor to the text box completed in Question "1.a" cell H19. In this example, the students have programmed this cell to display the word "Semi-annual." This will give the students a hint that they have first calculated the semi-annual duration value and must convert this into an annual duration value. Exhibit 9 reveals the answers to Question "1.c." As shown in Exhibit 10, students will divide the Net Present Value answer obtained in Question "1.b" by the present value of the bond found in Question "1.a." This is the semi-annual duration. Therefore, the student will have to adjust this calculation based upon the

frequency of the coupon payments in order to obtain an annual duration required in the green final answer cell as shown in Exhibit 10.

Exhibit 8. Student View of Question "1.c"

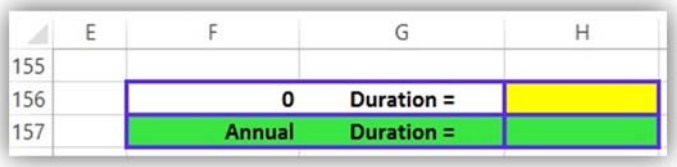


Exhibit 9. Numerical Answers to Question "1.c"

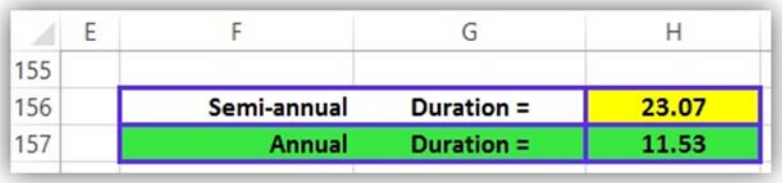


Exhibit 10. Cell Formula answers to Question "1.c"

Question 2 asks students to create data tables to display four properties of bond duration. Therefore, there are four data tables that will allow the student to observe and interact with the relationships described in Table 1. Due to the creation of the flexible duration calculation in Question 1, the students can now quickly learn about the results of changing the time to maturity, coupon rate, yield to maturity, and frequency of coupon payments. Additionally, graphs are generated for each property that display the effects on duration to provide immediate visual feedback.

Exhibits 12, 13, 14 and 15 illustrate the data tables and graphs which represent the answers to Question 2 parts "a," "b," "c," and "d." The Excel data table feature is found on the "Data" tab under the "What-If Analysis" drop down menu. Since only column information varies per table, the "column input" choice is used within the data table feature. Therefore, Exhibit 11 illustrates the instructions provided for students to construct the data table portion in question "2.a." Also, note that the graph contains a fill-in-the-blank portion for students to type in either "Direct" or "Inverse" to describe the relationship between duration and particular bond features.

Exhibit 12 illustrates the direct relationship between duration and time to maturity. Students obtain the instant feedback using the "Data Table" feature in Excel. The graph demonstrates that as time to maturity increases, duration increases. Therefore, if interest rates were expected to fall, portfolio managers would desire bonds with longer time to maturity to maximize their gains. Likewise, if interest rates were expected to rise, portfolio managers would choose bonds with shorter time to maturity to minimize their losses. Also, the "Delta" calculation in the graph illustrates that bond duration sensitivity to time to maturity increases at a decreasing rate.

Exhibit 13 illustrates the inverse relationship between duration and the coupon rate. The graph demonstrates that as the coupon rate increases, duration decreases. Therefore, if interest rates were expected to fall, portfolio managers would desire bonds with lower coupon rates to maximize their gains. Likewise, if interest rates were expected to rise, portfolio managers would choose bonds with higher coupon rates to minimize their losses.

Exhibit 14 illustrates the inverse relationship between duration and yield to maturity. The graph demonstrates that as yield to maturity increases, duration decreases. Therefore, if interest rates were expected to fall, portfolio managers would desire bonds with lower yields to maturity to maximize their gains. Likewise, if interest rates were expected to rise, portfolio managers would choose bonds with higher yields to maturity to minimize their losses.

Exhibit 11. Data Table Illustration for Question "2.a"

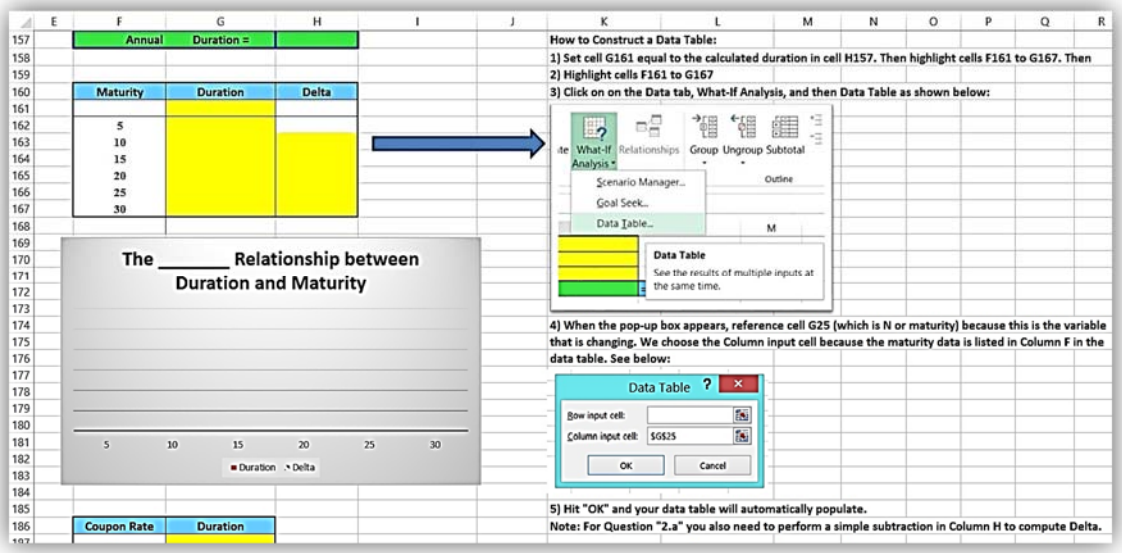


Exhibit 12. Question "2.a": The Relationship between Duration and Time to Maturity

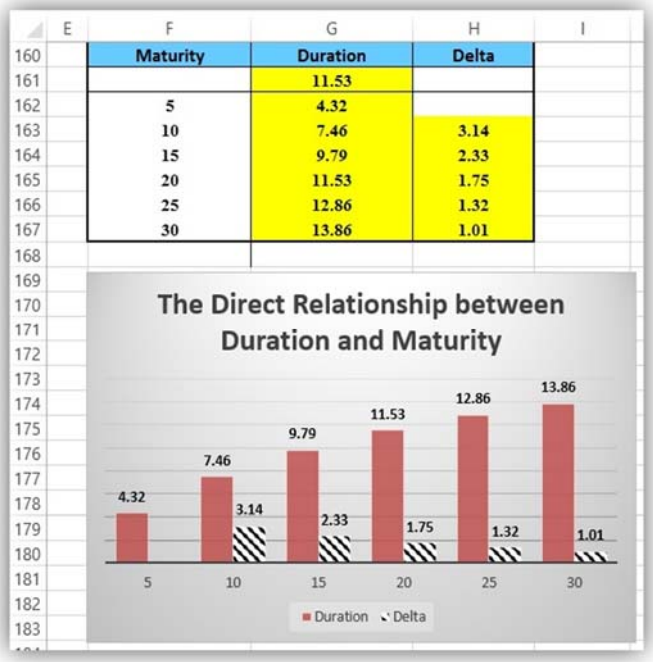


Exhibit 13. Question "2.b": The Relationship between Duration and the Coupon Rate

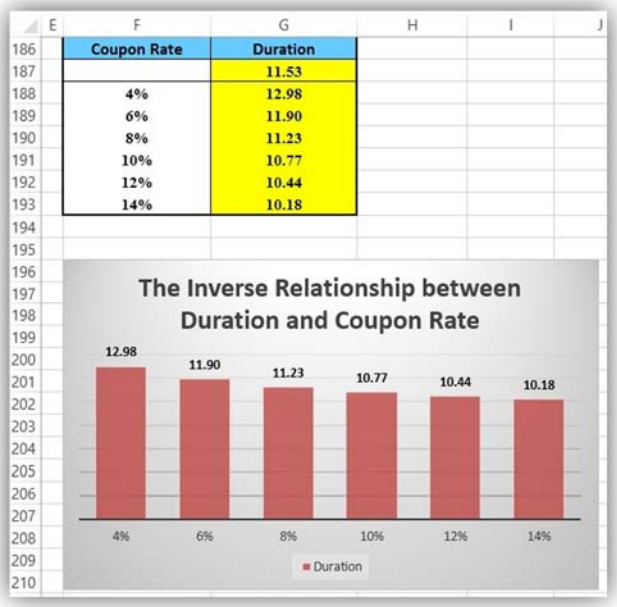


Exhibit 14. Question "2.c": The Relationship between Duration and Yield to Maturity

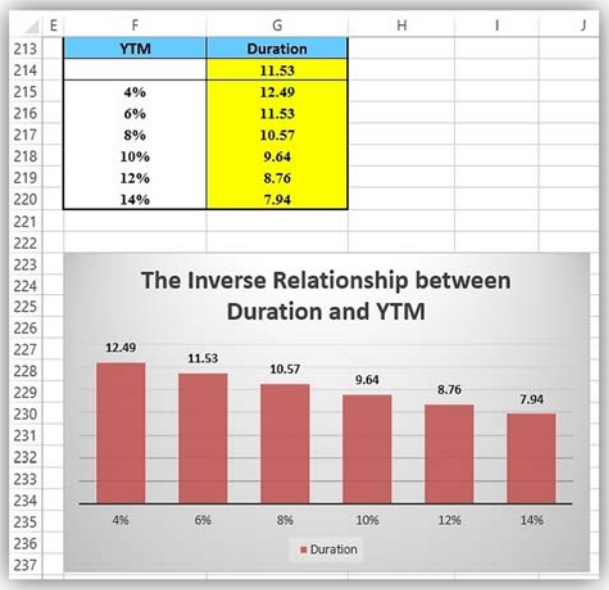
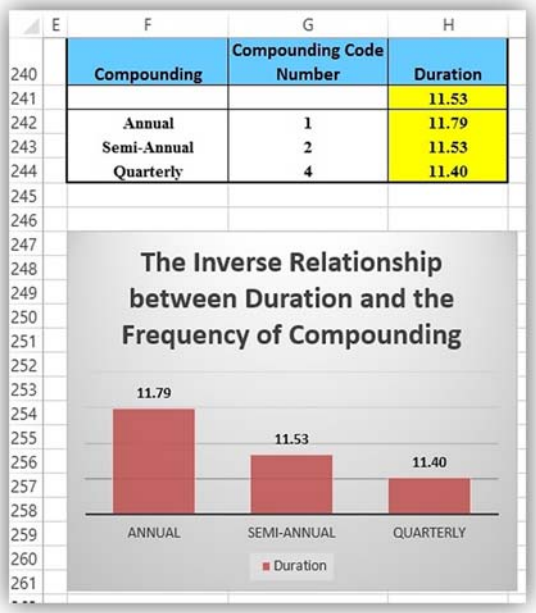


Exhibit 15 illustrates the inverse relationship between duration and the frequency of coupon payments. The graph demonstrates that as the frequency of coupon payments increases, duration decreases. Therefore, if interest rates were expected to fall, portfolio managers would desire bonds with lower compounding frequencies to maximize their gains. Likewise, if interest rates were expected to rise, portfolio managers would choose bonds with higher compounding frequencies to minimize their losses.

Exhibit 15. Question "2.d": The Relationship between Duration and the Frequency of Coupon Payments



The next step involves creating a simple macro function called "CellFormula" that aids the instructor in grading by revealing the actual cell formulas created by students (Wann, 2015; ExtendOffice, 2014). Since the data tables depend upon the correct construction of the duration table, it is sufficient to only check the data table formulas and answers. A separate tab in the Excel file is created and contains an answer key for formulas and numerical answers. Exhibit 16 demonstrates the results of using the "CellFormula" macro. Notice that across each row in Column B and Column C of the answer key the same cell reference such as "G162" on the "Duration Worksheet" tab is used. However, the function used in Column B is "CellFormula" and shows the instructor the formula created by the student to complete the question. In Column C just the numerical value of the cell is referenced so the instructor can check the numerical answer obtained by the student.

There is an additional column called "Is the answer correct?" This column provides a quick way for the instructor to check if the numerical answers obtained by the student are equal to the correct answers. If these two numbers are equal, then the message "Correct" displays. If the answer is wrong, then the message "WRONG" is displayed. This useful to both the student and the instructor. By providing the correct answers, students can verify if they have done the problem correctly. Also, instructors can quickly check the numerical answers and then focus on checking the cell formulas used to obtain the answer.

Exhibit 16. Demonstration of "CellFormula" References in Student Answer Key Tab

	A	B	C	D	E
1		NAME:_____			
2		Formulas	Student Answer	Correct Answer	Is the answer correct?
3	2.a	=CellFormula('Duration Worksheet'!G162)	='Duration Worksheet'!G162	4.320862763023	=IF(ROUND(C3,7)=ROUND(D3,7),"Correct","WRONG")
4		=CellFormula('Duration Worksheet'!G163)	='Duration Worksheet'!G163	7.461079755848	=IF(ROUND(C4,7)=ROUND(D4,7),"Correct","WRONG")
5		=CellFormula('Duration Worksheet'!G164)	='Duration Worksheet'!G164	9.787440813850	=IF(ROUND(C5,7)=ROUND(D5,7),"Correct","WRONG")
6		=CellFormula('Duration Worksheet'!G165)	='Duration Worksheet'!G165	11.53331914757	=IF(ROUND(C6,7)=ROUND(D6,7),"Correct","WRONG")
7		=CellFormula('Duration Worksheet'!G166)	='Duration Worksheet'!G166	12.85506479151	=IF(ROUND(C7,7)=ROUND(D7,7),"Correct","WRONG")
8		=CellFormula('Duration Worksheet'!G167)	='Duration Worksheet'!G167	13.86159802591	=IF(ROUND(C8,7)=ROUND(D8,7),"Correct","WRONG")

Exhibit 17 shows what a correctly completed Excel answer key should look like. Most importantly, the instructor must check that there is a valid data table function in Column B. Otherwise, a student could enter the correct answers without really completing the assignment. Therefore, students cannot cheat by knowing the correct answer because of the "CellFormula" macro function. This check key reveals whether the student hard-coded the correct answer without creating the data table required by the question. For example, if a student hard-coded the answer "4.32" in the first

row of the data table for Question "2.a", then the number "4.32" would show up in the Formulas column. The instructor would immediately know that the student had not completed their assignment due to the lack of a Data Table function.

Exhibit 17. Sample Portion of a Correctly Completed Student Answer Key

	A	B	C	D	E
1		NAME:_____			
2		Formulas	Student Answer	Correct Answer	Is the answer correct?
3	2	=TABLE(,G25)	4.32	4.32	Correct
4		=TABLE(,G25)	7.46	7.46	Correct
5		=TABLE(,G25)	9.79	9.79	Correct
6		=TABLE(,G25)	11.53	11.53	Correct
7		=TABLE(,G25)	12.86	12.86	Correct
8		=TABLE(,G25)	13.86	13.86	Correct

Conclusion

This paper provides educators with a constructivist learning approach by implementing an Excel assignment to calculate duration and discover the properties of duration. The traditional classroom teaching approach for duration lacks the benefits of the constructivist approach. We propose using an Excel-based assignment because it requires students to create knowledge using logic-based formulas that enables students to instantly receive feedback regarding duration sensitivity to different coupon rates, time to maturities, yield to maturities and frequencies of coupon payments. Students can then evaluate which bond characteristics are desired based upon the current term structure of interest rates. Further, Excel skills are highly valued on the job market. Thus, teaching bond duration with Excel has many benefits. By following our approach, we believe that it will help educators to enhance student learning experiences and chances for job market success. The Excel file exhibited in this article may be requested by contacting the authors.

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Using the Automobile Lease to Illustrate Topics in Corporate Finance

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Abstract

Despite the growing popularity of consumer automobile leases, they remain poorly understood by many consumers. This teaching note describes a possible spreadsheet assignment based on an ordinary automobile lease advertisement. With careful analysis of the proposed lease, several important financial concepts are revealed, including: internal rate of return, net advantage to leasing, opportunity cost, sunk costs, liquidity, equivalent annual cost, crossover rate, and real option value. By using the familiar and relatable auto lease example, student engagement with the material is improved. The examples and associated problems given are suitable for intermediate-level students of managerial finance, personal finance, or capital budgeting.

Introduction

Leasing has played an increasingly important role in the financing of new-vehicle purchases in the United States. According to a report by J.D. Power Associates (2014), 26.5% of new vehicle purchases in the US in 2013 were financed with a lease. This was at the time the highest lease penetration rate on record, up from less than 17% only 5 years prior (Edmunds.com, 2014). Despite its popularity, though, the financial aspects of vehicle leasing remain poorly understood by many adults. Devaney and Bechman (1997) found that, although consumers generally expressed satisfaction with lease transactions, there was a need to assist consumers in better understanding "the terms used with leasing, the costs involved, the conditions of the lease, and how to compare one lease with another." More recently, several well-known consumer finance "experts" emphatically reject vehicle leasing altogether, seemingly unable or unwilling to recognize the possibility that leases may be a viable, cost-effective way to finance the acquisition of an automobile (Ramsey 2014, Orman 2014).

From a pedagogical perspective, the vehicle lease offers that are so widely promoted by automobile manufacturers provide relatable, real-world illustrations of several important financial concepts. The purpose of this teaching note is to describe how such a lease offer may be used as the basis for a corporate finance classroom assignment. This is beneficial in at least two ways: (1) the prospect of purchasing and financing a new car is often interesting and relevant to college students, and thus the exercise increases their level of engagement with the related finance topics, and (2) students become more informed consumers when entering the market for vehicles.

This paper presents an example assignment suitable for students of introductory or intermediate managerial finance, reproduced as Appendix I. The assignment is framed as a spreadsheet project, though the computations could easily be completed using a standard financial calculator. A spreadsheet containing proposed solutions appears as Appendix II. The project is based on a typical BMW lease promotion available at the time of this writing (BMW USA 2014). It would be a simple matter for instructors to create a new, novel assignment by merely attaching a different advertisement and making minor modifications to some of the questions.

Lessons from a consumer vehicle lease

At its core, any lease agreement can be described in terms of a handful of parameters: the *term* of the lease (typically a number of months), the *capitalized cost*, the *monthly payment* and the *residual value*. Taken together, these values provide a basis for judging the attractiveness of the lease. The interpretation of the *lease term* and

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monthly payment figures is obvious. The *capitalized cost* measures the amount of money being financed by the lease. The *residual value* is the price for which the lessee has the right (but not obligation) to purchase the vehicle at the end of the lease. Automobile lease agreements also specify a variety of other payment amounts, such as delivery charges, security deposits, sales tax, disposition fees, early termination fees, and excess mileage charges, to name a few. Part of the challenge of the exercise is for students to determine whether and how to incorporate these values into their calculations.

The lease rate (IRR)

One fundamental aspect of the vehicle lease that is sometimes overlooked by individuals with limited financial literacy is that leasing is simply an alternative method of financing the cost of an asset. While some consumers may believe that they can avoid paying interest by leasing rather than borrowing, nothing could be further from the truth. Students should be reminded that when they take possession of a car (or any asset) that they have not fully paid for, they are using someone else's capital, and that the provider of capital will be expecting to earn a rate of return on their investment.

Although any lease represents an investment of capital and carries a promised rate of return for the lessor, leasing companies generally do not describe the cost of funds implied by their offers in terms of a percentage. In fact, in the United States, the Consumer Leasing Act of 1976 prohibits lessors from using terms such as "annual lease rate" or "annual percentage rate" to describe the cost of funds embedded in an offer. Ironically, as pointed out by Nunnally and Plath (1989), this legislation, designed to inform consumers of the cost of leasing, actually hampers their ability to accurately compare financing options. Lessors may represent the lease rate to potential customers as a percentage, but at present there is no federal standard for the calculation of such a lease rate. Furthermore, any such representation must also acknowledge that the stated percentage may not represent the overall cost of financing (*Federal Reserve Bulletin* 1996).

What must be disclosed to lessees is the cost of the lease in the form of a "rent charge": the total amount paid by the lessee, minus the difference between the capitalized cost and the residual value. This is certainly a valid measure of the dollar cost of financing, but it's of limited use when comparing across a variety of offers, or comparing with the borrow-and-buy alternative. For example, suppose a proposed lease contains a rent charge of $1500; is that a good deal? The answer of course depends on the term of the lease, the capitalized cost, and the residual value. It also depends upon the financing alternatives available at the time.

Any student of finance should quickly recognize that for the purposes of comparing alternative financing arrangements, it's best to express financing costs in terms of an annualized percentage in order to make valid comparisons. To do so, we can apply the concept of *internal rate of return*. Assignment question Q1 is an example of such a problem:

Q1: Consider the lease offer described in the attached advertisement. Calculate the annual percentage cost of financing implied by this offer.

Given a term, present value, and payment amount, students receiving this assignment should be able to compute the internal rate of return using either a spreadsheet package or the annuity functions of a standard financial calculator. Henceforth, calculations will be demonstrated in Microsoft Excel format; adapting the formulas to financial calculator inputs should be straightforward for instructors who prefer their use.

The Excel function for finding the rate of return generated by an annuity is *=RATE(nper, pmt, pv, [fv], [type], [guess])*. Some of the parameters are obvious; the payment amount (*pmt*) is $329, and the number of periods (*nper*) is 36. For precision, it's worth noting that lease payments are made in advance, with the first month's payment being due upon delivery. Consequently, the stream of lease payments is an annuity due, and the student should account for this fact by setting the *type* variable equal to one.

To determine the present and future values (*pv* and *fv*), though, students must dig into the fine print a bit. According to the advertisement, this agreement requires an up-front payment of $3,804. Further reading of the specifics reveals that this amount is actually comprised of the first month's payment of $329, an "acquisition fee" of $725, and a down payment (or *capitalized cost reduction* payment) of $2,750.

When assigning an amount to the present value parameter, the student should recognize that the first monthly payment of $329 has already been accounted for, by setting *pmt*=329 and *nper*=36. The proper cash outflow at $t = 0$ would appear to be $3,475; the down payment plus the acquisition fee.

At this point, students may be tempted to solve the problem on the basis of the lease cash flows alone, the implicit assumption being that the car will be returned to the dealer at the end of the lease. A typical attempt might be

=RATE(36, 329, 3475,0,1). Students attempting this will quickly find that the formula returns a "#NUM!" numerical error message. This is because all of the amounts have been entered as positive numbers. They may recognize this as a problem, but the solution is usually not obvious. Upon reflection, they should realize that the *pv* and *pmt* amounts entered here must have the same sign, because they flow in the same direction. Including the $350 disposition fee as a future value doesn't help matters, as it too is a cash outflow.

The internal rate of return of a "project" is ultimately a measurement of the *value received* in relation to the *amount invested* (or paid). So far, we've identified the amounts to be paid by the lessee, but have not yet specified the value to be received in exchange. In this case, the value to be received is in the form of physical delivery of a car. In our example, the car has a manufacturer's suggested retail price of $38,875, so the net transfer of value at *t=0* is:

+ 38,875 (cost of the vehicle)
+ 725 (acquisition fee)
- 1,000 (manufacturer discount, called "build-out credit" here)
- 3,475 (down payment & acquisition fee, required at delivery)
= 35,125 net value received at *t = 0*. This would be the *net capitalized cost*.

This, then is the correct value for *pv*. Incorporating that into the calculations, we would have the following Excel syntax: *=RATE(36,-329,35125,0,1)*. Computing the IRR on the basis of those figures gives a nonsensical (negative) result. The reason should be immediately apparent; the 36 payments don't come close to repaying the full value of the car, and we haven't yet considered the necessity of either returning or purchasing the car at the end of the lease.

Typical consumer vehicle leases in the U.S. give the lessee the right, but not the obligation, to purchase the leased vehicle at the end of the lease for an amount specified in advance (the *residual value*). This flexibility leaves us with two possible scenarios that may occur at the end of the lease: (1) the vehicle is returned to the lessor and the required disposition fee is paid, or (2) the vehicle is purchased for the residual value. In the latter case, no disposition fee is usually required.

Modeling the first scenario is somewhat problematic, because we would need an estimate of the car's actual value at the end of the lease to incorporate as a future value outflow, and this can't be known in advance with certainty. The second scenario is more definite and therefore easier to model, and as we will see, probably more relevant. Assuming that the lessee purchases the vehicle at the end of the lease, there will be a cash outflow at that time of $24,880, the residual value specified in the offer.

Admittedly, by using the lease residual as the future value, we are implicitly assuming that the consumer will exercise the right to purchase the car at the end of the lease, which may or may not be the case. But if the consumer is facing the decision whether to lease the car or to borrow-and-buy, this is the proper assumption to make, as it most closely resembles the borrow-and-buy alternative.

Now we have the following formula: *=RATE(36, -329, 35125, -24880,1).* The result is an implied lease rate of 0.14874%. Students may need to be reminded that: since we have assumed monthly payments, this is a monthly rate. For comparison to other financing rates, we should annualize this result by multiplying it by 12. The annualized leasing rate for this offer, then, is about 1.785%. That is, this manufacturer is offering to provide capital to the consumer at an annual nominal cost of under 2%; a low rate in any context, but comparable to other promotional financing offers available.[2]

Automobile dealers sometimes make use of a quantity known as the "money factor" to represent the cost of lease financing. Appendix III provides a detailed explanation of this concept.

Net Advantage to Leasing

Most corporate finance textbooks discuss a calculation known as the *net advantage to leasing* (NAL) as a means of evaluating the attractiveness of a lease. NAL is not limited to textbooks; Mukherjee (1991) finds that most large American firms do in fact use the model to analyze proposed leases. In short, the NAL is calculated as the difference between the net present value of the leasing cash flows and the net present value of the purchasing cash flows, or equivalently, the net present value of the cash flow differences in each period. For students of finance, the automobile lease provides an opportunity to develop proficiency with this technique. An example assignment question could be:

[2] At the time of this writing, BMW was also offering purchase financing for 36 to 72 month terms at a promotional APR of 3.20%.

Q2: Suppose that as an alternative to the lease, you have arranged 36-month financing for the purchase of this car through your credit union at an APR of 3.5%, with the same $3,475 initial payment as required by the lease. Calculate the Net Advantage to Leasing based on the two alternatives at hand.

Calculation of the NAL is straightforward, especially if one recognizes that the NPV of the purchasing cash flows (including the down payment) is, by definition, equal to the cost of the vehicle. To find the NAL, students need only calculate the NPV of the lease cash flows at the assumed financing rate of 3.5%, and subtract the total delivered cost of $38,600. A sample worksheet summarizing these calculations is presented as .

Figure 4.

Figure 4 - NAL calculation

	A	B	C	D	E	F	G	H
11								
12	**NAL Calculation**							
13								
14	**NPV of Leasing**				**NPV of Purchase**			
15	*Nper*	36			MSRP		$ 38,875.00	
16	*Rate*	0.002917	=0.035/12		Acquisiton Fee		$ 725.00	
17	*PMT*	$ 329.00			Discount		$ (1,000.00)	
18	*FV*	$ 24,880.00			Net purchase price		$ 38,600.00	
19	***PV***	**$ 33,664.12**	**=-PV(B16,B15,B17,B18,1)**					
20	Down Payment	$ 3,475.00						
21	Total NPV	$ 37,139.12	=B19+B20		**NAL**		**$ 1,460.88**	=G18-B21

We knew from the previous exercise that the proposed lease embeds a cost of capital of about 1.785%, so it is no surprise that the credit union's 3.5% lending rate results in a greater total cost to the consumer; the NAL simply puts a dollar value on the difference.

The importance of market value

The lease promotion also offers an opportunity for students to understand the importance of accurately assessing market values when evaluating investment projects. Thus far, we have used the manufacturer's suggested retail price (MSRP) of the car to represent the value received. This is consistent with industry practice, as it casts a favorable light upon the lease offer. But if the consumer is facing a decision whether to lease or to borrow-and-buy the vehicle, it may not be the ideal assumption to make.

The purchase of an automobile is one transaction in which it is customary for buyers and sellers to negotiate the purchase price. It's not unusual for transactions to occur at prices 10% or more below the MSRP. That being the case, if a consumer has the opportunity to purchase the example BMW for, say, $34,000 cash, calculating the lease rate based on the MSRP adds a hidden cost to the lease. A question that could be used to highlight this consideration might be:

Q3: Now, suppose you have determined from online research that the actual selling price of this car is normally about 10% below MSRP. Faced with this information, the dealer informs you that he could sell you the car for $34,000 cash, but the "build-out credit" would not apply. You could still use the credit union financing described in the previous question to take advantage of this new, lower price. Does this new opportunity affect the annual cost of lease financing?

To answer this question, students need only recalculate the lease IRR using the $34,000 cash price in place of the MSRP. The calculation would be

+ 34,000 (market price of the vehicle)
+ 725 (acquisition fee)
- 3,475 (down payment incl. acquisition fee)
= 31,250 net value received at $t = 0$.

The Excel syntax would then be *=RATE(36, -329, 31250, -24880,1)*12*, resulting in an annualized lease rate of approximately 6.53% per year.

It's important to note that this new calculation doesn't actually represent a real lease offer. It only serves to point out the opportunity cost of the lease; if the *true market value* of the car is $34,000 (and not $38,875 minus the $1,000 discount), the actual value received upon delivery is less than the MSRP. In light of the smaller present value, the lease payment of $329 now implies an annual cost of funds of about 6.5%, not 1.8%. In other words, if the lease transaction embeds a higher vehicle price than the *actual market value of the car*, the difference can and should be considered part of the cost of leasing.

The question provides an important lesson for students of managerial finance. Sound capital budgeting practice requires that any resources used for a project be evaluated based on their true market value (or opportunity cost). When analyzing a capital investment project (for example, the construction of a new building), accounting for the land used at its historical purchase price would be a mistake. So too, it would be a mistake to evaluate the lease proposal based on an artificially inflated purchase price.

Question Q3 is phrased in such a way that the calculation above reveals the answer: borrowing at 3.5% is less costly during the first three years than leasing at 6.5%. It does not consider other differences between buying and leasing, such as the size of the payments, the necessity to refinance at the end of the lease, or the option to walk away; we consider those factors in later sections.

The impact of the price difference could also be expressed easily in terms of the net advantage to leasing. Since the purchase transaction involves a total purchase price of $34,725 rather than $38,600, the advertised lease is $3,875 "less advantageous" than the purchase. Under the revised assumption, the NAL would be calculated as (34,725 – 37,139.12) = -2,414.12. Whether expressed as a dollar figure or a financing rate, the outcome is the same. The important lesson here is that assets should be considered at their actual market value or opportunity cost when making investment decisions.

The opportunity cost lesson can be reinforced by considering the value of a trade-in as well. When an existing vehicle is offered for trade-in credit, it provides the dealership with another variable which it can use to tilt the transaction in its favor. It's important for potential lessees to think critically about the value assigned to the traded vehicle. Some additional questions to be posed might be:

Q4: Suppose now that you already own a vehicle; a ten-year-old Toyota. The BMW dealer has offered to take your car in trade in place of the down payment and acquisition fee ($3,475 in total credit). Is this a good deal? What else would you need to know in order to answer this question?

Q5: Numerous websites offer online vehicle price estimates. Suppose that you have determined from such sources that your Toyota has an estimated trade-in value of $3,000. How does this information affect the attractiveness of the dealer's proposal?

Q6: Suppose that you have made extensive cosmetic modifications to your Toyota, which appeal to your next-door neighbor. Your neighbor has offered you $4,500 for your old car. How does this information affect the attractiveness of the dealer's proposal?

Q7: You believe that if you advertise the Toyota for sale, you could find a buyer willing to pay $5,000 for it. How does this affect your decision?

Obviously it's impossible to give a definitive answer to the first part of Question Q4. Students should recognize that the dealer's proposal assigns a value of $3,475 to the Toyota, but at this point we have no frame of reference regarding its true value. Question Q5 provides one reference point, an online appraisal of $3,000. If we accept this as the true value of the car, the BMW dealer's proposal becomes more attractive. The lessee will trade an asset with a presumed value of $3,000 for $3,475 in credit towards the new car.

Question Q6 provides another point of reference, a firm offer to purchase the Toyota for $4,500. With this offer in hand, the dealer's proposal appears quite a bit less generous. If we were to accept the proposed lease and trade-in, we would be giving up $4,500 of value to cover $3,475 worth of down payment and acquisition fee. It's possible to compute the lease IRR by substituting the $4,500 trade value for the down payment and acquisition fee. The Excel formula would be: *=RATE(36, -329, 34000+725-4500, -24880,1)*12*. Accepting the dealer's lease offer then implies a cost of funds of 7.9% during the life of the lease. The low trade-in offer (relative to the actual market value of the car) has added another hidden cost to the lease, which is reflected in the IRR but not in the size of the monthly payment.

It's fairly obvious in this example, though, that one should not accept the trade-in proposal, but rather sell the car to the neighbor for $4,500 cash.

An opportunity to discuss the importance of liquidity can be found in question Q7. Students may be asked to identify which value is more relevant, the firm offer of $4,500 or the hoped-for estimate of $5,000. Once again, when analyzing a capital investment project, resources should be evaluated at their true market value. The dealer's offer of $3,475 and the neighbor's offer of $4,500 are real bids; the valuations of $3,000 and $5,000 are only estimates, and should be treated accordingly.

The effect of Residual Value

The lease residual is another parameter which can have a profound impact on the attractiveness of a particular offer. Lease residuals can differ considerably from one car model to another, and are not typically subject to negotiation. They are specified by the institution providing the lease financing, and are based on the expected resale value of the vehicle at lease end. From the consumer's perspective, the larger the lease residual, the more costly is the lease, all else equal. This is demonstrated with question Q8:

Q8: Suppose that you decide to comparison shop for vehicles, and you discover that the Cadillac dealership is making the following deal available:36 month lease, monthly payment of $329, MSRP = $37,125, delivery charge =$500, $2,829 due at signing (including first month's payment of $329). This offer has a lease-end residual of $26,500. In terms of financing cost, how does this compare to the BMW offer presented in the advertisement?

This hypothetical offer has been constructed to be nearly identical to the BMW offer in terms of cash flows; the only real difference is the residual. Students should be encouraged to compute the IRR for comparison to the BMW offer. The PV should be calculated as follows:

+ 37,125 (cost of the vehicle)
+ 500 (delivery charge)
- 2,500 (down payment & delivery charge, required at signing)
= 35,125 net value received at $t = 0$.

The Excel formula then is: *=RATE(36, -329, 35125, -26500,1)*12* . The resulting IRR is 3.498% per year. While still competitive, this offer incurs a higher financing cost than the BMW offer.

A consequence of the positive relationship between lease residuals and financing costs is that: for a given lease rate, the larger the residual, the smaller the lease payment. Because of this, the resale value of the vehicle under consideration is an important factor in the decision-making process. At a given price point and lease rate, cars with higher resale values can be expected to have lower monthly lease payments. [3]

Equivalent Annual Cost

The automobile lease provides an ideal example for demonstration of the *equivalent annual cost* calculation. Calculations of this sort are especially useful in the context of choosing between lease offers with different durations. For example, consider the following question:

Q9: In the course of car shopping, you have narrowed your options to two: the BMW lease offer described in the attached advertisement, and a similarly-equipped Lexus. The Lexus lease offer is for 25 months, monthly payment of $349, with a capital cost reduction payment of $1,900 (total due at signing is $2,249). The Lexus MSRP is $39,900, and the lease-end residual is $33,000. Which lease carries a lower equivalent monthly cost?

The two offers have several differences: the BMW requires a larger down payment, but the Lexus requires larger monthly payments, and only lasts for 25 months. One way to analyze capital investment projects with unequal lives

[3] Not every lease promotion specifies the residual value in the advertisement, although it must be disclosed to the consumer prior to the signing of a lease. If the chosen promotion does not contain a residual value, an estimate can be found at http://www.cars.com/go/alg . The residual estimates found here come from *Automotive Lease Guide* (ALG), the standard source of residual value estimates for the leasing industry. Note that many promotional offers will incorporate larger residual values than the ALG estimates, as a way of reducing the monthly payment.

(where replacement is expected) is to compute the equivalent annual cost; the annuity payment which has the same present value as the cash flows incurred under the proposed project. In this case, since lease terms are expressed in months (and don't necessarily correspond to whole year increments) it makes sense to find the equivalent *monthly* cost, but the logic is the same.

The equivalent cost calculations are displayed in Figure 2. The present value of costs for the BMW would be: $11,541.26 (*=PV(0.01785/12, 36, 329, 0, 1)*) plus the initial payment of $3,475, a total of $15,016.26. A 36-month annuity due having this present value would have a payment amount of $428.06 (*=PMT(0.01785/12, 36, 15016.26, 0, 1)*). This is a reasonable estimate of the per-month cost of driving the BMW.

Figure 5 - Equivalent Cost Calculations

	A	B	C	D	E
35					
36	**BMW Lease**			**Lexus Lease**	
37	Annual Rate	1.785%		Annual Rate	1.785%
38	Nper	36		Nper	25
39	Pmt	329		Pmt	349
40	FV	0		FV	0
41	PV of payments	$ 11,541.26		PV of payments	$ 8,571.25
42	Initial Payment	$ 3,475.00		Initial Payment	$ 1,900.00
43	**Total PV of costs**	**$ 15,016.26**		**Total PV of costs**	**$ 10,471.25**
44					
45	**Equivalent Monthly Cost**	**$428.06**		**Equivalent Monthly Cost**	**$426.36**

The corresponding calculations for the Lexus would be: $8,571.25 (*=PV(0.01785/12, 25, 349, 0, 1*) plus the capital cost reduction of $1,900, a total present value of $10,471.25. A 25-month annuity due with this present value would have a monthly payment of $426.36. It seems the BMW carries a slightly higher equivalent monthly cost. The discount rate chosen is the BMW lease rate of 1.785%, which is a valid measure of the cost of lease financing for this consumer at this time.

Embedded options

From a financial perspective, a lease can be considered similar to a partially-amortized loan, with an attached put option[4]. As we have seen, the advertised BMW lease carries an IRR of 1.785%. Given the $35,125 capitalized cost, the fully amortizing monthly loan payment at this interest rate would be $1,002.78 (*=PMT(0.01785/12, 36,35125,0,0)*). If a loan were offered with a monthly payment of only $329, the payments would not come close to paying off the debt in 36 months; a balloon payment of $24,880 (the remaining unpaid balance) would be required.

Effectively, a loan of this type would replicate the cash flows of the lease. The lease, though, includes the guaranteed ability to surrender the car to satisfy the final obligation; that is, the lease includes the option to "sell" the car for the amount of the balloon payment – a put option.

Detailed procedures for estimating values of the options embedded in automobile leases have been developed by Miller (1995) and Giaccotto, Goldberg, and Hegde (2007). Oppenheimer (2002) demonstrates that the option value is an important factor in determining the desirability of leasing. For the present purposes, without an estimate of the volatility of the used car's value (or an offer for balloon payment financing at a rate lower than the lease rate), it's neither practical nor useful to estimate the dollar value of this option. However, a question like Q10 may be used to emphasize the importance of the option in facilitating the transaction, and its value to the lessee.

Q10: Suppose that Bernie's Exotic Auto Finance is offering to provide financing for the purchase of this BMW under the following terms: $3,475 down payment, balance of $35,125 to be financed for 36 months. The monthly

[4] It's tempting for students to try to analyze leases in *call* option terms, because they are frequently described as including the "right to purchase" the asset at the end of the lease. This is problematic, though, because in order to replicate the rights of the lessee using call options, we would also have to assume the lessee is able to enter a short forward contract for the sale of the car at the end of the lease. Because such contracts are not typically available, it's much more practical to replicate the rights of the lessee in terms of a purchase combined with a put option. Students who have some familiarity with option valuation may be encouraged to see this equivalence as an example of put-call parity.

payment is only $300, but the loan requires a balloon payment of $24,880 after 36 months. What is the annualized percentage rate built into this loan? How does it compare to the advertised lease? Would you consider accepting Bernie's offer?

The values given have been contrived to mirror the original lease offer (except for the monthly payment amount). The loan is definitely cheaper; it saves the buyer $29 per month relative to the lease, a total savings of $1,044 over 36 months. The APR for this loan comes out to only 0.6134%, quite a bit lower than the lease rate embedded in the advertised offer (*=RATE(36, -300, 35125, -24880, 0)*12*). The distinguishing feature, of course, is the fact that Bernie's balloon payment loan does not include the option to surrender the car and walk away. Setting aside the fact that automobile financing is not customarily available under terms like these, most consumers would be extremely reluctant to take on such a large obligation, even in light of the $1,044 savings. Although they may not think of it in these terms, most would recognize that the necessity to sell or refinance the car after three years carries substantial price and liquidity risk. The put option built into the lease effectively shifts these risks onto the leasing company, and therefore is valuable to the lessee. This risk-shifting characteristic is one reason that equipment leasing often plays an important role in corporate risk management.

Other Considerations

There are numerous other ways in which lease financing differs from traditional purchase financing, and leasing isn't a wise choice for every consumer. Students will be well served to become familiar with the particulars before considering a lease.

Sunk Costs – delivery charges, etc.

New vehicle transactions are notorious for incorporating a variety of add-on fees and charges: Delivery charges, acquisition fees, destination charges, "dealer prep"… ultimately they all increase the cost of the vehicle to the consumer, and are all relevant in some way.

Individuals considering the acquisition of a new vehicle are faced with a variety of decisions, including: (1) the decision to purchase (affordability), (2) vehicle selection, and (3) how to finance the transaction. If the question at hand is "can I afford it", the analysis should include ALL of the costs; the consumer is comparing the cost of the vehicle to some amount known to be affordable. If the question at hand is "which car should I choose", only the incremental costs should be considered. If one dealer charges an acquisition fee while the other does not, that fee is incremental to the cost of the first car. If, on the other hand, you're deciding between two different models with the same acquisition fee, it's not incremental and can be ignored for decision purposes… a sunk cost (although it is still relevant to affordability).

The focus of this teaching note, though, is the lease-versus-purchase decision, so we are only considering cash flows which are incremental to the financing method chosen. Question Q11 is an example of a question that can be used to prompt students to identify the incremental costs.

Q11: Assume you have settled on the BMW described in the attached promotion, and have determined that it fits within your budget. The only question remaining is how to finance it. Which of the following amounts would influence your lease-versus-buy analysis?

a) $1000 manufacturer build-out credit (described in the promotion)
b) $2000 manufacturer rebate on purchase
c) $550 dealer-applied rust protection treatment
d) $175 title & registration fees
e) $600 security deposit

Of these, only the "build-out credit" appears in the advertisement; the rest are assumed to exist for the purposes of this question. The two clearly irrelevant sunk costs on the list are the (optional) rust protection and (required) registration fees. Neither of those is affected by the choice of financing method. The build-out credit, as described in the lease advertisement, is also not incremental to the leasing decision. The offer details specify that it is a credit that applies to either a lease or a purchase. Consequently, it has no bearing on the choice of financing method, though it does have the effect of reducing the net capitalized cost of the vehicle.

The others are incremental, and should be considered as follows: The rebate (item b) applies only to a purchase, so when evaluating the lease, the opportunity cost associated with purchasing the vehicle (MSRP) should be reduced accordingly. The security deposit would only apply in the case of a lease, and should be accounted for by reducing

both the present and future value amounts by $600 (the net value received at t=0 is reduced by the additional payment required, and the "cost" incurred at the end of the lease is partially offset by the return of the deposit.)

Excess mileage

Probably the most notable "gotcha" in an automobile lease is the mileage allowance. Leases specify a maximum number of miles that can be driven during the lease term; if the limit is exceeded, excess mileage charges will apply. Such charges typically range from $0.15 - $0.25 per mile, payable upon surrendering the vehicle at the end of the lease. While this may not seem like much, it can add considerably to the cost of the lease. Students might be encouraged to think about the effect of this cost with a question like Q12:

Q12: Consider the BMW lease proposal in the attached advertisement. You like the car, and are satisfied with the lease terms stated in the offer. However, you recognize that your workplace is 25 miles from your home in the suburbs. Assuming you only drive the car to work and back (250 days per year), how much will you owe in excess mileage fees at the end of the 3-year lease?

The calculation is simple: the daily commute amounts to (25 *2 = 50 miles round trip) * (250 days per year) * (3 years) = 37,500 miles over the life of the lease. The fine print at the bottom of the lease offer specifies a mileage allowance of 30,000 with an excess mileage fee of $0.20 per mile. The fee would be (37500 – 30000)*(0.20) = $1,500, due upon return of the vehicle, assuming that the car is driven only to work and back. While this is not a quantitatively challenging problem, it serves to point out that the mileage fees can be considerable, even under very realistic assumptions.

Necessity of re-entering the market at the end of the lease

One of the realities of lease financing that is often overlooked (but acknowledged by Aizcorbe, Starr, and Hickman 2004) is that leases only offer *temporary* financing. At the end of a lease agreement, the lessee must renegotiate financing in order to maintain access to a vehicle. The BMW example, as advertised, carries a cost of funds of approximately 1.785%. While the rate is low, this source of financing is only available for 36 months; after that time, the lessee must either seek new financing for the purchase of the leased (or other) vehicle, or else seek out a new lease. Either way, the consumer must re-enter the financing market at that time, and may be forced to accept a higher cost of funds. By contrast, the offer to finance the purchase at 3.5% is fixed until the car is fully paid for. Whether or not this is desirable depends upon the expectations of the consumer. If the customer plans to keep the vehicle beyond the lease term, it may be desirable to lock in the promotional lending rate. If, on the other hand, the customer expects to replace the car with a newer one at the end of three years, it makes no sense to pay a higher rate (3.5% vs. 1.785%) for "permanent" financing that will only be used temporarily, and in fact lacks the valuable put option embedded in the lease.

Conclusion

The decision whether to lease or purchase a vehicle is faced by a great many consumers in today's marketplace. Most university students have either considered a lease themselves, or are familiar with someone who has. Ultimately, though, it is a financing decision, and most consumers are not well versed in the techniques that businesses routinely use to help make decisions of this type. As a result, leases are not well understood by many consumers, and all too often, they find themselves bound by unnecessarily costly lease agreements.

The standard vehicle lease, and the associated decision process, can be used to illustrate a surprisingly wide array of concepts related to financial management: net present value, internal rate of return, and net advantage to leasing are obvious examples. Upon further examination, though, it's easy to see a variety of other considerations: equivalent annuities, option characteristics, incremental cash flows, and sunk costs can all play a part in the decision making process. Presenting these concepts in the context of an automobile lease makes them more relatable to students, thereby benefiting them both as consumers and as future financial analysts.

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Appendix I – Auto Leasing Assignment

FIN 3xx - Fall 2015
Auto Leasing Assignment

Your task for this assignment is: Conduct a detailed analysis of the proposed BMW Lease agreement described in the attached advertisement. Specifically, you are to create a spreadsheet in Microsoft Excel that answers each of the following questions.

Consider the lease offer described in the attached advertisement. Calculate the annual percentage cost of financing implied by this offer.

Suppose that as an alternative to the lease, you have arranged 36-month financing for the purchase of this car through your credit union at an APR of 3.5%, with the same $3,475 initial payment as required by the lease. Calculate the Net Advantage to Leasing based on the two alternatives at hand.

Now, suppose you have determined from online research that the actual selling price of this car is normally about 10% below MSRP. Faced with this information, the dealer informs you that he could sell you the car for $34,000 cash, but the "build-out credit" would not apply. You could still use the credit union financing described in the previous question to take advantage of this new, lower price. Does this new opportunity affect the annual cost of lease financing?

Suppose now that you already own a vehicle; a ten-year-old Toyota. If you lease the BMW, the dealer has offered to take your car in trade in place of the down payment and acquisition fee ($3,475 in total credit). Is this a good deal? What else would you need to know in order to answer this question?

Numerous websites offer online vehicle price estimates. Suppose that you have determined from such sources that your Toyota has an estimated trade-in value of $3,000. How does this information affect the attractiveness of the dealer's proposal?

Suppose that you have made extensive cosmetic modifications to your Toyota, which appeal to your next-door neighbor. Your neighbor has offered you $4,500 for your old car. How does this information affect the attractiveness of the dealer's proposal?

You believe that if you advertise the Toyota for sale, you might be able to find a buyer willing to pay $5,000 for it. How does this affect your decision?

Suppose that you decide to comparison shop for vehicles, and you discover that the Cadillac dealership is making the following deal available:36 month lease, monthly payment of $329, MSRP = $37,125, delivery charge =$500, $2,829 due at signing (including first month's payment of $329). This offer has a lease-end residual of $26,500. In terms of financing cost, how does this compare to the BMW offer presented in the advertisement?

In the course of car shopping, you have narrowed your options to two: the BMW lease offer described in the attached advertisement, and a similarly-equipped Lexus. The Lexus lease offer is for 25 months, monthly payment of $349, with a capital cost reduction payment of $1,900 (total due at signing is $2,249). The Lexus MSRP is $39,900, and the lease-end residual is $33,000. Which lease carries a lower equivalent monthly cost?

Suppose that Bernie's Exotic Auto Finance is offering to provide financing for the purchase of this BMW under the following terms: $3,475 down payment, balance of $35,125 to be financed for 36 months. The monthly payment is only $300, but the loan requires a balloon payment of $24,880 after 36 months. What is the annualized percentage rate built into this loan? How does it compare to the advertised lease? Would you consider accepting

Bernie's offer?

Assume you have settled on the BMW described in the attached promotion, and have determined that it fits within your budget. The only question remaining is how to finance it. Which of the following amounts would influence your lease-versus-buy analysis?

$1000 manufacturer build-out credit (described in the promotion)
$2000 manufacturer rebate on purchase
$550 dealer-applied rust protection treatment
$175 title & registration fees
$600 security deposit

You have decided that you like the BMW, and are satisfied with the lease terms stated in the offer. However, you recognize that your workplace is 25 miles from your home in the suburbs. Assuming you only drive the car to work and back (250 days per year), how much will you owe in excess mileage fees at the end of the 3-year lease?

Current 320i xDrive Sedan Special Offers

2014 Lease Offer

Well-equipped including features such as Premium Package (Moonroof, Comfort Access, Satellite Radio), iPod/USB Adapter, Hands-free Bluetooth and Destination charges.

$329*/month for 36 months. $1,000 Build-Out Cash is included in payment.

- $329 First months payment
- $2,750 Down payment
- $0 Security Deposit
- $725 Acquisition fee
- $3,804 Cash due at signing

*Lease financing available on 2014 BMW 320i xDrive Sedan vehicles, only at participating BMW centers on leases assigned to BMW Financial Services NA, LLC/Financial Services Vehicle Trust through September 02, 2014. $1,000 Build-Out Cash is a credit against the MSRP of the final purchase, loan or lease on a 320i xDrive Sedan through September 02, 2014. Monthly lease payments of $329.00 for 36 months based on MSRP of $38,875.00. Vehicle may need to be ordered. Total Lease payments are $11,844.00 Excludes tax, title, license and registration fees. Program available to qualified customers and not everyone will qualify. Subject to credit approval. See participating dealer for details. Dealer contribution may affect terms. Lessee must cover insurance and all items not covered under the BMW Maintenance Program. At lease end, lessee will be liable for disposition fee ($350.00), any excess wear and use as set forth in the leases agreement and excess mileage charges of $0.20 per mile for miles driven in excess of 30,000 miles. Purchase option at lease end for $24,880.00 excludes taxes. Lessee acquires no ownership interest unless purchase option is exercised. See participating BMW centers for details and vehicle availability. For more information call 1-800-334-4269. Special lease rates and pricing may not be reflected throughout www.bmwusa.com. All figures presented are estimates only. Actual selling price may vary. Please see your BMW center for details. Ultimate service covers all factory recommended maintenance on all new vehicles, as determined by the Service Level Indicator, for 4 years or 50,000 miles, whichever comes first. Exclusions from coverage: gasoline, gasoline additives, windshield washer additives, tires, wheels, wheel alignment, tire balancing and rotation. All work must be performed by an authorized BMW center. See the Service and Warranty information booklet for more details and specific terms, conditions, and limitations. ©2014 BMW of North America, LLC. The BMW name, model names and logo are registered trademarks.

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Appendix II

Leasing Project - Solutions

Q1.

nper=	36	pv=	35125	
pmt=	-329	fv=	-24880	rate = 1.785%

=RATE(C1,C2,E1,E2,1)*12

Q2. NAL Calculation

NPV of Leasing			NPV of Purchase	
Nper	36		MSRP	$38,875.00
Rate	3.500%		Acquisiton Fee	$ 725.00
PMT	$ 329.00		Discount	$ (1,000.00)
FV	$ 24,880.00		Net purchase pric	$38,600.00
PV	**$33,664.12**	**=-PV(B16/12,B15,B17,B18,1)**		
Down Payment	$ 3,475.00			
Total NPV	$ 37,139.12	=B19+B20	**NAL**	**$ 1,460.88** =G18-B21

Q3.

nper=	36	pv=	31250	
pmt=	-329	fv=	-24880	rate = 6.533%

Q4. Impossible to know without an estimate of the Toyota's value

Q5.

nper=	36	pv=	31725	
pmt=	-329	fv=	-24880	rate = 5.915%

In light of this information, the dealer's offer of $3475 credit for a car worth only $3000 makes the proposal more attractive

Q6.

nper=	36	pv=	30225	
pmt=	-329	fv=	-24880	rate = 7.906%

If the Toyota is truly worth $4500, accepting $3475 of trade credit for it effectively raises the financing cost.

Q7.

nper=	36	pv=	29725	
pmt=	-329	fv=	-24880	rate = 8.595%

As the presumed actual value of the trade-in goes up, the lease offer seems less attractive. The question remains, what is the TRUE market value of the Toyota?

Q8.

nper=	36	pv=	35125	
pmt=	-329	fv=	-26500	rate = 3.498%

Same as the original offer, except for the residual. Higher residual imples higher financing cost.

Q9. Equivalent Monthly Cost

	BMW Lease		Lexus Lease	
	Annual Rate	1.785%	Annual Rate	1.785%
	Nper	36	Nper	25
	Pmt	329	Pmt	349
	FV	0	FV	0
	PV of payments	$11,541.26	PV of payments	$ 8,571.25
	Initial Payment	$ 3,475.00	Initial Payment	$ 1,900.00
	Total PV of costs	**$15,016.26**	**Total PV of costs**	**$10,471.25**
	Equivalent Monthly Cost	**$428.06**	**Equivalent Monthly Cost**	**$426.36**

Q10.

nper=	36	pv=	35125		
pmt=	-300	fv=	-24880	**rate =**	**0.620%**

Same as the original lease, but lower monthly payment, thus lower rate. Less financing cost, but locks the buyer into a large balloon payment!

Q11.

Items a, c, and d are not incremental and can be ignored.
Item b applies only to a purchase, effectively reducing the value received at T=0 by $2000
Item e applies only to a lease, and reduces both the value received at T=0 and the residual by $600

Q12.

50	miles per day to/from work
250	work days per year
3	year lease term
37,500	Minimum miles driven
30,000	Lease mileage allowance
7,500	Excess miles
0.20	Charge per excess mile
$1,500	**Expected excess mileage fee**

Appendix III - Industry practice – the "money factor"

It's a common practice among automobile dealers to express the cost of lease financing in terms of a quantity known as a *money factor*. The money factor is usually stated as a small decimal number, and it is widely understood in the industry that it is approximately equal to 1/2400th of the lease rate (stated as a percent).

Under this method of calculation, the monthly lease payment is considered to have two components: (1) the *depreciation charge*, or the average monthly decrease in the vehicle's value, and (2) the *rent charge*, or average monthly financing cost. If we know the lease terms, it is possible to compute the money factor, and thereby the approximate cost of funds, without relying on complex annuity calculations. The calculation of the depreciation charge is straightforward:

$$Depreciation\ Charge = \frac{(Net\ Capitalized\ Cost) - (Residual\ Value)}{(Lease\ term\ in\ months)}$$

In the BMW example from the text, the depreciation charge would be (35,125 – 24,880)/36, or $284.58 per month.

The rent charge is similarly easy to calculate. The standard calculation is given as

$$Rent\ Charge = (Money\ Factor) \times [(Net\ Capitalized\ Cost) + (Residual\ Value)]$$

It is possible to use the money factor to estimate the annual percentage cost of financing.. Given the monthly payment and depreciation charge in the example at hand, the rent charge embedded in this lease would be $329 – $284.58 = $44.42. Solving for the money factor, we would have

$$Money\ Factor = 44.42\ /\ [35{,}125 + 24{,}880] = 0.000740272$$

Multiplying this result by 2400 yields an approximate annual lease rate of 1.777%, consistent with (but not identical to) the IRR of 1.785% calculated in the text. The money factor procedure is a reasonable, easy-to-compute approximation that avoids the necessity of using a financial calculator or complex annuity formulas. As with the lease rate, federal law does not require disclosure of the money factor, so dealers may not be forthcoming with this information.

How the money factor computation works is not usually immediately obvious, but it can easily be understood by most students of finance. Consider: at the beginning of the example lease, the lessee owes the lessor the net capitalized cost of $35,125. If this were a loan, the interest due on this balance for the first month would be $0.01785/12 \times 35{,}125 \cong 52.25$. At the end of the lease, the remaining "balance owed" is the lease residual of $24,880. The "interest" due for that month would be $0.01785/12 \times 24{,}880 \cong 37.01$. The money factor calculation works by assuming that the monthly financing charge decreases linearly from 52.25 to 37.01 over the course of the lease. Under that assumption, the average monthly finance charge would be $(52.25 + 37.01)/2 = 44.63$. The overall calculation would be:

$$Avg.Monthly\ rent\ chg\ = \frac{\left[\left(\frac{Lease\ Rate}{12}\right) \times Net\ Cap.Cost\right] + \left[\left(\frac{Lease\ Rate}{12}\right) \times Residual\ Value\right]}{2}$$

Simplifying, we get

$$Avg.Monthly\ rent\ chg\ = \left[\left(\frac{Lease\ Rate}{24}\right) \times (Net\ Cap.Cost + Residual\ Value)\right]$$

If the lease rate is expressed as a percent rather than a decimal, the divisor must be *24*100*, and we can then see the equivalence: $Money\ Factor = \ (Lease\ Rate(\%))/2400$. In fact, the remaining balance (and thus the monthly finance charge) does not decrease in a straight line, but for relatively short terms and typical financing rates, the approximation is very close.

Utilizing Fantasy Sports to Enhance Student Learning

Mark S. Nagel[1]

Abstract

Over the past 20 years, participation in fantasy football has increased dramatically. During this timeframe, many universities have encouraged instructors to diminish the importance of the traditional "lecture format" in the classroom. Many institutions have begun to insist that the most effective teaching involves active student participation rather than one-way communication (Rocca 2010). This paper discusses the implementation of a semester-long fantasy football exercise that is primarily designed to require students to demonstrate their understanding of strategic management and basic economic principles by mandating they apply those principles to situations such as an auction draft and labor disputes.

Introduction

Fantasy sports, and fantasy football in particular, have grown tremendously over the past 20 years. In 2012, over 33.5 million Americans participated in at least one fantasy sport (Subramanian 2013). With the growth of fantasy sport participation, a niche industry that was once misunderstood or perceived as the pursuit of social outcasts is now estimated to attract multiple billions of dollars in direct spending on entry fees and advice-related materials (Goff 2013) with Darren Rovell (2014) reporting that the industry should achieve greater than 7% annual growth over the next five years. As its popularity has grown, fantasy sports has been implemented in a variety of educational settings (Barr 2006, Newman, Irwin, Klenosky, & Gillentine 2003; Toporek 2014). This paper details the use of fantasy football as a semester-long class activity designed to teach strategic management, economics, and finance. It has been successfully utilized in a variety of sport management classes including Introduction to Sport Management, Strategic Decision Making in Sport, Sport Economics, and Sport Finance. In most cases, the semester-long activities are incorporated into weekly class sessions, with the length of time devoted each week varying from minimal (10 minutes) to extensive (entire class periods) depending on the specific class topics and instructor needs.

Fantasy Sports Development

It is difficult to ascertain exactly who "invented" fantasy sports as there have been a variety of small, local leagues since the 1960s. Harvard sociologist William Gamson developed a "Baseball Seminar" that awarded points to participants based upon their selected player's final season standings. There were other small "leagues" of friends who developed fantasy like games that did not receive much attention such as the East Meadow Strat-o-Matic Baseball League that was founded in 1972. Fred Thomsen and his friends developed a fantasy football league in 1963. The Greater Oakland Professional Pigskin Prognosticators League (GOPPPL) still exists and functions much like it did when George Blanda was the first pick (Hruby 2013). It is often credited with being the first fantasy league as it mimics how most current fantasy leagues operate.

The first fantasy league to receive extensive attention was developed by prominent author Daniel Okrent in 1980. His Rotisserie League was named after the La Rotisserie Francaise restaurant where the first draft was held and the original owners, most of whom were writers, often met. Okrent's "baseball invention" became popular

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among fans once some of the league members began writing about their exploits. They later unsuccessfully attempted to develop materials that would create extensive profits for their "invention." By the late 1980s, it was estimated that over 500,000 people were playing fantasy sports (Walker 2006) and a variety of publications offered rules, advice, and what would become the backbone of the industry, statistical analysis.

Though Okrent has never received extensive revenue from his notoriety, others helped transition Rotisserie Baseball into a thriving fantasy sports industry. A variety of publications, including *USA Today*, offered fantasy sports advice, often to the chagrin of industry "insiders" who sometimes perceived the "nerds" who played fantasy sports as detracting from the enjoyment of the "true" action on the field. Though fantasy sports were growing and various rules had been developed not only for baseball but football, basketball, hockey and some additional sports, in the pre-Internet era of the early 1990s, the estimated 1 million+ fantasy players either had to compute statistics by hand or utilize fantasy scoring services that often required extensive time to provide updated standings (Walker 2006).

Fantasy sports, and in particular, fantasy football, exploded in popularity in the late 1990s as the proliferation of the Internet as a mainstream tool of commerce brought fantasy leagues online. ESPN, Yahoo, CBS Sports and a variety of other popular webpages began to offer fantasy sports leagues, which enabled participants to enjoy their fantasy teams without having to have someone in the league compute the daily or weekly statistics. These websites also began offering extensive fantasy advice columns, with some being updated daily during various sport seasons. In addition to free content, fantasy sports websites were able to successfully offer pay content that enabled subscribers to have access to enhanced league statistics, "insider" information, and other additional features. As the number of fantasy sport participants expanded dramatically, the National Football League (NFL), Major League Baseball (MLB), National Basketball Association (NBA), and National Hockey League (NHL) altered their course away from largely ignoring fantasy sport participants to instead embracing them as the realization that these consumers could join gamblers and out-of-town fans as high consumers of league content, specifically the profitable and significant specialized cable broadcasts of games.

The Fantasy Trade Association (FSTA) was founded in 1997 and has tracked and represented an industry that has been expanding rapidly. Current estimates indicate that over 41 million people played fantasy sports in the USA and Canada in 2013 ("Industry demographics…" n. d.). These fantasy sports participants are estimated to spend $467 per person. With additional money devoted to advertising revenue and other spending, the entire industry may exceed $70 billion when intangible activity is added to spending that is directly measurable (Goff 2013). In addition to spending money, fantasy sports players also invest significant amounts of time, particularly when playing fantasy football. As Goff notes,

> The FSTA estimates that the average fantasy gamer spends 3 hours per week managing a team(s), translating to 1.2 billion hours for 23 million players over a 17-week season. Of course, all of these numbers are a bit sketchy because of things like drafts add hours along with off-season reading and discussion (para 3).

Other researchers have noted that fantasy players spend an average of nine hours a week watching games, checking stats, and making roster moves (Dwyer & Drayer 2010), meaning that regardless of the exact time and money spent, the industry is massive.

The continued expansion of fantasy sports, particularly in the mainstream, has been aided by the Unlawful Internet Gambling Enforcement Act of 2006. Signed into law by President George W. Bush, the Act specifically noted fantasy sports, and any transactions from banks or similar institutions for fantasy sports, were legal (Brustein, 2013). Fantasy sports were deemed games of skill that did not determine winners based upon the outcome of one specific player's or team's performance though some jurisdictions continued to argue that some elements of fantasy sports were illegal (Moorman 2008).

Even if deemed illegal, fantasy sports would still be popular and widespread, much like weekend poker games and other small stakes gambling activities that usually go unnoticed or ignored by law enforcement. However, the classification by the Unlawful Internet Gambling Enforcement Act has created an environment where big stakes fantasy leagues can be implemented and marketed. Recently, some of these high-dollar-entry-fee fantasy leagues have morphed from "traditional" fantasy leagues that are played over an entire professional sport season to daily fantasy leagues where players can make selections and compete against other players every night. Websites like

FanDuel and DraftKings have marketed these opportunities to compete and win big money every day rather than waiting to win a fantasy league at the end of a season. The daily fantasy market has been estimated at $492 million in annual spending with dramatic increases expected in the near future (Brustein 2013).

The rapid growth of daily fantasy sports has caught the attention of various media pundits, and members of Congress (Smith 2012). Some have questioned if the dramatic change in the format of daily competitions is so different from the exemption that was carved out of the original 2006 legislation. As other "traditional" Internet gambling sites have been shut down, recently FanDuel raised $11 million from investors which included Comcast's venture capital arm (Brustein 2013). Despite the concern that daily fantasy may be under greater scrutiny in the near future, and comments that were made in March 2013 by MLB against daily fantasy leagues, in March 2014 MLB signed DraftKings as its official mini fantasy game (Edelman 2014). In addition, some MLB players have now become formally associated with daily fantasy sites, with San Francisco Giant Pablo Sandoval becoming a top endorser for FantasyAces in 2013 ("FantasyAces forms…" 2013), leading some to speculate it is only a matter of time before the entire fantasy sports industry is once again under Congressional scrutiny (Edelman 2013).

As the fantasy sports industry has matured, it has begun to attract a larger percentage of females than it did in the early 2000s when it was almost exclusively the domain of men. A variety of professional leagues, particularly the NFL, have begun to actively court the female fantasy football participant, which was estimated by TheFootballGirl.com managing editor Melissa Jacobs to be at least 20 percent of the overall marketplace (Bowens 2013). The total number of females playing rose from 462,000 in 2012 to over 6.4 million in 2013 (Pesce 2014). Future growth is expected to continue in the future. The rise of female fantasy sport participation has created a need to study the female fantasy sport participant as well as the male reaction to the female interest and heightened participation (Grappendorf & Ruihley 2014).

Fantasy Sport in the Academic Setting: Theoretical and Practical Applications

Over the last 35 years, increasing learning among students has become an important topic in education. Where once the traditional lecture and other passive learning outlets such as watching videos and reading textbook materials dominated the majority of higher educational settings, numerous researchers have noted that teaching effectiveness increases when students are engaged and actively participating in various learning activities. *Experiential learning* (EL), where students learn by doing, has been discussed by a variety of researchers since Kolb (1976) developed an Experiential Learning Cycle of Development. As noted by Spence, Hess, McDonald, and Sheehan (2009), "When actively engaged in inductive, 'learn by doing' EL processes, students are directly responsible for participating in their own learning" (pg. 2). Since Kolb's work, experiential learning has been shown to often be more effective in many higher educational settings, including in sport management and other similar disciplines (Bennett, Henson, & Drane 2003; Cunningham, Sagas, Dixon, Kent, & Turner 2005; Irwin, Southall, & Sutton 2007; Pauline & Pauline 2008; Southall, Nagel, Legrande, & Han 2003; Verner, Keyser, & Morrow 2005).

In sport management, a variety of unique experiential learning methods have been utilized. Drayer and Rascher discussed the use of an Oakland A's simulator to enhance student learning in sport finance (2007). A variety of researchers have studied the use of "real-world" sales opportunities in enhancing student learning of the sales process (Irwin et al. 2007; McKelvey & Southall 2008; Pierce & Petersen 2010). In regards to fantasy sports, Newman et al. (2003) noted its enhancement of student learning in sport marketing and sport management classes, while Davis (2012) and Gillentine & Schultz (2001) also noted its effectiveness in enhancing student learning in sport marketing. Additionally, Einolf (2005) reported the use of fantasy sports in a sport economics simulation.

Perhaps the most concise rationale regarding fantasy sports as an effective student learning endeavor and its need to be enhanced in future educational activities was noted by Professor Ben Motz of Indiana University,

When I joined a fantasy football league, I realized that these people who I'd never thought of as quantitatively minded-people who think in terms of numbers- were doing what I want my students to do. They were thinking critically about data, using patterns they were seeing and making extrapolations about data yet to come. It was pretty clear to me that it had the power to help people think empirically about data (pg 12).

The following section details a semester-long fantasy football activity that is designed to enhance student learning by helping students to think quantitatively. It is designed for and has been successfully utilized in sport finance, sport economics, introduction to sport management, and strategic management in sport classes at the undergraduate and master's level. In addition, versions of the project have also been implemented in undergraduate and graduate sport marketing classes. The project can be adapted to "fit" various classes as certain topics that are present in selected courses can be emphasized (such as a player strike being a component of sport labor disputes in economics, finance or management). Appendix 1 provides an outline of a sample sport finance class schedule that utilized fantasy football assignments to buttress other class activities.

Fantasy Football Class Protocols

In order to maximize learning through fantasy sports, a variety of important steps must be taken to implement it into a full-semester curriculum. The following information regarding current fantasy football protocols has been developed since its initial creation and implementation in 2000, a time when fantasy sport participation was largely unknown or misunderstood, even among sport management students. Since its initial introduction, a variety of minor changes have been implemented, particularly in regards to weekly activities, but the core concepts, rules and applications have remained largely intact.

At the beginning of the semester, the faculty member must first collect important information regarding each student's understanding and interest in professional football and fantasy football. Typically, this information can be gathered with other first-day-of-class materials. Ideally, assuming the "typical" class of 20-40 students, the class will contain at least 10 students (or 12 in particularly large classes where the league will need to include 12 franchises) who have participated in fantasy sport activities in the past so that each of the league's eventual franchises has at least one member who has a rudimentary or more advanced understanding of fantasy sports basics. When allocating franchise members after the first class meeting, it is critical that "experts" are diffused among the league's franchises so that teams can immediately begin work on draft preparation. In cases of smaller classes (less than 20 students) with few fantasy football veterans, the use of general professional football knowledge can be utilized to balance the expertise of class franchises. The general idea is to help students understand the importance of working in groups, identifying leaders, and learning from colleagues to create the best possible outcome. The instructor should pay particular attention to students indicating limited fantasy football experience and those exhibiting little initial project interest. In many cases, the instructor needs to help "individualize" the assignment and help impress upon those students that the exercise will enhance student learning of key class materials. Since yahoo and most other mainstream fantasy football sites require a commissioner to participate in the league, the instructor must carefully select a fantasy football veteran to operate the commissioner franchise after the league website has been established. Though this franchise will gain commissioner "rights," the structure of the league precludes any potential malfeasance on the part of the commissioner's team. When first demonstrating the league website, the instructor can also explain that any "illegal" moves will be charted as every fantasy football website keeps a running log of player transactions.

Since most semester-long classes begin in late August and the NFL typically begins its season in early September, classes will not have a tremendous amount of lead time to prepare for their player drafts[2]. During the first and second weeks of classes, a basic history of fantasy sports should be presented via class readings and lectures, and a more detailed examination of the fiscal impact of fantasy sports is presented.[3] Often included in these

[2] The author has implemented class fantasy football leagues that have drafted before the NFL season starts and in some cases after week 1 of the NFL season has been played. In many years, the draft-date decision is "made" by the NFL and the school's master calendar since the author likes to have at least two weeks of classes before the draft rather than having only one week of class and then drafting during the second week of classes. In either scenario, the discussion of available data can be woven into class discussions, especially when the students draft after the NFL's opening weekend and students then have 1 game out of 16 to incorporate into their projections.

discussions are short videos from HBO's *Real Sports* and ESPN's *Outside the Lines*.[4] These fantasy sports materials are typically augmented by readings pertaining to game theory and strategic decision making. The goal is for students to understand why fantasy sports is an emerging and important force in the sport management industry and to prepare them to begin to apply strategic thinking and problem solving to plan for the upcoming draft. Certainly, differences in class title (marketing, finance, revenue development, economics, etc.) can impact the initial pre-draft readings, lectures, and discussions, as well as post-draft activities[5].

Though many class members will likely have played fantasy sports in the past, the developed rules (Appendix 2) are designed to target student's research skills, understanding of strategic thinking, and application of financial and economic principles. The key differences in the developed fantasy football rules include:

1) A two-tiered victory format where there is an on-field champion as well as an overall money winner[6]. This mimics the (often unfortunately from the team's fan's perspective) realities of North American professional sports where some owners attempt to maximize wins while other attempt to maximize profits (Brown, Rascher, Nagel & McEvoy 2010). Franchises in the class can pursue either strategy (or both) but must fully explain their rationale in their pre-draft papers[7].

2) The use of a live auction format rather than a traditional snake-draft. Snake-drafts provide a simple-to-use fantasy format but do not require nearly the amount of preparation and strategic thinking of an auction (Cockcroft 2011, 2014). In an auction, participants can follow a variety of strategic plans (stars and scrubs, balanced approach, etc.) to achieve on-field success. In addition, an auction format negates the potential concerns that fantasy football is won disproportionately by franchises holding one of the top three picks.

3) Use of money to complete post-draft transactions. This adds an additional element of strategic thinking as franchises have to plan their pre-draft budgets to include the likely amount of money needed for future transactions. Given the higher injury rates in football than in other sports, and the likelihood in fantasy football that "unknowns" will develop mid-season and become key contributors, this is an often under researched rule for participating students[8].

4) A scoring system that is slightly different than most "standard" formats found on popular websites such as espn.com, yahoo.com, and cbssports.com. This requires students to not only research player projections but then to convert them to the class scoring system, causing additional thinking and preparation.

5) A restrictive position requirement which prevents franchises from "overstocking" additional players at a certain position during the draft (though additions to the roster – which can be critical to eventual on-field success - are permitted each week under the transactions rules).

A variety of key economic and financial principles should be explained as students prepare their papers and register their franchises on yahoo (or another fantasy football site that the instructor selects). Certainly, students must understand *valuation* as an auction format requires participants to evaluate projected player statistics given the amount of franchises in the class, depth at the position, and overall target points. *Risk* is also a critical component of draft preparation as professional football is a contact sport, where injuries are unfortunately common. Player

[3] The author typically teaches classes in a sport management curriculum so a detailed understanding of fantasy sports and its impact upon the industry is warranted. Other professors utilizing fantasy sports to teach strategic thinking, finance or economics may not need the detailed examination of the fantasy sport industry and why and how it is being utilized by the NFL, MLB, etc.

[4] The author is happy to share all materials previously gathered with any interested reader.

[5] For example, if the exercise is utilized in a sport marketing class, a discussion of branding and logo creation could be emphasized with students required to create their own marks. In other classes such as in sport finance or economics, these types of activities could be replaced with other exercises that are more narrowly focused in the class' main subject areas.

[6] Since 2000, no class has had one franchise claim both the on-field and money titles, though a few have come close.

[7] Since 2000, 95% of class participants have begun the year primarily pursuing a "win-on-the-field" strategy at the beginning of the season.

[8] Each year, a variety of fantasy football prognosticators discuss the ability of unknowns to impact the latter part of fantasy football seasons. In many cases, fantasy football pundits invoke the memory of Billy Volek, a NFL quarterback of marginal ability who had a glorious stretch in 2007 where he entered the season after starter Steve McNair was injured and proceeded to pass for 1187 yards and 11 touchdowns in a three-game stretch that happened to coincide with most fantasy football league's playoffs (Fabiano 2008).

projections and their potential worth must be determined by incorporating risk. It is often helpful to explain *VORP*, value over replacement player, as it is a key concept in sport economics, and applies in the fantasy sport auction setting (as well as in many other areas of business and sport business in particular). Students may need initial help understanding what players are "free" to acquire at the draft and should be allocated $1 in value. For instance, in a 10-franchise league, 20 quarterbacks will drafted, meaning a franchise could elect to wait until the end of the draft to take the 19th and 20th best quarterbacks for "free," meaning there would be no competition for their $1 bids. Any additional money allocated to the 18th best quarterback should be based upon that player's value "over" the 19th best player at the position who can be acquired for the minimum bid of $1.

Certainly, the size of the class will impact the number of franchises utilized in the fantasy football league. Though there is no ideal number, if only eight franchises are assigned, the quality of NFL players available to every franchise will be extremely "deep," meaning nearly every franchise will have multiple top players at various positions. If the class is assigned 10 or 12 franchises, then the quality of players readily available for each franchise will be "thin," requiring more accurate preparation to achieve on-field success. By adding franchises, the length of time needed to execute the draft will increase - an important consideration as most drafts should be completed in one 150-minute period or two 75-minute periods. With 10 or 12 franchises drafting 15 players each, the draft should be able to be completed in these standard class formats.

The use of a head-to-head regular season schedule introduces added elements of luck and uncertainty, which creates a livelier season-long challenge for students. Though head-to-head is recognized as being more likely to reward inferior teams with "unearned" victories, most students appreciate the opportunity to compete against specific class opponents each week. As noted by Drayer and Rascher in their discussion of the sport finance simulation (2007, p. 63) "system randomness" that occurs in computer programs mimics the real world as events often occur that fall outside the predicted norms. Students should strive to produce the highest fantasy points possible each week but understand that often random results will occur, particularly when competing in a head-to-head format over a short season.

The instructor can adjust the number of playoff teams and the playoff format as necessary, but the traditional semester-long academic calendar typically fits nicely in a 10-team league as every franchise can play the others at least once prior to the playoffs. A key consideration is to establish a trade deadline early enough (usually at least a few weeks prior to the end of the regular season) to require franchises to make tough decisions regarding going for the money title or the playoffs.

Selected Assignments

Instructors can certainly craft various assignments to meet their class needs, however, requiring a detailed pre-draft paper that incorporates extensive preparation will greatly assist the students in understanding how fantasy football operates, and, more importantly, the level of detail that is required when undertaking economic and financial analyses. The pre-draft paper will challenge a number of students who are used to participating in fantasy football by simply following a pre-draft cheat sheet. The instructor needs to be available in the days preceding the draft (when the pre-draft paper should be due) so that students can ask detailed questions and receive feedback on their thoughts and their initial work.

Of particular concern is the understanding that the pre-draft paper must establish a maximum valuation for each player that could be drafted (in a league of 10 franchises, 20 QBs, 30 RBs, 40 WRs, 20 TE, 20 K, and 20 D). Students will often write a range of prices for each player which does not prepare the franchise for the draft. Within the initial lectures and individual tutoring, the concept of *scarcity* can be introduced and reinforced. Many students will simply estimate the players (typically QBs) scoring the most projected points to be the most valuable, but in reality, points that are scarce are the most important to pursue. Often in fantasy sports, the concept of establishing player *tiers* can be an effective method to better understand resource allocation (Bliss 2013; Dorey 2004). Players who will produce similar points should be valued in tiers and if there are large gaps in the projected points in one position, that is an area of increased resource allocation.

For example, each position tends to have clusters of players who score similar amounts of points. In fantasy football, if the top five quarterbacks are projected to score within 15 points of each other, they will likely be allocated the same pre-draft price as 15 points over a season is essentially meaningless[9], but if the next set of quarterbacks are projected to score 75 points less, then a drop in assigned draft value should occur. Students need to look across all the different positions to make their pre-draft assessments.

Certainly, an important component of the pre-draft paper is the identification and explanation of money to be saved for post-draft activities. The instructor can inform the students that additional resources will come into the league, but that students will not know when or in what form. Students should be able to provide their rationale and details regarding their plans.[10]

The post-draft paper should incorporate the results of the draft and an analysis of where each team stands in both projected points but also money saved and what picks were "good" or "bad" given their pre-draft assessments. Groups that complete an excellent pre-draft paper typically do not require extensive time to complete their post-draft papers because they can simply take their projected points and allocate them to each franchise and provide appropriate commentary. The instructor may wish to help franchises understand that total points for each franchise may not be enough of an analysis given that not every player is "active" each week in fantasy football. A detailed discussion regarding bench scoring, NFL bye weeks, and other variables can be utilized by students to demonstrate their understanding. Of particular concern is emphasizing to students that the post-draft paper should reflect their assessment as the point when the draft concludes. They should ignore the results of the first week of fantasy competition in their analysis.

Typically, the first and second week of competition should proceed without league issues being presented so that every student can fully understand the repercussions (good or bad) of their draft, amount of money remaining, and initial injuries. Also, the "silent" auction that is utilized for acquiring new players after the draft teaches new concepts and strategic thinking. In the silent auction, franchises submit sealed bids for the players they want. Since each franchise only has one sealed bid for all of the players they wish to acquire, they have to not only identify their franchise needs and financial resources, but also the other franchises' roster and financial position. Once at least a week or two has been completed (and in some cases much of the remaining post-draft money exhausted), league "issues" should be introduced.

In addition to the pre-draft and post-draft papers, students should write reactions (typically 2-3 pages in length) to proposals made to the league's owners. These will typically not occur each week but should be introduced by the instructor at times to reinforce course concepts. It is important that the instructor closely examine the league's rosters and financial situations when crafting the specifics of the league issues. They should be designed for students to think about concepts, their position in the standings, and the competitive environment in which they are operating. The instructor can spur more lively debates and enhanced strategic decision making if scenarios can have disparate (but not necessarily unfair) impacts on individual teams. Much like college sport athletic conferences and professional leagues, class votes should require a majority of responses to implement league actions.

A variety of scenarios have been successfully utilized but the following are some that have received the most favorable feedback for enhancing student learning.

Tight End Strike (Appendix 3)

This scenario certainly teaches students about collective bargaining and its application to professional sport league management. More importantly, it also demonstrates to students that some franchises may vote a particular way for selfish reasons rather than for ideological purity. Ideally, this issue should be introduced in either the second or third week of the fantasy league season. By having the tight ends strike rather than most other positions, a small

[9] Of course, they will certainly be ordered in preference by highest-scoring to lowest among the group.

[10] The author often tells students to pretend that instead of $100 they have been given $100 million. If that were the case, what type of planning and explanation of strategy would the owner assigning such a large amount of money expect from the general manager?

group of franchises will likely be earning significant points from their tight ends while other franchises may not receive consistent points because in most seasons, there are a small number of NFL tight ends who contribute extensively to their teams' passing attacks. In addition, by strategically allocating the tight end credit demands, some franchises can evaluate the value of voting in a manner that provides their franchise a competitive advantage given their remaining credits compared to other franchises. While leading discussion before the vote, the instructor should cover impacts of various league decisions (if the league immediately submits to the tight end's demands, other positions may follow suit; is a "bad" message being sent to players striking while under contract, etc.) if league owners do not discuss them. For academic courses that involve collective bargaining, labor relations, league financial structure and player compensation as core topics, supplemental readings about the history of player unions (including materials regarding Marvin Miller, Gene Upshaw, etc.) and the current issues facing them today (salary caps, individual salary caps, player shares of overall league revenues, etc.) will enhance student learning.

Revenue Opportunity (Appendix 4)

Though it may appear that the European-based revenue opportunity provided is designed to teach globalization, it primarily is designed to provide a real-world example of how franchises often vote in their own best interests rather than for the benefit of the league. The revenue can be from any source, as the key discussion points are how to disperse this incoming revenue. The first revenue opportunity should occur in the same week as the tight end strike, or, ideally in the week following. It is important that there be at least a few weeks of results for teams to evaluate their standing in the class and to assess their upcoming schedule, likelihood of having a successful season that would generate opportunities to be the game-of-the-week, etc. When crafting the dollar figures attached to the revenue opportunity, it is important that the "capitalist" model provide many more total dollars than the "socialist" model so that some franchises can argue for the league receiving a higher amount of incoming money. Obviously, the decision to accept either of the revenue options will impact how the league operates throughout the remainder of the semester (and if the game-of-the-week option is selected, then the instructor has to evaluate and allocate additional credits each remaining week of the regular season). Depending on the course, additional readings can focus on revenue sharing models, the history of the NFL's "league-think," *free riding* by individual franchises when too much revenue sharing exists, and professional sport leagues that utilize promotion and relegation.

Sponsorship Opportunity (Appendix 5)

This revenue opportunity is designed to test the league's owner's ethical stance for or against potential sponsors that have taken controversial positions that may elicit public backlash. Though obviously a fantasy league, the use of "real" companies that have received negative publicity can cause many members of the class to be opposed to conducting any business with the proposed sponsor. Most importantly, if the issue is introduced after 4-5 weeks of the regular season, a variety of franchises will likely be out or nearly out of money and therefore more willing to take a deal to get any credits, regardless of the potential public backlash. Supplemental readings can involve corporate responsibility and how it has become a key component of many organizations' strategic plans.

Franchise Relocation (Appendix 6)

Offering some of the league franchises the opportunity to move is typically done once at least two of the franchises have lost enough games that pursuing a playoff position is unlikely and therefore their willingness to pursue the financial championship may be heightened. Certainly, the number of teams offered to move can vary depending on the size of the league (10 franchises versus 12 franchises) and how late in the year the issue is introduced (ideally with at least three weeks remaining in the regular season). The instructor needs to analyze the on-field and financial positions of each franchise to craft the offer in such a way that multiple opinions can be elicited. The franchises selected for the potential move may need specific coaching to help them prepare to best position themselves for a positive vote. Additional readings may focus upon league relocation rules and their impact

on the individual franchises and entire league (such as in the Rams' move from Los Angeles to Saint Louis in 1995), previous court cases (such as in the Raiders relocation lawsuits), revenue sharing, and the potential problems that occur when some franchises maximize revenue rather than pursue a winning on-field strategy.

Make-A-Wish Foundation Request (Appendix 7)

This revenue opportunity should only be introduced in the last or penultimate week of the regular season. The use of a fundraiser that removes players from a teams' active roster will typically create a variety of strategic moves for league teams, particularly among those facing the choice to pursue the money championship or attempt to secure a playoff spot. If the proper players from each roster are identified for "benching," then some franchises with a vested interest in a lower performing franchise competing with their full roster may be forced to negotiate to prevent the acceptance of the non-profit's offer. This issue can be supplemented with readings regarding *tanking* and its impact upon an individual franchise and the overall leagues' brand. Included in this discussion could be a detailed analysis of the NBA's Philadelphia 76ers and MLB's Houston Astros who have recently taken advantage of league rules that may encourage teams to not only perform poorly, but exceptionally poorly. Though designed to help the "worst" teams acquire the "best" players, the current MLB and NBA rules may have created a variety of unintended consequences (Jazayerli 2013; Lowe 2014).

Grading

Certainly, students will be worried about their grades and in some cases will be more concerned about their grades than their education. As noted by Banks, "Grades are the carrot and can conflict with learning" (2000, p. 23). At the beginning of the semester, the instructor needs to emphasize that fantasy football grading is based primarily on the quality of the written work and the observation of each team's thought process, weekly execution, and effort throughout the semester. Certainly, in the real world winning and making money is rewarded and there are rewards in the form of a limited amount of academic points for winning one of the two championships. However, given the "lucky" nature of fantasy football and the class setting, students should be assured that a bad grade does not necessarily get assigned for finishing at the bottom of the standings and, conversely, a league or revenue championship does not necessarily earn an 'A' grade. The instructor can continually remind students that the class project is ongoing and students will be evaluated on every aspect of their performance, not just their franchise's final record or amount of credits retained.

In any group setting, but particularly in ones where the instructor assigns the teams, there is always a concern that some class members will not be fully engaged. In each class where fantasy football is utilized, students are required to provide confidential feedback regarding group performance to the professor at regular intervals during the semester. This feedback (as well as instructor observations of group dynamics) is incorporated into the student's grades for the semester-long activity (which is usually 15-30% of the overall class grade to insure that each student understands the importance of every fantasy football activity). The instructor needs to remind group leaders, particularly students who clearly have the greatest incoming fantasy football knowledge, that not every group member is expected to be as knowledgeable as the others. However, every member of the group should be willing to work on items that they can accomplish and every group member should be learning about what is happening each week. The instructor can often provide simple quizzes in class where individuals have to provide information regarding their franchise's recent activities. Fortunately, the use of the two championship winners and the special league actions creates an environment where all franchises – and every class member - have a reason to remain engaged throughout the semester. The end-of-the-semester confidential review of each class member should solicit information concerning how less informed group members learned throughout the semester. This mandates the leaders of each group actively engage their group members and teach them about the intricacies of fantasy football.

In regards to specific assignments, students will often ask, "What do I need to turn in to receive a certain grade?" The pre-draft paper is one of the most difficult assignments for students to understand the amount of information

that can be gathered. Unfortunately, the proliferation of fantasy football information can often be a hindrance, rather than an asset, especially for students who are participating for the first time. Appendix 8 provides a grading rubric for the pre-draft paper. Though the rubric provides guidance, students will often need assistance understanding the instructor's expectations for the various areas. One of the best ways to get students working effectively in groups is to require a rough draft be turned in 3-4 days before the final paper is due. Instructors can quickly glance at the rough draft and provide initial feedback to the students, which will help focus the student's energies, without requiring too much of the instructor's time. The rubric can be modified for the post-draft paper by changing the expectations to focus upon what happened, what should have been done differently, how each team ranks in team performance positioning, and remaining money. For the mini assignments where only 2-3 pages of written work is required, it is fairly easy to emphasize to students similar components of the pre-draft and post-draft grading rubric. Ultimately, students can better assess their own work if they are asked to think of the following question: "If you were turning in this analysis for your job, do you think your boss would find it well developed, supported with evidence, and presented in a readable and actionable format?" To better demonstrate how all of the fantasy football assignments can be incorporated into a course, Appendix 9 details a sample grade weighting structure.

Fantasy Football Student Feedback

Since implementing the first fantasy football class activity in 2000, the author has utilized fantasy football in a graduate class (and a couple in undergraduate classes) every year except for 2006 and 2013. Each semester, data from every student is collected at the beginning of the term regarding fantasy football and general football knowledge and at the end of the semester (in an anonymous manner) regarding the appropriateness of the class activities, learning outcomes, etc. Each of the classes where this exercise was utilized was in a sport management program (sport finance, sport economics, introduction to sport management, strategic management in sport, etc.), rather than a general business class, though a small number of students from other graduate programs have typically taken these classes as electives each year. The collected data reveals some interesting findings:

Paralleling the growth of fantasy football throughout the United States, the general familiarity with fantasy football has increased dramatically as in 2000 and 2001 less than 25% of the students had previously participated in a fantasy football league[11]. Since the 2009 class, the number of students entering class having played fantasy football has been over 60%, with men having played at least once over 85% of the time. Nearly every American student since 2007 has at least heard of fantasy football, even if they had not previously played it. Reflecting the NFL's plan to increase female football knowledge and participation in fantasy football, from 2000 to 2008, few women (typically less than 10% each year) had previously played fantasy football before entering their graduate class. In 2009, that percentage began to gradually increase and in 2014, 70% of the female students indicated previous knowledge of fantasy football with 50% of them having participated in fantasy football or some other fantasy sport previously. Perhaps reflecting the NFL's problems (compared to the NBA and other North American-based professional sports) in international markets, the vast majority of international enrollees (greater than 90%) had no knowledge of fantasy sports, and fantasy football in particular, before entering the studied classes.

Despite the lack of previous knowledge among many students, participation in the fantasy class activities is typically perceived as providing a positive impact on learning and, in many cases, is seen as a lot of fun, though often not immediately. Students have frequently noted comments such as,

I was resistant to the entire exercise when it was first introduced in class, but I now understand how important it is and how it can engage fans.

It took a few weeks for me to understand why the class was doing this activity, but I realize now how much I learned and what I can apply to other areas of my professional life.

[11] Of note, in 2000 and 2003 when fantasy sports were introduced as class activities in the author's department, a number of other professors had no knowledge of fantasy sports, let alone any participation experience. In 2014, the author's department faculty started a fantasy football league.

Although every year there is a small percentage of students who indicate they did not "like" the activity, typically over 80% indicate they see how it has enhanced their learning of class material. It also creates some interesting friendly rivalries in class that students often indicate makes their time in class more enjoyable.

Despite having little knowledge of fantasy sports and fantasy football when entering the class, a number of international students each year indicated their appreciation for the activity[12]. In some cases, students have informed the author that they have taken fantasy football back to their home countries after graduation and have created their own fantasy leagues in various sports.

Though the fun and rivalry of the semester-long exercise has its merits, the ultimate evaluation of fantasy football in a class is the ability it has to train students to apply class material, particularly through the league issues that are introduced. Each year, a majority of students indicate that they have a much stronger grasp regarding how labor negotiations are completed, how revenue sharing can become problematic when individual franchises seek their own benefits solely, and how a variety of finance and economic principles can be applied. In most years, students provide comments such as,

I knew about revenue sharing but now can really relate to the positions that some franchises take when arguing with other owners about how league money should be divided.

Participating in the league issues made me better aware of how individual franchises often find it difficult to act in the best interest of the league, if it conflicts with their individual short-term best interests.

Conclusion

The proliferation of fantasy sports is likely to continue as both a marketing tool and as an educational activity. Participating in fantasy sports requires critical thinking and active use of research skills, topics that are important not only in sport management settings, but also other educational subjects. The fantasy football activity presented should not only enhance student learning, but create a fun class environment where students are engaged. Since initially creating and implementing the first fantasy football activity in 2000, the author has created additional successful fantasy activities based upon the National Collegiate Athletic Association Men's and Women's Basketball Tournaments, The Masters, and college football. Some of those assignments have been utilized in a variety of classes, particularly ones that are held in the spring semester. Though they are not exactly the same in structure and content, the pre-draft and post-draft assignments can mimic many of the learning outcomes in the spring semester classes that the fantasy football assignment accomplishes in the fall semester classes.

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[12] Over the past five years, a number of articles have been written regarding the proliferation of fantasy sports to international markets. The author often provides the entire class or specific students, articles covering fantasy soccer, Australian Rules Football, cricket and sumo, to reinforce its importance in getting fans to actively closely follow their favorite sports activities.

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Appendix 1

Sample Sport Finance Class Schedule Incorporating Fantasy Football Activities

Week	Topic
1	Course Introduction – The nature of sport finance
	Government Activity and its impact upon sport finance
Introduction of Fantasy Football Activity (30 minutes)	
2	Risk
	Fantasy Football Application (30 minutes)
3	Valuation
	Fantasy Football Application and Draft Preparation (30 minutes)
4	Fantasy Football Draft (2.5 hours)
	Pre-draft Papers Due
5	Financial Ratios
	Application of Ratios to Fantasy Football – Draft Review (30 minutes)
	Fantasy Football Player Transactions (10 minutes)
6	The Professional Sport Labor Environment
	Fantasy Football Strike (20 minutes)
	Fantasy Football Player Transactions (10 minutes)
	Post-Draft Papers Due
7	Budgeting
	Initial Fantasy Football Budget Review (10 minutes)
Fantasy Football Player Transactions (10 minutes)	
8	League and Team Revenue Development – Revenue Sharing
Fantasy Football Revenue Opportunity (15 minutes)	
Fantasy Football Player Transactions (5 minutes)	
9	Time Value of Money
Fantasy Football Player Transactions (5 minutes)	
10	Capital Budgeting
Facility Issues & Revenue Sharing	
Franchise Relocation Activity (15 minutes)	
Fantasy Football Player Transactions (5 minutes)	
11	Facility Financing
Fantasy Football Player Transactions (5 minutes)	
	Fantasy Football Make-A-Wish Opportunity (5 minutes)
	Case Analysis I Due
12	Feasibility Studies
Fantasy Football Player Transactions (5 minutes)	
13	Economic Impact
Fantasy Football Playoffs	
	Fantasy Football Player Transactions (5 minutes)
14	Debt and Equity Financing
Fantasy Football Playoffs	
	Fantasy Football Player Transactions (5 minutes)
15	College and Non-Profit Sport
	Case Analysis II Due
16	Final Exam

Appendix 2

Fantasy Football Rules

During this semester our class will form a fantasy football league as a supplement to class activities. The league will provide an opportunity for students to apply their knowledge of strategic management, finance, and economics to a "real-life" situation. Similar to major American sports' leagues, the purpose of the season is to win as many games as possible *and/or* save as many financial resources as possible. Teams will compete in a head-to-head format each week with the ultimate goal of advancing to the Class Super Bowl. There will also be a money champion awarded to the franchise that accumulates the most credits at the end of the year (I used to call this the Mike Brown Memorial Trophy but there were too many complaints that it was unfair to Bengals' fans and Mike Brown, so I no longer do that).

Throughout the semester teams will have the opportunity to acquire additional resources, determine league rules and procedures, and manage potential problems in the areas of scarcity, revenue sharing, budgeting, administration, sponsorship and many others. During each Wednesday class session there will be a league meeting to detail the previous weeks' performance, debrief the owners regarding upcoming events, and provide an opportunity for owners to debate and vote on new proposals.

Some of the rules of the league will be determined as the season progresses. There will also be situations that affect the league that are beyond the control of the owners (i.e. introduced by the commissioner). Please remember that this exercise is primarily for educational purposes-learn, have fun, compete and remember that the commissioner has final authority on *all* league matters.

Assignments/Reflection Papers

Throughout the semester there will be numerous opportunities for the league owners to vote on proposals. In the week immediately following a vote, one team representative must complete a brief (2-3 pages maximum) discussion of the team's voting position. Please analyze the league proposal and determine its potential effect (both if it would have passed or failed) on **your franchise** given its current (and/or) future position. If you are unsure what to discuss, imagine that the issue was presented to ESPN to analyze and then tell me what happened for your franchise and, more importantly, WHY. There will be *at least* two league issues so each class member should have an opportunity to "lead" on one reflection paper this semester.

Students will complete other assignments as a team to provide a "real-life" experience. Information regarding the guidelines and expectations for these assignments will be distributed during the semester.

Rules

Each team has **100 credits** to begin the season. This is not a salary cap-it is merely a limit to what a team can spend at the draft. If a team can acquire additional resources through league activities, player transactions, etc. it will increase its ability to acquire additional players later in the year and to compete for the most "credits" award. Every credit spent on a player or other activity is removed from the league. So if team A spends 80 credits on players at the end of the year they would have 20 remaining credits (assuming no additional credits gained/spent during the year). A team can never overspend or assume future income to cover current costs. If you need a player you must have the money *at that time* to acquire the player's services.

Once a player is purchased, he may be traded for other players or credits with no ramifications on a teams' resource allocation-a player initially purchased for 10 credits may be traded for a player who was originally purchased for one credit. Essentially, teams have two things to worry about-maintaining their rosters and monitoring how many *remaining* credits they have. Similar to the real NFL, teams may trade and/or sell players to other teams BUT the commissioner maintains the right to review trades to protect the integrity of the league (an all-out fire sale will likely be rejected by the commissioner [see Bowie Kuhn and the Oakland A's in the 1970s]). We will use a limited amount of class time (15 minutes) for "normal" non-debate weeks during the season. This means teams must come to class on Wednesdays with trades ALREADY completed and with potential roster moves ready to be executed. At certain times during the semester, league issues may take more time, but for ordinary activities the teams should anticipate only 15 minutes to conduct transactions.

Note-TEAMS may change their weekly starters on yahoo at any time prior to the start of NFL games. HOWEVER, only the commissioner may execute roster changes (free agent acquisitions, trades). Team owners (though able to on yahoo) MAY NOT drop, add, trade, etc. any player outside of class time. Any individual doing this will receive a zero for ALL fantasy football assignments. We had a class member a few years ago who did this and it was not good for his final grade (or his standing in the class).

Roster

Teams will select their players using an auction format. Players must be purchased for a minimum of one credit. This allows every team to have a chance to bid for the particular players they want. The highest bidder is awarded the exclusive rights to the player. Teams must not exceed their initial 100-credit limit (at the draft) and must maintain the following roster specifications (at a minimum) *throughout* the season:

2 QB
3 RB
4 WR
2 TE
2 K
2 D/ST

(Players playing more than one position will be placed in the position deemed most appropriate by the commissioner on draft night for purposes of the class "minimums.")

After the draft is complete, a roster can exceed these minimums (read on for details). However, yahoo only permits rosters to reach 29 players maximum.

Each week teams must start the following positions

1 QB
2 RB
3 WR
1 TE
1 K
1 D/ST

Scoring will be as follows

All touchdowns (by any method) 10 pts
1 point for every 25 yards passing

So a QB who throws for 333 yards and 1 td gets (10 + 13 = 23)

1 point for every ten yards of rushing or receiving

So a 50 yard rushing and 50 yard receiving game gets 10 points.

4 points for any 2 point conversion
2 points for a PAT

Interception = -3
Fumble lost = -2

FGs
3 pts – <20 yards
3 pts – 20-29 yards
4 pts – 30-39 yards
5 pts – 40-49 yards
6 pts 50 yards +

Players may receive points from any position and by any method (if a RB throws a td he gets the passing yards).

Defense/Special Teams

Sack – 1
Interception – 3
Fumble Recovery – 3
TD – 10 (can be from interception, fumble, kickoff or punt return)
Safety – 5
Block Kick – 3
Points allowed:

0	25
1-6	18
7-13	10
14 -20	3
21-27	0
28-34	-3
35+	-10

Games will be played each weekend until the top six teams play a single elimination tournament (one & two seeds get byes) starting in week 11 of the NFL season (Nov 13-17). Each team will play one game against every other team.

Trade deadline in the league is October 15th. Transactions (add/drops) may not be made after November 13 EXCEPT that each playoff team may make one add/drop or add during the first two rounds of the playoffs. That is ONE total move for the entire first two weeks of the playoffs.

Transactions

Teams control the ability to change their starters/bench players on yahoo (remember bye weeks!). However, teams may only make weekly adjustments to their overall roster (add, drops, trades, etc.) in class. **It costs credits to make changes to your roster**.

Trades (or other cross-team activities) **cost each team involved** one credit-although the initial purchase price of the player is meaningless in these transactions).

Waiver wire pickups

Although at the draft the minimum player cost is one credit, after the season has begun costs increase. To drop a player and add one to your roster will cost a minimum of **two credits**.

To add an additional player without removing a player (which may be done a maximum of **one time per week**) costs a minimum of **three credits**. Each week you may expand or change your roster (**Note**, the maximum of players per roster on yahoo!)

Player transactions will occur as follows: each Wednesday teams will submit **"silent"** requests for additions and/or deletions to their roster to the commissioner during class. Teams must clearly indicate what they intend to do (add and delete or just add, etc). The professor must be able to determine the teams' request or it will be denied. Teams must include what they are willing to pay for this particular transaction. In the event multiple teams want the same player, the highest bidding team will receive the player. In the event of a tie in silent auctioned $, the player will be awarded to the team with the lower record (based upon won-loss, then total points). Teams may need to submit multiple requests for players to protect themselves from not receiving their first choice of transactions.

Each week head-to-head competition will yield a victory, loss, or tie for every team. Standings are compiled first by win-loss record and then by total points scored during the season (so a high scoring loss still may help your playoff chances).

Draft – Sept 10

For draft preparation:

www.yahoo.com
www.espn.com
numerous other websites provide info for fantasy football cheat sheets, etc.

Schedule: See Yahoo website

League ID: TBD
Password: TBD

(one important note, make sure the yahoo user name you utilize has one of the team's owners in it)

Team 1 – See me for registration information since the commissioner has to have a franchise in the yahoo league

Once the yahoo league is established, each team should create a team city/region, name and logo (please create one to import on yahoo or at least make one to turn in at class), please do not just simply use the standard helmets) and should have these ready for the draft.

Pre-draft paper: your franchise must write a paper outlining your upcoming draft strategy. INCLUDE SPECIFICS beyond, "we will draft the best players at the best price." Most students do a poor job on this paper, so begin to plan what you will do (and get me involved with rough drafts, ideas, etc.). Take a look at ESPN to see how detailed these papers could become. This paper is due on September 10th at 3:55pm.

Important items to cover:
What is your overall philosophy – money or victories?
How much money will you keep for post-draft moves?
How did you determine the projected productivity of each potential draftee?
How do those point projections convert to a dollar amount given our league size, budget, etc.?
What players are significantly over or underrated and why?
What specific strategies do you have for each time it is your turn to "nominate" a player in the live auction?
Provide details for any other important component that would indicate that you are prepared for the season.

Post-draft paper: Once the draft has concluded, each franchise should evaluate the draft results. Assuming your pre-draft papers have been done effectively, it should not be difficult to tabulate how each franchise should perform during the season (may need to do analysis of "starters" and then also evaluate bench players). A discussion of money spent on players and remaining money for each franchise is an important component of the post-draft analysis. Indicate areas of concern you have for your franchise and evaluate what picks may have been especially poor and what picks may have been especially good for your franchise and others. Explain what you learned from the draft that would cause you to behave differently if the draft were redone.

Appendix 3

Tight End Strike

Please come prepared to discuss these issues in class. Remember, any league vote requires a majority of teams (6/10) to agree. For the following week (10/1), each franchise must write a 2-3 page response explaining how the situation impacts their franchise, their desired outcome from league deliberations, and their motivation behind their actions/response/vote.

The commissioner has been informed that the league's tight ends have formed a new union-The United Tight End Players Association. The tight ends feel the league's owners have neglected them. The new union has demanded changes to the current salary structure.

The union is proposing an across-the-board strike of all league tight ends if their demands are not immediately met. Each TE wants a two-credit increase in salary. This increase would not affect new signings (would still only be a minimum of three credits to add, two credits to add/drop, etc.) but would immediately increase the payrolls of all teams.

The league owners can respond to their demands with the following solutions or attempt to find an alternative way to resolve this dispute. All decisions must be approved by at least six votes from the league owners.

1. Reject the tight ends' request for additional pay, or table the discussion until the following week for further review by the leagues' owners. This solution would eliminate the use of tight ends during games this week, as they would be on strike. The commissioner could then take a counter proposal to the union during the week.

2. Agree to the tight end's request but let the individual owners pay their tight ends. This would require each team to pay two additional credits to continue to use one of their TE (or four credits to use both TEs). Teams that could not or would not meet the financial requirements for their individual TEs would be forced to not start a player in the TE slot. Under this solution, teams will agree to the TE's demands but may not elect to increase their individual player's salaries on their roster. A team could theoretically only activate one TE for this week (and the rest of the season) by paying two credits to increase their salary.

(A second potential option if the league chooses #2 is for teams to have two weeks to meet the TEs request. If the requests were not met after two weeks, the teams could lose their TE to the leagues' free agent pool.)

Appendix 4

Revenue Opportunity

European Football Ventures (EFV), a new media company, has offered to broadcast one of the leagues' games live each week in Europe for the remaining weeks of the regular season (starting with games on Oct 2). This would provide the league valuable exposure throughout the world and future potential revenue opportunities. The league would also be positioned as one of the first American sport organizations to fully "expand" into the European market (for the sake of the league discussion it is assumed that this would have no impact on current television/radio deals).

EFV has proposed two different revenue packages available for the league to consider if we decide to accept their offer to broadcast games.

1. Each franchise would receive (on Oct 1) five total credits for their participation with EFV regardless of which teams are broadcast.

2. Each franchise would immediately receive two credits for participation, would receive one credit on November 5, AND each week EFV (with the help of the commissioner) would decide one "game of the week" for broadcast. Those two teams selected each week for broadcast would receive three credits for being selected the first time. If they were selected a second time, they would receive five credits (and three for a third, fourth, etc. appearance). In the final two weeks of the regular season, there would be two "games of the week" and four teams would receive credits for appearing. Teams would be selected for broadcast based upon their likelihood to present the best possible game for the audience, so criteria like overall record, recent performances, overall health of the roster, etc. would contribute to the game-of-the-week decision.

The league may also propose other revenue options, but they might require a week for the commissioner to confer with EFV. A majority of league franchises must agree (6/10) for a proposal to be accepted.

Appendix 5

Sponsorship Opportunity

In an effort to secure revenue for the league, the commissioner has been active in pursuit of sponsorships. Promising leads have been developed for corporate partners. Our league must decide if we would like to accept the offer of one of the following companies to become our top corporate partner of our league. The primary benefit our top corporate partner would receive is their name and logo on all league materials (schedules, webpage, etc.).

This partnership will provide revenue, but it also ties our organization to the activities of the sponsor. There are other potential sponsorships and "other" revenue opportunities (that will likely be more lucrative) that are nearing completion. Any activity we take may impact future operations, especially if it changes fan perceptions of our league. As usual, all offers are open to negotiation.

The following offers have been made:

Solyndra will provide each team with 3 credits of revenue for the right to be the top corporate partner.

Crazy Horse Gentlemen's Club has also offered 5 credits per team for the right to be the top corporate partner.

We can only have one “top” corporate partner. We do not necessarily have to have one.

We must have a majority vote (6/10) in favor of adopting either of the offers or no action will be taken.

Appendix 6

Franchise Relocation

The commissioner has been investigating opportunities to increase revenue and an interesting proposal has just been received. Two cities in Europe have requested that two teams in our league move to Berlin and Moscow. These cities understand that having teams move in the middle of the season is an inconvenience and they are willing to compensate the league as a whole and the individual owners. The cities have identified which teams they would like to have move:

Berlin – MorganUBargained4
Moscow – The Decepticons

Realizing that travel to and from these cities will be cumbersome, the cities have proposed that each of the non-moving teams receive three credits immediately and moving teams receive a set payment on the day they move – which will be one week after the vote is approved. The payments will be MorganUBargained4 – 8 and Decepticons – 10 (payments vary by cost associated with distance). In addition, any of the non-moving teams that play one of these teams (starting on Oct 22) will receive a two-credit bonus that week to cover the increased travel costs.

The cities have also proposed a second option where each team in the league would receive two credits immediately and the two teams would move at the end of the year (there would be no extra money for the moving teams or teams they play this year).

With either option, the two moving teams would have to elect to BOTH move AFTER the league has voted with a majority vote (6/10) for the proposal. The move will not work unless the league gets 6 yes votes to move and then the two "moving" teams agree. The implications of this ruling can be discussed prior to class and prior to the class vote (moving teams should see me if they have any questions).

There are certainly other potential payment options, but they might involve the commissioner having to discuss the situation with the cities (which would take a week).

[Depending on the remaining credits that each team has and the remaining weeks in the regular season, the following additional announcement may be made with this revenue opportunity:

There will be at least one more opportunity to generate revenue, likely in the second-to-last week of the regular fantasy football season season. That revenue opportunity will NOT be dependent on other teams impacting individual team choices, though individual teams may not be in a position to want to accept that revenue opportunity.]

Appendix 7

Make-A-Wish Foundation Request

The Make-A-Wish Foundation has contacted the league about selected players appearing at a special banquet this weekend. If the teams are willing to send their players, they will receive three credits. Of course, if those players attend the banquet, they will be INELIGIBLE to compete for their teams this weekend. The following players were selected:

Peyton Manning
Julius Thomas
Aaron Rodgers
Drew Brees
Demaryius Thomas
DeMarco Murray
Tom Brady
Andrew Luck
Calvin Johnson
Arian Foster

If your franchise wishes to "bench" your player, you can report that to the class on Wednesday night. You will receive the three credits immediately (of course, the player must be benched this weekend) and these can be used immediately in this week's free agent transaction requests. There is no requirement to write a 1-2 page paper about this issue. Remember, the playoffs are quickly approaching and there is a deadline for ALL player transactions!

Note – you may negotiate (pay) other teams regarding their choice to play or bench their players.

Appendix 8

Fantasy Sports Grading Rubric – Pre-draft Paper

Score	Excellent (100%)	Good (90%)	Satisfactory (80%)	Unsatisfactory (70%)	Unacceptable (less than 50%)
Analysis of "The Plan" (35%)					
/7	Demonstrates a thorough understanding of the general issues of the assignment, how the fantasy rules impact potential team structure, amount of money saved for post-draft activities, historical performance of fantasy football players, and the philosophy your franchise will employ given these areas (and other areas of impact not specifically required).	Demonstrates a grasp of the major issues of the assignment with only 1 or 2 minor omissions or areas of deficiency.	Demonstrates an understanding of most of the major issues of the assignment with only one major issue omitted, or has excessive minor omissions.	Missed more than one major aspect of the assignment.	Missed more than one major issue in the assignment and has excessive minor omissions.
"Financial" Evaluations (35%)					
/7	"Correctly" completes and justifies player valuations (based off of established franchise dynamics previously explained and the unique nature of each individual player)	Has only minor errors in player evaluation or insufficient valuation justifications.	Made several errors when completing the player evaluations or fails to provide sufficient valuation justifications.	Made major errors when completing the player evaluations or fails to provide significant support for valuation justifications.	Made several major errors when completing the player evaluations and/or provides no justification for valuation justifications.
Conclusion (15%)					
/3	Effectively synthesizes and summarizes the analysis and financial calculations to form a coherent plan of action. Provides insights regarding proposed draft plans (who to throw out in the auction, etc.) and areas where players and/or individual positions have over or underrated amounts of value.	Synthesizes or summarizes the analysis, but the solution misses important points.	Does not synthesize or summarize the analysis but does mention some components necessary to proceed effectively.	Provides some usable plans, but those are not based upon any synthesis of information.	Does not attempt to synthesize or summarize, or or provide any actionable insights.
Writing Mechanics (15%)					
/3	Has proper spelling and no errors in grammar.	Has only a few minor errors in spelling and grammar, and these are not distracting and do not affect the reader's comprehensio n.	Has frequent and noticeable errors in spelling and grammar.	Has an excessive number of errors in spelling and grammar.	Has an excessive number of errors in spelling and grammar, and these greatly distract and affect the reader's comprehension.

Appendix 9

Sport Finance Grade Weighting

Assignment	Percentage of Overall Course Grade
Quizzes and Participation	10%
Pre-draft paper	15%
Post-draft paper	10%
Mini-fantasy assignments	5%
Case Analysis I	10%
Case Analysis II	10%
Final exam	40%

Common Resource Bargaining: A Collective-action Game

Stephen Cotten and Robert F. Hodgin[1]

Abstract

We present an intuitive, time-efficient common pool resource game set in a flexible framework that illustrates collective-action conflicts. The game's interactions demonstrate that not all economic markets yield privately or socially efficient results. Students own tracts of land with access to oil. In the first (optional) stage, students manage the resource rights; in the second stage they make resource extraction decisions. Students' understanding of markets deepens via the conflicts from interdependency versus incentives in common resource allocation. Economic issues addressed include collective action, contracting problems, game theory and externalities.

Keywords: Classroom game, bargaining, common-pool resources, pro-rationing

Introduction

As the gap between the analytical tools used for cutting-edge economic research and the skills possessed by undergraduate students has widened, pure theory-based undergraduate economic education has separated from what many economists actually do. Several authors have suggested ways to close this gap without requiring students to increase their prerequisite knowledge for undergraduate economics courses. Ferguson (2011) suggests more coverage devoted to collective-action problems with social and strategic interaction among players. In concert, Colander (2005) suggests moving from models as descriptors of the economy toward models as guides, addressing specific questions while emphasizing broader social and economic complexities like those presented in Giraud and Hermann's (2002) scenario-based approach.

There is a push toward more active learning in economics courses. The tools of experimental economics, where student research subjects are often used in laboratory markets, can be repurposed for use in the classroom. These classroom experiments can demonstrate the power of economic theory by accurately predicting the decisions students will make, in large groups, with complex parameters, prior to making them. Existing games range from trading colored paper needed to buy wheat to demonstrate purchasing power parity (Mitchell et al, 2008), to letting students self-report grades to show the incentives and social implications of fraud (Balaban, 2006), to using candy bars thrown on the floor to simulate the common-pool resource problem with fisheries (Wentworth and Ratte, 2002), to students choosing investment levels when total investment levels increase payoffs to show how uncertainty of future economic performance can cause a recession. (Hazlett, 2007). There are hundreds of these experiments, and students walk away from the well-designed ones impressed with the ability of economic theory to explain observed behavior.[2] We add to this literature by presenting a core game with additional modules. The core game is a simple common-pool resource dilemma, which has been addressed differently by other authors (e.g. Wentworth and Ratte (2002), Murphy and Cardenas (2004)). Students hold land over a common oil field and may choose to build costly wells to extract that oil.

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[2] See Charles Holt's Classroom Experiment page for a large list of classroom games. http://people.virginia.edu/~cah2k/teaching.html. A similar page is operated by Greg Delemeester and Jurgen Brauer at https://www.marietta.edu/~delemeeg/games/

Each additional well increases the share of oil extracted by the student, but decreases the total extraction from the field, reducing allocative efficiency and imposing a negative externality on other student well owners. We allow students to trade the land or form joint operation agreements as a way to avoid the CPR problem, but these mechanisms face problems of bargaining costs, uncertain information, and hold-up.

Design, Implementation, and Lessons Learned

The Well-Building Game

The core of the game is the "well-building game", designed to illustrate the common–pool resource problem. Common-pool resources are rival, but non-excludable. With open-access, there is tension between individually-optimal behavior and group-optimal behavior as users inefficiently race to acquire the resource ahead of other users. This "tragedy of the commons" (Hardin, 1968) results in exhaustion of resources that cannot replenish themselves, and for both renewable and nonrenewable resources, leads to an overinvestment in extraction and storage tools and more volatility in prices. In the case of oil, the race to extract creates a drop in the subsurface pressure and reduces the amount of ultimately recoverable oil (Wiggins and Libecap, 1985).

In our game, tracts of land, on individually numbered pieces of paper or small index cards, are divided randomly among the students. Each tract of land provides access to a common pool of oil, where a student may build one costly well on each tract of land they possess. The common-pool resource dilemma is that each well increases the share of oil extracted by the student (the private incentive) but decreases the total amount of extracted oil (the social cost). In the game we have run successfully many times there are 100 tracts of land, extracted oil sells for $100 per barrel, each well costs $1 million, there are 2.5 million barrels of oil in the field, and the percentage of that oil that is extracted is $\frac{201-W}{200}$, where W is the total number of wells constructed.

On a sheet of paper, students record their name and the number of wells they wish to build, and return that paper along with their tracts of land to the instructor. They do not tell other students their build order. The instructor records each build order by hand or in Excel and sums the number of wells to calculate the total amount of oil extracted from the field $(\frac{201-W}{200} \times 2{,}500{,}000)$, where W is the total number of wells, and the profit of each student is $\pi_i = \$100 \times \frac{w_i}{W} \times \frac{201-W}{200} \times 2{,}500{,}000 - 1{,}000{,}000 \times w_i$, and w_i is the number of wells constructed by the student. Students receive the share of total oil commensurate with their share of wells built (e.g. a student building 5 wells where a total of 25 are built receives 20 percent of the total yield). The first term is the revenue from selling oil from the field. The second term is the cost of the wells. Students usually hew close to the Nash equilibrium and purchase a socially excessive number of wells. The instructor reveals the build orders to the class at this time and the game is complete.

We have conducted this game in class for both undergraduate and graduate students at the University of Tennessee and the University of Houston–Clear Lake. We first run this game *before* discussion of relevant issues. Students therefore enter the lecture portion of the relevant lesson with a demonstration of how their behavior leads to the predicted outcomes, though it could easily be run after the related discussion for illumination. The core design remains the same between introductory and advanced classes, but the depth of the discussion and analysis of the game is deeper in the more advanced course. Introductory students are asked for a qualitative analysis of the game, or for basic mathematical analysis. Advanced students are typically asked to derive the privately and socially optimal outcomes and describe optimal behavior in a number of scenarios. In the appendix, we attach some of the discussion questions we have used in the past.

To improve time efficiency, we give students the relevant instructions one class period in advance and ask them to consider the decisions they would make before we play the game. We ask that they not communicate with other students about their plans, and they appear to respect our wishes. To provide an incentive to make careful decisions, we tell the students that we will award extra credit that is scaled based on performance in the exercise, though other incentives such as cash or candy will serve as well. We briefly quiz the students over the basics of the instructions (e.g. How much does a well cost? If 20 wells are built in total, how much oil is extractable from the field?). We do this online where we can make them take a quiz until they make a perfect score, but paper works as well. This is an additional reinforcement to make sure they understand the game before returning to class to play it. With the students primed with the instructions, this game is generally completed within 15-20 minutes. Most students will build wells on every tract of land they own, as theory suggests they should, even though this reduces total yield. The best outcome for society is for one well to be built that extracts the oil. Like any good common-pool resource game, the decision

environment clearly reveals the tension between privately optimal and socially optimal decisions, and the externality that extraction imposes on other users.

The Land-Trading Game

The well-building game is a nice illustration of a common pool resource problem, but there are other competing CPR games (again, Wentworth and Ratte (2002) is a favorite). The fun, and insight, begins when we expand the game to give students the chance to overcome the common-pool dilemma. The first mechanism is to let students buy and sell the tracts of land they have received in an open-pit market, before playing the well-building game. Students recognize from the well-building game that if they become a monopolist[3] of the field, they will make much more money than if they all compete. The instructions for this game *do not* need to be given out in advance, although there is no harm in doing so. What is very important is that students have played through the well-building game at least once because they need to understand the value of optimally building wells to make good decisions in the land trading game.

The one addition to the land-trading game from the well-building game is currency. Each student gets $300 million in small bills (1-$50, 6-$20s, 6-$10s, 10-$5s, 20-$1s work well). Then they buy or sell their land, which is once again randomly and relatively evenly distributed. It matters very little if a student gets one fewer land tract than others, though we often take that into account when calculating credit. We have tried to use realistic parameter values to give students a feeling they are making oil extraction decisions for real, but instructors are free to scale down the parameters, which reduces the pieces of paper. Using record sheets should be approached with caution. We have found that accounting errors discovered at the end of the game induced students to buy land they could not actually afford, and skewed the results. We also tried having students sign contracts for trading land, but the trades happen so quickly that the recording process becomes a bottleneck. Using fake cash, while it increases the setup time for the game, enforces budget constraints and makes trade accounting smoother. The students simply report their final cash balances, and so cash only needs to be counted if the total adds up to less than the total amount of cash in the system.

The land-trading game is where class size makes a difference, more in the preparation time than in the processing of the game. Since the best learning occurs when students fail to reach a complete bargain, larger class sizes actually *increase* the odds of a desirable outcome. The amount of prep-work (ensuring the students receive and understand instructions, creating and counting initial allocations of currency) scales up linearly with the number of players. Once students are given the signal to begin trading, the room gets chaotic, with ambitious students running around trying to make deals as quickly as possible. A few will generally ask the instructor to clarify what exactly is going on, though advance instructions minimize this. The instructor knows the game is near conclusion when a handful of students is offering deals to one another, none of which are accepted. The students, as inexperienced traders, face the disparity between the maximum they are willing to pay for land they wish to acquire and the minimum they are willing to accept for land they hold (Horowitz and McConnell, 2002, and List, 2003). In addition, we frequently hear selling-students tell potential buying-students that they should be approached later, suggesting that they are trying to be the last to sell in order to extract a hold-up. In post-game discussion, we generally ask these students what they were thinking and they admit as much. Once trading quiets down, we give a five minute warning. The last couple of trading minutes generally are quiet, as trade has deadlocked. The would-be monopolists holding onto land typically end the game frustrated that they cannot close a deal for the last tracts of land. This part of the game takes a total of 15 minutes, then the well-building game begins. Students bring to the instructor their land cards, currency, a statement of how much currency they have, the number of wells they wish to construct. A build order is valid as long as the wells to be built are equal to or less than the number of tracts of land they possess. Then calculation of profits proceeds. If there is a discrepancy, we announce provisional results then count currency to calculate final numbers. The land-trading/well-building combination takes 30 minutes, so we run a well-building round, then a land-trading/well-building round in a single 50-minute class.

Several learning objectives are achieved via the land-trading game. The first is the role of transaction costs and uncertainty in bargaining. Bargaining will almost certainly fail due to a combination of too many parties and

[3] Most introductory economics classes focus their attention on how competition is better for society than is monopoly, but with this CPR game a monopolist provides efficient resource development. We remind students when this comes up that the oil is being sold into a competitive market (hence the fixed $100/bbl price), but we are often able to relate this as similar to the case of natural monopoly.

uncertainty regarding the final value of the land. With our parameterization, the value of each tract of land can range from $262,500 to $2,490,000, a very large relative range. The marginal value of buying an additional tract of land increases faster than the average value of a tract of land, as the number of tracts owned by the largest landowner increases. This reality comes from the fact that if one player successfully acquires all of the land, he or she can build one well at a cost of $1,000,000 and extract all 2.5 million barrels for revenue of $250,000,000. That is a profit of $249,000,000 spread over 100 tracts of land. If, however, the land is spread out among many landholders who each build one well, only 50.5% of the oil is extracted for total revenue of $126,250,000 on a cost of $100,000,000 for 100 wells. That yields a profit of $26,250,000 over 100 tracts, or $262,500 per tract. When a student sells land, he or she may be unloading a tract worth $262,500, or in the most extreme case where a student has 99 tracts of land and only 1 more is available, one worth $43,125,000[4]. Furthermore, as the number of landholders decreases, the average value of all land increases. It quickly becomes clear to students that they will benefit by being the last to sell (invoking hold-up). If nobody moves first, trading gridlocks.

One nearly identical variation is to place the students in groups and pass out tracts of land to between 3-6 different holders. With fewer actors there are fewer transaction costs and bargaining sometimes (though not always) reaches a successful conclusion. With the brainpower of a group, students often discover the mechanism of contingent contracts and only agree to buy if other groups agree to sell to them.

Finally, land-trading changes the character of the well-building game. If one landowner captures more than 10 tracts of land, it ceases to be optimal to build on every single tract of land. Optimizing behavior becomes more subtle. The amount of additional oil captured ceases to be worth the cost of the well plus the reduction in oil received by other existing wells. This is discussed in the model in the appendix, but the optimization problem with concentrated land-holdings is a teachable moment for students.

Unitization Game

Unitization is a form of joint-operation agreement. Wiggins and Libecap (1985) discuss unitization agreements, where a single firm develops the oil field and shares the net returns with all parties. This is not to be confused with pro-rationing, where quota assignments control individual output (Libecap and Wiggins, 1984). One solution for students is to agree among themselves to *act like a monopolist*, by choosing to build one well collectively then splitting the profit between them. Give students the ability to set up enforceable joint-operation contracts in the land-trading or well-building game and they can get this result.

The real-world problem with oil is that it is difficult to allocate production to each tract of land. Optimal management of a field often requires that inert gas and water is injected into reservoirs to raise pressure to extract more oil. Injection into one side of a field will push the oil toward wells on the other side of the field, so the revenue from oil has to be divided up before the oil is extracted. Likewise, extraction at wells will reduce pressure at that well, drawing oil toward it and away from other wells. Therefore, a rule that owners are paid based on how much oil comes out of their wells will not work because where the oil is extracted may be manipulated by the operator. Also, owners of land may have very good information about what resources are extractable, but less accurate information about the surrounding land. The neighboring tract of land may be very expensive to drill through and be nearly worthless to overall extraction, so paying a uniform share to all land is unattractive.

We simulate this problem through the unitization game variant, using instructions included in the appendix. A little bit of work is added since each tract of land now needs a private and common value (in the past we have used the same 2.5 million barrel common reservoir but added from 3,000 and 20,000 barrels of privately extractable oil to each tract of land–different values on each card). Instead of trading land, students may make binding joint-operating contracts, choosing to team up with each other and divide up the total amount of oil they extract. As an example, assume there are 3 students (A, B, C) sharing the 2.5 million barrel reservoir. Student A has private information that her land has 500,000 barrels of private oil on it, student B knows she has 300,000, and student C knows he has 200,000. A knows her private oil is relatively high and C knows his is relatively low, and after haggling they agree on a 60% split for A then a 40% split for C. The two bargain with B and agree that the A-C combination gets two thirds and B gets one third. They then play the well-building game, with A receiving 60% of 2/3 of the oil, B receiving 1/3 of the

[4] In the 99-1 case, privately optimal behavior calls for 9 wells over the 99 tracts and 1 well on the 1 tract. Profit to the single tract of $22,875,000, and profit to the 99 tract holder is $205,875,000. Since profit is $249,000,000 to the holder of all 100 tracts, that implies a maximum WTP of $43,125,000 (and minimum WTA of $22,875,000) for the final tract. Not even MBA students figure this out on the fly (though we pose this as homework after the fact), but many students definitely get the feeling they want to be the last to sell.

oil, and C receiving 40% of 2/3 of the oil. If the A-C group had not reached an agreement with B, then both groups would go into the well building game separately.

We find that students are able to successfully unitize, at which point they earn monopoly profits as a group after their prior experience with the well-building game. We also find, in line with literature on this problem, that individuals with land that has good private holdings are willing to subsidize the individuals with bad holdings in order to get a deal done, and reap the gains from having fewer wells built in the well-building game. Individuals with poor land are able to exert "hold-up". The ladders of shares that form (e.g. 60% of 2/3) can be tracked in Excel, and with prior experience land trading and well building, students can generally complete this variation within 15 minutes. Students unitize extremely quickly when there is no uncertain information, but it is more difficult with the uncertain information. This situation also is in line with data regarding unitization agreements reached on private versus public lands.

Conclusion

The common starting point for traditional introductory and intermediate economics courses--a focus on pure competition and rationality which assumes away transactions costs and uncertainty to demonstrate the limits of allocative efficiency--leaves students sensing a separation between theory and reality. We believe it is important, even in basic courses, to illustrate why there are complex regulations, contracting regimes, and imperfect outcomes. In that vein, we offer a time-efficient, active learning game to demonstrate some economic consequences from alternative market structures.

For this game we use oil–a commodity students easily relate to in their daily lives. The game vividly demonstrates *in*efficient market outcomes and collective action problems, using the multiple variations from the base structure, eliminating the need to explain a new decision environment for each application. The students learn from the simple economics of market failure, where all of the math is in front of them as they strive to achieve an optimal outcome. They directly observe the effects of uncertainty and asymmetric information. They are able to grasp how rules and institutions may be required to foster more efficient, but still imperfect, outcomes. In addition to the lessons, they have some fun, frequently citing the game as one of the highlights of the class on their end-of-year evaluations.

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Appendix

Instructions for the Well-Building Game

In this game, your role is that of a fortunate landowner who owns the mineral rights to land on top of a newly discovered oil field containing 2.5 million barrels of oil. A total of 100 tracts of land exist for this field.

You are about to participate in an experiment that will last for two stages: an assignment stage and a building stage.

1. In the assignment stage, each player holds a number of tracts of land and $300,000,000.
2. In the building stage, each player will build wells. Each tract may only contain one well, so each player will submit on the provided sheet of paper the number of tracts on which they wish to build a well. Each well costs $1,000,000. Also, each total well *beyond the first* reduces the overall yield of the oil field by one-half of a percentage point, so 21 wells reduces the yield of the field to 90%.
3. Once the build orders are submitted, the total number of wells built will be calculated which determines the yield of the field. Each player will then receive a share of the yield equivalent to their share of the number of wells built. For example, if 21 total wells are built and a player has constructed 4 of those wells, then that player will receive 4/21 of the 90% yield of the oil field.
4. All oil sells for $100/barrel.

Instructions for the Land-Trading Game

In this version, you are playing the role of a fortunate landowner who already owns the mineral rights to land on top of a newly discovered oil field containing 2.5 million barrels of oil. There are 100 tracts of land on this field.

You are about to participate in an experiment that will last for three stages: an assignment stage, a trading stage, and a building stage.

1. In the assignment stage, each player holds a number of tracts of land and $300,000,000.
2. In the trading stage, each player is able to buy and sell their mineral rights (in the form of tracts of land) to other players. Use your provided cash for these transactions.

3. In the building stage, each player will build wells. Each tract may only contain one well, so each player will submit on the provided sheet of paper the number of tracts on which they wish to build a well. Each well costs $1,000,000. Also, each total well built *beyond the first* reduces the overall yield of the oil field by one-half of a percentage point, so 21 wells reduces the yield of the field to 90%.

4. Once the build orders are submitted, the total number of wells built will be calculated which determines the yield of the field. Each player will then receive a share of the yield equivalent to their share of the number of wells built. For example, if 21 wells are built in total and a player has constructed 4 of those wells, than that player will receive 4/21 of the 90 percent yield of the oil field.

5. All oil sells for $100/barrel.

Instructions for the Unitization Game

In this version, your role is that of a fortunate landowner who owns the mineral rights to land on top of a newly discovered oil field containing 2.5 million barrels of oil. 1.5 million barrels of oil are commonly accessible by everyone with land on the field. The remainder is accessible only to the owner of the land. There are 100 tracts of land on this field.

You are about to participate in an experiment that will last for three stages: an assignment stage, an agreement stage, and a building stage.

1. In the assignment stage, each player holds a number of tracts of land. Each tract of land has the amount of oil that only it may access on it. Do not share this information with other players. If they ask for it, you may tell them how much oil you have, but it does not have to be the truth.

2. In the agreement stage, each player is able to make an agreement with other players to share the oil produced from their tracts of land. You will fill out a contract specifying the share of oil produced that each of you get.

3. In the building stage, each group of players will build wells. Each tract may only contain one well, so each group will submit the tracts of land on which they wish to build a well. Each well costs $1,000,000. Also, each total well built, *beyond the first,* reduces the overall yield of the common oil field by one-half of a percentage point, so 21 wells reduces the yield of the field to 90 percent.

4. Once the build orders are submitted, the total number of wells built will be calculated, which determines the yield of the field. Each group will then receive a share of the common field equivalent to their share of the number of wells built. For example, if 21 wells are built in total, and a player has constructed 4 of those wells, than that player will receive 4/21 of the 90 percent yield of the common oil field. Any tracts with wells on them will also yield the oil that is accessible only by the landowner.

5. All oil sells for $100/barrel.

The Model

The base form of the model supposes that N firms have access to a resource with R units of economically recoverable reserves. Each unit of the reserves sells for price P. Access to the resource can be divided into L tracts, and each tract supports a single unit of extraction technology (a well) at cost C. For simplicity, there is no extraction cost beyond technology installation. Let w_i represent the number of wells built by firm i. The total number of wells built by all firms is, W, where $W = \sum_{i=1}^{N} w_i$, and each tract of land may have no more than one well so $W \leq L$. To create the tension between the private and socially optimal outcome, the total yield of the field, $Y(W)$, declines with the intensity of extraction effort, $Y'(W) < 0$.

The total profit for the industry becomes:

$$\Pi = R \cdot P \cdot Y(W) - C \cdot W$$

The marginal profit for the industry for adding an additional unit of the extraction technology beyond the first is:

$$\frac{\partial \Pi}{\partial W} = R \cdot P \cdot Y'(W) - C < 0$$

Total industry profit declines as additional wells get built. In addition to the decline in total extracted reserves, the industry also pays for the cost of additional wells. Hence, the optimal outcome for the industry is to build a single unit of extraction technology and achieve complete extraction while minimizing the capital cost.

For individual owners, the amount of resource extracted is a share of their extraction units. The simple logit form of $\frac{w_i}{W}$ expresses the share. For example, if one firm builds a single extraction unit and the all other firms build four more (for a total of five), then the one firm generates one-fifth of the extracted reserves. Substituting $W = w_i + W_{-i}$, where W_{-i} is the sum of all extraction units *not* built by firm i, the individual profit for firm i is given by:

$$\pi_i = \frac{w_i}{w_i + W_{-i}} R \cdot P \cdot Y(w_i + W_{-i}) - C \cdot w_i$$

The marginal profit to a firm for adding an additional unit of the extraction technology, beyond the first and subject to the firm owning additional tracts on which to build, becomes:

$$\frac{\partial \pi_i}{\partial w_i} = \frac{R \cdot P \cdot W_{-i} Y(w_i + W_{-i})}{(w_i + W_{-i})^2} + w_i \frac{R \cdot P \cdot Y'(w_i + W_{-i})}{w_i + W_{-i}} - C$$

In short, building each new well is bad for the group because it decreases total extraction, but it gives the building firm a larger share of that extraction. The first term in the expression above is the firm's marginal revenue from increasing the share of the total yield accruing to it due to adding an additional extraction unit. The second term is the marginal production loss to the firm from production by all existing extraction units, as each new extraction unit gets added. The third term, C, is the marginal cost of an extraction unit. As long as the increase in share of the yield exceeds the cost of the additional unit and the loss from existing units, it is privately optimal to add an additional drilling unit, but it is never optimal for the group as a whole to do so.

Model Parameters

Reserves	$R = 2{,}500{,}000$
Yield Function	$Y(W) = \frac{201 - W}{200}$
Cost of building a well	$C = \$1{,}000{,}000$
Price of oil	$P = \$100$
Tracts of land	$L = 100$

Discussion Questions–Introductory and Intermediate Classes

1. Describe your experience in the game. What did you do and why? What do you wish you would have done differently? Did the other students behave rationally? Why or why not?

Answer: There is no right answer to this question, but good students can typically reason their way through the game at this point.

2. In this game, more oil can be extracted by a monopolist than numerous competing firms. However, it is generally considered more desirable to have many firms competing. Is society better off with one firm or numerous firms extracting the oil? Does it matter what type of market the oil is sold in? Please provide any assumptions you make in support of your answer.

Answer: In this case, society is better off letting one firm extract the oil, because this is not the only oil in the world. This oil will still be sold on a competitive oil market, as specified by the assumption that oil is sold for a common price.

3. Assume there are 100 firms, each with 1 tract of land over the oil field, and they have entered the well-building phase. How much is each tract of land worth to each firm? If 1 firm owned all 100 tracts of land, how many wells should it build and how much would each tract of land be worth on average then? Using your answers above as a guide, explain why it was so difficult for all of the land to be traded?

Answer: Total profit: $\Pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-100}{200} - \$1{,}000{,}000 \cdot 100 = \$26{,}250{,}000$
Average value of land: $262,500 (the above divided by 100)

Total profit for monopolist: $\Pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-1}{200} - \$1{,}000{,}000 \cdot 1 = \$249{,}000{,}000$

Average value of land: $2,490,000 (the above divided by 100)

Multiple firms want to get into the position of being the monopolist, so bargaining becomes fiercer as firms get closer to achieving a monopoly.

4. What do you think would have happened if students were allowed to form cartels – working together to choose how many wells to build and then splitting the profits? What if students were given the chance to announce how many wells they intended to build before choosing how many wells to build?

Answer: There is no single correct answer to this question, but most students suggest that it would have been easier to reach an agreement if they could all reap the rewards of being a monopolist instead of awarding it to just one student. The second part of the question, coming after the first, clues students in that the outcome is probably going to be

different if they can just announce how many wells they intend to both. Most students (correctly) suggest that people will probably cheat.

5. (If the unitization game is run). Historical data show that firms have an easier time reaching unitization agreements when the land being operated on is public land that firms have no private drilling experience on. When firms own the land and have private information about the amount of extractable resources on that land, agreement tends to be harder to reach. Why is this?

Answer: With perfect information, it is easy to divvy up the revenues based on how much oil each landowner is contributing to the common pool. With *im*perfect information, a revenue division plan will generally adversely select poor land tracts. However, in reality, many owners of good landholdings are willing to accept some inequity in their division in order to reap the gains of efficient management of the entire field.

6. How is the "Tragedy of the Commons" reflected in the well-building game?

Answer: Each additional well that is built reduces the amount of oil available for other players, but increases oil to the player building it. Therefore, an inefficiently high number of wells is built and the ultimate amount of extraction is reduced.

Discussion Questions--Advanced Classes

1. Assume the land is evenly divided between 20 firms (5 tracts each) and no cooperation takes place.

a. How many wells are constructed?

Answer: 100

b. What is the total profit earned?

Answer: $\Pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-100}{200} - \$1{,}000{,}000 \cdot 100 = \$26{,}250{,}000$

c. What is the value of each tract of land?

Answer: $\frac{\$26{,}250{,}000}{100} = \$262{,}500$

2. Assume the land is divided so that one firm has 62 hectares and the other nineteen firms each have 2 hectares. No cooperation takes place.

a. How many wells are constructed?

Answer: It is straightforward to show that any landowner with 2 tracts of land will build 2 wells. Building 1 is required for any profit, and building 2 nearly doubles a firm's share of oil while barely increasing costs. It is more difficult to calculate how the firm with 62 hectares will behave, but we know she should maximize profits subject to 38 other wells (2 each from 19 firms) being constructed.

$$\pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-(W+38)}{200} \times \frac{W}{W+38} - \$1{,}000{,}000 \cdot W$$

$$= \$250{,}000{,}000 \times \left(\frac{201W}{200 \times (W+38)} - \frac{(W+38)W}{200 \times (W+38)}\right) - \$1{,}000{,}000W$$

$$= \$1{,}250{,}000 \times \left(\frac{201W}{(W+38)} - W\right) - \$1{,}000{,}000W$$

$$\frac{\partial \Pi}{\partial W} = \$1{,}250{,}000 \times \left(\frac{-201W}{(W+38)^2} + \frac{201}{W+38}\right) - \$1{,}250{,}000 - \$1{,}000{,}000 = 0$$

$$\frac{\partial \Pi}{\partial W} = \frac{-201W}{(W+38)^2} + \frac{201}{W+38} = 1.8$$

$$-201W + 201(W+38) = 1.8(W+38)^2$$
$$7638 = 2599.2 + 136.8W + 1.8W^2$$
$$5{,}038.8 = 136.8W + 1.8W^2$$
$$W = 27.15$$

Answer: 27 wells. 65 wells total (with the small firms)

b. What is the profit earned?
From each small firm:

Answer: $\pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-65}{200} \times \frac{2}{65} - \$1{,}000{,}000 \cdot 2 = \$3{,}230{,}769$

From each large firm:

Answer: $\pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-65}{200} \times \frac{27}{65} - \$1{,}000{,}000 \cdot 27 = \$43{,}615{,}385$

c. What is the average value of each tract of land?

Answer: The profit generated by land on average is:
$\$3{,}230{,}769 \times 19 + \$43{,}615{,}385 = \frac{\$104{,}999{,}996}{100} = \$1{,}049{,}999.$

d. Why is the average land value for the large landowner lower than that of the small landowners?

Answer: The small landowners maximize their yields because they have a relatively small share of access to the oil. The large landowner has market power and leaves many tracts of land unproductive to increase total yield of the field. This is much akin to the role that Saudi Arabia plays in oil markets. It has extra productive capacity but does not use it because it would depress oil prices too much, harming itself. Other countries produce their maximum production.

3. Assume that land trading may take place. Assume from question #1 that one of the firms is able to purchase all of the land.

a. How many wells are constructed? Answer: 1
b. What is the total profit earned?

Answer: $\Pi = 2{,}500{,}000 \cdot \$100 \times \frac{201-1}{200} - \$1{,}000{,}000 \cdot 1 = \$249{,}000{,}000$

c. How much would that firm be willing to pay for the 95 tracts of land?

Answer: In question 1, the value of each tract of land was $262,500, so the value of 5 tracts of land was $1,312,500. This is the profit from the status quo. Thus, the firm would be willing to pay as much as $249,000,000 - $1,312,500 = $247,687,500 for the remaining 95 tracts of land.

d. How much would each of the 19 other firms be willing to accept for their land?

Answer: The least they might be willing to accept is the $262,500 per tract they would be earning if they worked it. If, however, land was bought sequentially, their value would go up as more and more land was locked up.

4. Assume that one firm from question #1 is able to buy out 17 others. Now there is 1 firm with 90 tracts of land, and two firms each with 5 tracts of land. Assume the owners of the three firms are rational profit-maximizing individuals. If land may still be traded, how might this scenario play out? What are problems that may result?

This may seem vague. If so, here is a starting point. Calculate profits if nobody trades further. Calculate profits if the large firm buys both of the others (your answer from 3). Calculate profits if the large firm buys one of the others. Calculate profits if the two small firms merge. These are the only four reasonable outcomes and will give you the value in moving from one outcome to another. Consider how agreements could be set up *without using unitization* to facilitate getting to the best outcome.

Answer: There is very little sense in the two small firms merging. They cannot get market power if they do so. There is also little sense in the large firm buying just one of the small ones, though it is able to do so. The large firm should buy both small ones, but if they buy one, the other one will know that its relative value is much higher. One solution might be to reach agreements to purchase the land *contingent on* the other party selling. This is common in real estate and would reduce the likelihood of holdup.

5. A new section of the Gulf of Mexico is made available for oil and gas exploration and will be auctioned off. Twenty large companies are invited to run whatever tests they desire on potential drilling sites. After the tests are completed, each company submits their bid for the section in a sealed envelope. The winner pays the government for the drilling rights.One year later, the CEO of the winning company is fired. Why?

Answer: The winner's curse. The firm most optimistic about how much oil is actually in the ground makes the highest bid. The firm that is the outlier with the most optimistic assumptions will probably be overpaying.

Mimic Excel

Yuxing Yan[1]

Abstract

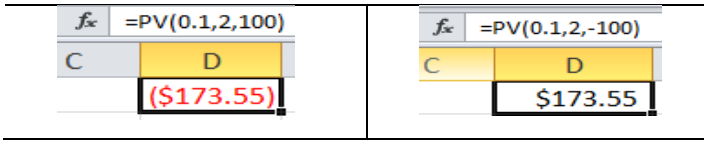
Although Excel is an excellent tool to teach finance, some of its properties really confuse my students, such as its sign convention and no clear explanation accompanying an error message. In addition, typing *=fv(0.1,2,0,100)* offers no clue about the formula being used. In this short paper, I will replicate several common Excel functions with and *without* sign convention. The beauty of functions without sign convention is that they come directly from our textbooks. In other words, an exact formula will accompany a result. When typing *=rateExcel(3,10,100)*, we will see the same error message plus a short explanation.

Introduction

When teaching various finance courses, I use Excel intensively. There is no doubt in my mind that Excel is one of the wonderful tools to teach finance. However, it does have some "undesired" properties that I have to spend a huge amount of time discussing with my students, such as its sign convention. There is also no clear and short explanation when an error message pops up. When teaching finance, we introduce many formulae. Nevertheless, no formula is presented when applying an Excel function, such as *=pv(0.1,2,100)*. In this short paper, I offer a simple solution to overcome these three shortcomings. Below, I explain why these issues really bother me and my students.

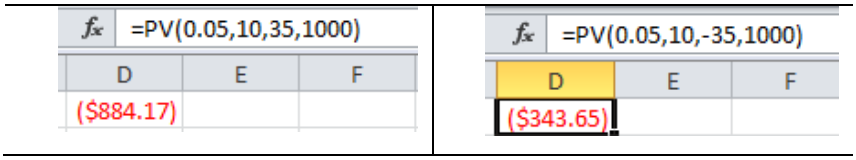
The first issue is the sign convention: if the future value is positive (negative), then the present value will be negative (positive). For many simple calculations, students are quick to grasp the meaning of such a convention. Here is a simple example. Assume that we want to estimate the present value of an annuity with a discount rate of 10% and an annual payment of $100, where annual cash flows happen at the end of each year for two years. For this example, we apply the Excel *pv()* function, shown below in Figure 1.

Figure 1



When enter a positive (negative) payment, we got a negative (positive) present value, i.e., -173.55 vs. 173.55. For such a simple example, students quickly learn why we have a negative or positive answer. On the other hand, it is a different story for more complex scenarios; Students could be extremely confused with such a sign convention. Let's look at a little bit more complex example. For a 5-year bond with an annual coupon rate of 7% paid semi-annually, what is the price if the YTM (Yield to Maturity) is 10% compounded semi-annually with a face value of $1,000? The correct answer is $884.17 shown in the left panel below in Figure 2.

Figure 2



During one exam, one of my students gave a value of $343.65, shown on the right panel above. When I asked the whole class the meaning of *=pv(0.05, 10, -35, 1000)*, no student offered a satisfactory explanation. Thus, the Excel sign convention makes such a simple case over complicated.

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When applying a formula just once, it is easy to understand the Excel sign convention. To finish my data cases, students usually have to go through several steps; In other words, the further analysis depends on the results of the previous steps. For my first data case in Corporate Finance, students are asked to produce an amortization table based on the estimated monthly payment. Assuming that we borrow $200,000 with a constant monthly payment of $2000 and a 0.25% monthly interest rate, we estimate interest payment for the first month by multiplying the beginning balance with 0.25%, i.e., 500. By deducting the interest payment from the total payment, we have principal reduction (2000-500=1500). Thus, by deducting principal reduction from the balance at the beginning of the period, we end up with an ending balance of 198,500 (200,000-1500). The next period's beginning balance is the same as the ending balance in this period. Repeating the same procedure, we would construct the whole amortization table, shown below in Table 1.

Table 1

Beginning balance	Monthly payment	Interest payment	Principal reduction	Ending balance
200,000	2,000	500	1,500	198,500
198,500	2,000			

Obviously, in the above chain of logic, we assume that every number is positive. Whenever a student uses the monthly payment based on the previous step, he/she might be confused with its sign. My solution is to use positive values only, i.e., ignoring the Excel sign convention.

The second issue is that Excel functions offer no clue about the formula being used. When discounting a future cash flow happening at the end of the n^{th} period with a discount rate of R, all finance textbooks introduce the following formula.

$$PV = \frac{FV}{(1+R)^n} \tag{1}$$

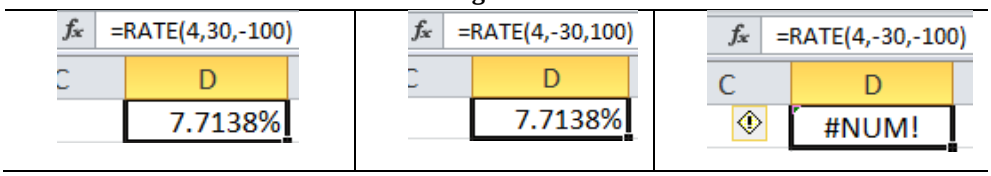
For example, assume that we have the following values: FV=100, R=0.08 and n=5. Based on the above equation, I can show my students that $100/(1+0.08)^5$ would lead to a result of 68.06. However, when using Excel's present value function of *=pv()*, I have to explain why we would get -68.06 instead of 68.06. Instead of the previous formula, the formula used by Excel is to add a negative sign in front of Equation (1), as shown below:

$$PV = -\frac{FV}{(1+R)^n} \tag{2}$$

Unfortunately, no finance textbook would write present value function this way. This is true for other Excel functions, such as the *fv()* function as well.

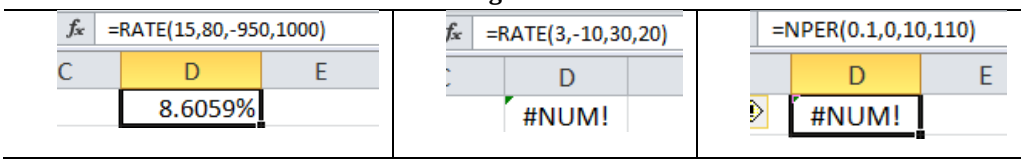
The third issue is that there is no clear and short explanation when an error occurs, such as #NUM! after typing *=rate(3,10,100)*. When applying the Excel *rate()* function, we could estimate yield or IRR, as shown below in Figure 3.

Figure 3



Here are other error messages.

Figure 4



When clicking the image on the left-side of error cell, we could explore a possible solution. However, few people would expend time on it.

A simple solution to overcome those three shortcomings

My approach is very simple: download and install R first. Then issue just one line of R codes. To install R, we have the following steps.

```
   Step 1: Go to http://www.r-project.org
   Step 2: Click "CRAN" under "Download, Packages" (left-hand
side)
   Step 3: Choose a mirror address
   Step 4: Choose appropriate software (PC, Mac)
   Step 5: Click "base"
```

After launching R, just issue the following one line codes.

```
   > source("http://canisius.edu/~yany/mimicExcel")
```

Here, ">" is the R prompt. Since R is case sensitive, we have to type "*mimicExcel*" instead of "*mimicexcel*". After hitting the Enter-key, the following screen would pop up:

```
     *-------------------------------------------------------------
*
     *   Mimic Excel                                  3/27/2015
*
     *-------------------------------------------------------------
*
     *   Functions         Utilities
*
     *-------------------------------------------------------------
*
     *   pvExcel           pvExcelNoSignConvention
*
     *   fvExcel           fvExcelNoSignConvention
*
     *   pmtExcel          pmtExcelNoSignConvention
*
     *   nperExcel         nperExcelNoSignConvention
*
     *   rateExcel         rateExcelNoSignConvention
*
     *   npvExcel          npv_f
*
     *   effectExcel       effectYan
*
     *   days360Excel
*
     *   priceExcel        shortcut
*
     *   yieldExcel        severalRcommands
*
     *-------------------------------------------------------------
*
     *   >pvExcel          # find out the usage of pvExcel
*
     *   >mimicExcel       # back to this menu
*
     *-------------------------------------------------------------
*
```

The last two lines are instructions on how to use those functions. For example, after typing *pvExcel* and hit return, we will see its usage, the names and meanings of all the input variables plus a few examples.

```
   > pvExcel
   function(rate,nper,pmt,fv=0,type=0){
     "Objective: mimic Excel function of
=pv(rate,nper,pmt,[fv],[type])
           rate : effective period rate
           nper : number of periods
           pmt  : payment per period
           fv   : future value
           type : 0 payments at the ends (default), 1 at the
beginnings

      Example 1: > pvExcel(0.1,1,0,100)
                   since fv>0, then pv <0
                   [1] -90.90909
      Example 2: > pvExcel(0.1,1,0,-100)
                   Since fv<0, then pv>0
                   [1] 90.90909
      Example 3: annuity
                 > pvExcel(0.1,3,10)
                   Since pmt>0, then pv <0
                   [1] -24.86852
      Example 4: > pvExcel(0.1,3,0,100,1)
                   Cash flows at the beginings of periods (due).
                   Since fv>0, then pv <0
                   [1] -75.13148
                >  pvExcel(0.1,3,0,100,0)
                   Since fv>0, then pv <0
                   [1] -75.13148
    ";pvExcel_(rate,nper,pmt,fv,type)
   }
```

By presenting two functions with and without sign conventions side by side, such as *pvExcel()* and *pvExcelNoSignConvention()*, students could grasp the meaning of each function quite easily, as shown below.

```
   > pvExcel(0.1,2,100)
   Since pmt>0, then pv <0
   [1] -173.5537
   > pvExcelNoSignConvention(0.1,2,100)
   Since fv=0, formula used is pv = c/r*(1 - 1/(1+r)^n)
   [1] 173.5537
```

Also, when we have an error, the program would offer a short explanation.

```
   > rateExcel(4,-30,-100)
   #NUM!
     Reason: it is not possible with cash outflows only
(pmt<0,pv<0,fv=0
   > rateExcel(4,30,100)
    #NUM!
     Reason: it is not possible with cash inflows only
(pmt>0,pv>0,fv=0)
   >
```

To estimate the EAR (Effective Annual Rate), Excel offers an function called *effect()* which takes two values: APR (Annual Percentage Rate)[2] and its compounding frequency.

```
   > effectExcel(0.1,2)
   [1] 0.1025
```

[2] Excel wrongly names the first input as Nominal Rate instead of Annual Percentage Rate.

Nevertheless, there is no general Excel function available to estimate other effective rates. For example, based on the 10% interest rate, compounded semi-annually, what are the effective monthly, daily or weekly rates? For this purpose, I wrote a general and much better function called *effectYan(),* a few examples are given below.

```
> effectYan(0.1,'s2a')
                        Two rates
effective annual rate    0.1025
APR                      0.1025
> effectYan(0.1,'s2q')
                         Two rates
effective quarterly rate 0.02469508
APR                      0.09878031
> effectYan(0.1,'s2c')
                            Two rates
effective continuously rate 0.09758033
APR                         0.09758033
```

The first input variable is APR while the second one is a string indicating how to convert this rate. Letters of "*a*", "*s*", "*q*", "*m*", "*d*", "*c*" are for annual, semi-annual, quarterly, monthly, daily and continuously compounded frequencies, respectively. Thus, '*s2a*' means from a semi-annual rate to an annual rate, while '*q2c*' indicates from a quarterly rate to a continuously compounded rate.

Conclusion

When applying Excel to finance, we have three shortcomings: Excel sign convention, no formula offered and no clear explanation when an error message pops up. In this short paper, I present a simple solution to overcome those three problems. A user needs to do two things: download and install R, then issue the following one-line R codes after launching R.

```
   >
source("http://canisius.edu/~yany/mimicExcel")
```

Again, I assume that a potential user has never heard of R, i.e., no prior knowledge about R. For an instructor who intends to use my method to help students to learn Excel, she could simply hand out one one-page instruction to her students at the beginning of each semester, see Appendix A for more details.

APPENDIX A: INSTRUCTION ON HOW TO USE MIMICEXCEL

First, you download and install R with the following 5 steps.

```
   Step 1: Go to http://www.r-project.org
   Step 2: Click "CRAN" under "Download, Packages" (left-hand
side)
   Step 3: Choose a mirror address
   Step 4: Choose appropriate software (PC, Mac)
   Step 5: Click "base"
```

Second, after launching R by clicking R icon on your desktop, just issue the following one-line R codes.

```
   > source("http://canisius.edu/~yany/mimicExcel")
```

Note that in the above one-line codes, ">" is the R prompt. Since R is case sensitive, you have to use "*mimicExcel*" instead of "*mimicexcel*".

Predictors of Success in an Online Undergraduate Core Course in Finance

Jeffery Bredthauer and Richard Fendler[1]

Abstract

Because finance is a technically oriented business subject where competence in math and accounting plays a role in student success, we posit that technical knowledge, as proxied by math and accounting pre-tests, may predict success in an online undergraduate finance course. Since little or no lecture support is generally offered while taking an online course, students that struggle with math or accounting may have a greater challenge with the online format for a finance course. Accordingly, the purpose of this study is to evaluate the key determinants of success in an online core course in finance.

Introduction

Over the past decade, there has been tremendous growth in the number of online courses offered by colleges and universities. Many of these new online courses are introductory level business classes, where the skills and interest levels of the students can vary widely. Because faculty teaching online classes cannot directly observe the specific areas where students struggle, research is needed to identify the factors that determine success, or more importantly lack of success, in any discipline-specific online introductory business course. Accordingly, the purpose of this paper is to investigate the characteristics that influence student outcomes in an online introductory course in finance. Knowledge of these factors can help faculty design online classes, better advise students, and create appropriate supplemental materials to best assist students, who might otherwise struggle in the class, to improve their chances of success. This in turn can improve student progress through degree programs as well as enhance student evaluations of online instructor effectiveness.

According to Allen and Seaman (2014), over 7.1 million higher education students took at least one online course in the fall 2012 term. Currently, over one-third of all college students take a class in an online setting and, over the past decade, the average annual growth rate in online course offerings in higher education has been 6.5 times greater than the growth rate in traditional course offerings. Online courses are also gaining wide acceptance from university administrators. Allen and Seaman (2015) report that 77 percent of academic leaders rate the learning outcomes in online classes to be equal, or superior, to those in equivalent face-to-face classes. Additionally, over 70 percent of academic leaders now see online learning as critical to their institution's long-term success.

Of the 1.72 million bachelor degrees conferred between 2010 and 2011 in the United States, the greatest concentration, more than one in five, was in Business Administration.[2] Since more students major in business than in any other area and since business programs tend to adapt to new technologies faster than more traditional academic areas, it is reasonable to assume that a significant proportion of the growth in online offerings are business courses. Furthermore, many of these new online business classes are most likely introductory-level courses, which are easier to experiment with and are more reliant on traditional textbooks that often provide useful supplemental material. Indeed, nearly all introductory-level texts offered by the major publishers now include plugins that allow seamless integration of videos, quizzes, exams, homework sets, and other learning features into popular learning management systems such as Moodle, Edmodo, Blackboard, and Desire2Learn.

Moreover, as noted in Allen and Seaman (2014), much of the recent growth in online education is occurring in large, traditional schools where both a regular classroom format and an online version of the same course are offered. Thus, many students who take an online class choose that particular format over a traditional class (and vice versa).

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[2] National Center for Education and Statistics: http://nces.ed.gov/fastfacts/display.asp?id=37.

As a result, the characteristics of students in an online class may be very different from those in a traditional class. For example, Fendler, Ruff, and Shrikhande (2011) find that when given a choice, females and non-majors are more likely to choose the online version of a course and males and majors are more likely to choose the traditional format. Dutton, Dutton, and Perry (2002), and Dutton and Dutton (2005) indicate that outside distractions (such as having a job or playing sports), GPA, age, and previous experience with online courses differ significantly in their comparison of online versus in-class student characteristics.

Whereas teaching any introductory course can be challenging, teaching a core course in finance is particularly difficult. In business schools, an introductory core course in all major subject areas is a common requirement for all students, regardless of major. Thus, nearly all business students must take a course in economics, general business, accounting, finance, marketing, management, and possibly others. Consequently, in a typical introduction to finance core course, the majority of the students most likely are not considering finance as a major and therefore, can have a significant variety of learning interests. Moreover, because finance is considered to be the 'math heavy' subject within the business core curriculum, less quantitatively skilled students, who are perhaps management or marketing majors, merely look to pass the finance core course to get it out of the way. Often their interest level in the topic is limited to learning the bare amount needed to get a minimal passing grade on the next exam.

Teaching a course with such a diversity of interests in an online format is especially challenging. In a traditional class setting, an instructor can visibly observe facial expressions, read body language, and analyze the level of student engagement to ascertain student interest and understanding. If these unique aspects of the class depict a lack of either student understanding or interest, the traditional class instructor can make changes to delivery, content, or evaluation processes to better adapt the class to the audience. Unfortunately, visual observation is not possible in an online class. Indeed, most online classes are designed before the course starts with little to no flexibility allowed after the course begins.

Therefore, there is a need to pre-identify the characteristics of students who are most likely to enroll and struggle in an online core course in finance. Then the course can be designed to maximize the chances of those students' success in the class. These design enhancements might include modifications in the course itself or including supplemental materials.

Accordingly, the purpose of this study is to evaluate the key determinants of success and lack of success in an online core course in finance, where students are free to choose between an online version and a traditional classroom based version of the exact same course offered on various day/time combinations. We study over 300 students relating a common final exam grade and final course grade to the score on a math pretest, perceived math ability, score on an accounting pretest, college GPA, student apprehension about taking the particular course in an online format, outside distraction measures, student satisfaction levels, effort, gender, declared major, total semester hours taken while in the course, and previous number of online courses taken. We are particularly interested in the relationship between math skills, both actual and perceived, and performance in the course, holding all other variables constant to determine whether designing and requiring online students to take a math refresher course as a prerequisite to enrolling in an online course would improve student-learning outcomes. In fact, we find that math and accounting pre-tests, major, and student satisfaction measures are positively correlated with success, while negative correlations exists with outside distraction, total semester hours taken and gender (i.e., female). Similar to prior studies, we find that GPA has a highly significantly positive effect on student performance.

Literature Review

Since accounting and finance have many similarities, especially in terms of being considered by business students as math heavy subjects, we provide a review of both the accounting and finance literature. Past research on learning outcomes in traditional classroom based introductory accounting and finance courses have investigated various factors associated with student performance. Prior studies have incorporated variables relating to previous academic achievement (GPA), math skills, grades in prerequisite courses, admission-test scores (SAT/ACT scores), gender, age, hours of employment outside of school, extracurricular activities, student satisfaction measures, and year of college. No currently published study specifically focuses on the characteristics that influence student performance in an online core course in finance with the purpose of suggesting course design improvements. This study fills that gap.

Eskew and Faley (1988) use SAT scores, high school grades, college GPA, effort and motivation, previous exposure to finance/math, and number of college hours completed to explain performance in an introductory accounting course. They find that SAT scores and effort explain 54 percent of the variance in grades in the course. Doran, Bouillon, and Smith (1991) and Maksy and Zheng (2008) use GPA as a measure of aptitude and past academic

performance. These authors report a significant positive relationship between GPA and student performance in accounting courses.

Collier and McGowan (1989) discover a significant positive relationship between student performance in mathematics and algebra and student ability to earn passing grades in accounting. Wong and Chia (1996) find that math background is significantly related to student performance. Clark and Sweeney (1985) show that college math grades predict student success in accounting courses.

Mutchler, Turner, and Williams (1987) report that female students scored significantly higher than male students in the college-level accounting course taken. Conversely, Gist, Goedde, and Ward (1996) and Keef and Roush (1997) find no significant differences in performance between male and female accounting students.

Borde, Byrd, Modani (1998) researched the relationship between performance in an introductory finance course and gender, age, transfer status (from community college), GPA, membership in student organizations, hours of employment, and performance in prerequisite accounting courses. They find that high performance in accounting prerequisites and a high GPA positively impacts performance in finance courses. They also note that males tend to perform better than females, community college transfers underperform students who begin their college careers at the university level, and students that worked fewer hours in a job outperform those who work more hours.

Marcal and Roberts (2001) report that students with better grades in statistics perform better in finance courses. Alcock, Cockcroft, and Finn (2008) find that advanced secondary mathematics improves passing outcomes for most business courses, including introductory finance. Grover, Heck, and Heck (2009) report that math and accounting questions on a traditional introductory finance course pre-test predict student performance. In a regression where they control for GPA, gender, year of study, and math/accounting knowledge, the authors find that only GPA and pre-test scores provide any significance in determining student performance.

Numerous studies examine the relationship between student outcomes in online versus traditional finance courses. Most of these studies consider student performance and/or student satisfaction measures. The main focus of these studies is on comparing outcomes; specifically, which mode of instruction is better.

We make no claim concerning whether online education is better, worse or equivalent to traditional education. Instead, we focus directly on the specific student characteristics that significantly correlate with high or low performance in an online finance course. Whether these characteristics are the same or different from the factors that determine success or failure in a traditional class is outside the scope of this research.

In fact, we are not sure that such comparisons are valid due to the differences we discussed in the introduction concerning the role of the instructor in traditional versus online classes. In a traditional class, instructors can adjust their teaching methods and evaluation processes “on the fly” to better assist struggling students. Such adjustments are logistically limited in an online course. Accordingly, pre-identifying characteristics that may limit student success in an online class is needed. This is the major purpose and contribution of our study.

The Course

The course evaluated in this study is the introductory finance course in the undergraduate program at a large, urban, research university. All business majors must take this course as part of the core business curriculum. Because students cannot enter the business school until their third year, and because few business electives can be taken until the finance core course is completed, nearly all students in this study are juniors. All other students in the class are seniors; university restrictions prevent graduate students from taking this course. The course is coordinated purposefully across all sections, with a common syllabus, textbook, and cumulative final exam. The topics covered in this course are financial statements, cash flow analysis, financial forecasting, time value of money, stock and bond valuation, and capital budgeting.

The core finance course is taught in many different sections each semester. Total enrollment across all sections averages approximately 700 students per semester. Every semester for the past ten years, one of the sections of the course has been taught online by one of the authors of this paper. The maximum enrollment in the online section is 120 students per semester.

The online section is taught using the Desire2Learn (D2L) learning management system. Students take an online quiz, consisting of ten to fifteen multiple-choice questions or open-ended problems, every week. A quiz can be taken as many times as the student wants and only the highest score counts, however, due to question alternates and the use of a random number generator, successive attempts are different. The quiz average counts as 10 percent of the final course grade; thus, a student’s quiz average represents more of an effort grade as opposed to a measure of knowledge or understanding.

Online students must also complete four 35-question take-home problem sets and three online exams. The take-home problem set (THPS) average counts as 10 percent of the final course grade. Online exams have a time limit of 150 minutes, and they can only be taken once during a 72-hour time window (over a weekend). Every question on an exam has numerous alternates and/or random number elements so that no two students take the same exam. The average grade on these three exams counts as 40 percent of the final course grade. The final exam, described in the next section, makes up the final 40 percent of the course grade.

Every aspect of the course is taught online. That is, there is virtually no face-to-face instructor-student interaction, except for an occasional office visit. The main forms of student-instructor interaction are weekly chat sessions and email. Audio chat sessions lasting up to two hours are held every week. Attendance is optional; a transcript of the session is available immediately after the session ends.

The Data

In addition to the quizzes, problem sets, online exams, and final exam, all online students complete a pre-course accounting test, a pre-course math test, a pre-course survey, and an exit survey. Data extracted from these items is described below. The university provides demographic data for all students.

Data was collected on all online students who completed the course in fall 2013, spring 2013, and fall 2014. Our data set consists of 309 students who finished the course and also properly completed the pre-course tests and surveys. Means tests conducted on all of the data collected for each semester show that there are no significant differences in any of the variables between semesters. Comparative statistics for all variables used in the study are presented in Table 1.

Table 1: Descriptive Statistics of All Variables

Variable	Average	Stand. Dev.
Final Course Grade	79.0%	10.4
Final Exam Grade	68.1%	16.5
Accounting Pretest	76.5%	14.9
Math Pretest	65.8%	19.7
Math self-perception (1 = lowest; 5 = highest)	3.4	1.1
Previous online experience (no. of classes)	3.9	3.0
Effort (1 = lowest, 10 = highest)	5.5	2.9
Work hours per week	22.8	13.3
Age	27.5	6.8
College GPA (maximum = 4.5)	3.1	0.4
Term Hours (most courses are 3 credit hours)	12.4	3.8
Unpredictability of schedule	13.6%	
Apprehensive about taking online course	8.7%	
Satisfied with course / instructor	75.7%	
Perceived effectiveness of instructor	37.5%	
Gender (percent female)	61.8%	
Major (percent finance or accounting)	30.4%	

Final Course Grade

This is the final numerical average that determines a student's final letter grade for the course. As noted above, this value is computed as follows: Final Overall Grade = (.10)(Quiz Avg.) + (.10)(THPS Avg.) + (.40)(Online Exam Avg.) + (.40)(Final Exam Grade).

Final Exam Grade

The comprehensive final exam consists of 40 multiple-choice questions that span all topics covered in the entire class. All students take the final exam in a physical classroom, on the same day, at the same time. The closed book,

closed notes exam is carefully proctored; students are prohibited from bringing anything into the exam room other than a Texas Instruments BA II Plus calculator and something to write with. Additionally, the exam is carefully distributed so that all adjacent seated students have different exam versions. Significant effort is made to prevent cheating on the final exam.

Accounting Pretest

Two basic accounting courses are prerequisites for the corporate finance course. To measure student knowledge retention from their experience in the prerequisite courses, all online students take a timed, accounting pretest during the first week of the course. The test consists of 25 multiple choice and open-ended problems mainly covering income statement and balance sheet components, and the relationships between financial statements.

Math Pretest

Many studies indicate that math skills are important for success in finance. College algebra is a prerequisite for all courses in the business school, however, when and where students satisfy this prerequisite varies widely. Many exempt the course via high school AP credit and others transfer the course in from any of a variety of other schools, including junior colleges and online programs. Also, some non-traditional students may have completed this requirement decades ago. Accordingly, to measure math knowledge, all students take a timed, online math pretest during the first week of the course. The test consists of 20 basic math and college algebra problems. Students are instructed to use a calculator for the test.

Math Self-perception

One of the questions on the pre-course survey asks students to rate their math skills. A Likert scale is used where 1 indicates that the student believes their math skills are weak, 2 indicates below average, 3 indicates average, 4 indicates slightly above average, and 5 indicates significantly above average. Because students have been studying math since first grade, we surmise that their perception of their math aptitude may differ from their performance on the simple 20 question pre-test. Indeed, we believe their life-built perception may be more indicative of their ability.

Previous Online Experience

Students are asked in the pre-course survey about their prior experience with fully online or hybrid courses. They are asked to indicate the number of courses they have taken in either high school or college in each category. The previous online variable is the sum of all online and hybrid courses.

Effort

Wooten (1998) provides an excellent review of a large literature that discusses a strong positive relationship between student effort and high academic performance. Several questions in the exit survey ask students about the effort they put into this online course. Specifically, they were asked to rank on a 5-point Likert scale (1= significantly less, 2= somewhat less, 3= about the same, 4= somewhat more, 5= significantly more) the amount of time, the amount of reading, and the overall amount of work they put into the online course compared to what they believe they would have done to earn the same grade if they had taken the course in a regular in-class format.

Outside Distractions

Wooten (1998) also reasons that students can exert greater effort in a class if they have fewer outside distractions from factors such as hours spent at work, extracurricular activities, and family responsibilities. Questions in the pre-course survey allow us to determine the average number of hours students spend per week working at a job or participating in official school-related athletic programs (essentially a job). We use student reported average number of hours spent per week in these activities to capture Wooten's first two outside distraction variables.

Although we do not have data to directly measure family responsibilities, we did include a question in the pre-course survey that asked students about the unpredictability of their schedules. We surmise that students with multiple children or students who are single parents will have highly or somewhat unpredictable schedules. Students who

indicated that their schedules were highly or somewhat unpredictable were given an unpredictability variable value of 1; otherwise the value is 0.

Age

This variable, provided by the university, is a student's age in years on the day they took the final exam in the course. Older students may not be as technically savvy as younger students. On the other hand, older students may be better disciplined in time management.

College GPA

GPA measures a student's general aptitude. Nearly all research concerning factors that determine student performance includes a GPA variable and this factor is always significant. Our measure represents the grade average of a student that covers over half of their entire college experience, since students cannot enter the business program at the school until their junior year.

Term Hours

This is the number of credit hours for which the student was registered during the term they took the online course. Nearly 70 percent of the students indicated on the exit survey that they spent more time on this course than they expected to when they registered for the course. We surmise that those with a particularly heavy course load may not have been able to devote as much time to the online course as they had originally hoped.

Level of Apprehension

Wooten (1998) notes that student expectations about a course can influence motivation levels. Because online courses are still new to many students, at least relative to a long history of taking classes in a traditional face-to-face format, students may enter an online course with much apprehension. If a student fears that a course may be particularly hard, especially in a lesser understood online format, their motivation may wane as challenges occur. We ask students to describe their level of apprehension about taking this course online. Students who indicate that they are strongly or somewhat apprehensive have an apprehension value of 1; otherwise the value is 0.

Student Satisfaction Measures

McFarland and Hamilton (2005-2006) report that overall satisfaction with the course significantly influences student performance in an online class. Summers, Waigandt, and Whittaker (2005) find that students in their online statistics class were significantly less satisfied with the course than were students who took the same course taught by the same instructor in a traditional classroom format. Yet, they found no significant difference in the learning outcomes of the students in the online course relative to the face-to-face course.

In the exit survey, we asked students to rank, on a scale of 1 to 5, their overall satisfaction with the course and instructor. Those who rated their satisfaction as high or above average received a satisfaction score of 1. Those who rated their satisfaction level as neutral, below average or low received a 0.

McFarland and Hamilton (2005-2006) also find that student perceptions of the effectiveness of the instructor in helping students learn the course material significantly impact student outcomes in an online course. The instructor is very active in our online course, posting detailed announcements at the beginning and end of each week, presenting weekly online lectures, commenting on student discussion board posts, and responding to all emails within 24 hours. In the exit survey we asked students to rank the effectiveness of the instructor in conducting the course relative to their expectations entering the course. Those who rate the instructor effectiveness as being significantly above or above expectations are coded as 1 and those who rated effectiveness as met, below or significantly below expectations received a 0.

Gender

The gender breakdown in the business school is approximately 51 percent female and 49 percent male. As shown in Table 1, nearly 62 percent of our sample is female. We have observed for many years that female students seem to choose to take the online course in significantly larger numbers than males.

Finance or Accounting Major

Finance and accounting are separate majors at the school in our study, but the subjects are closely related. Many students double major in finance and accounting or major in one and minor in the other. Finance and accounting are two of the more quantitative majors in the business school. Other majors, such as marketing and management (the two most popular majors), are more qualitative subjects.

Regression Results

To examine those factors that are most important in determining student performance in an online core course in finance, we regress both Final Exam Grade and Final Course Grade against all of the conditioning variables described in the previous section. Although the final exam grade constitutes 40 percent of the final course grade, these two measures differ in several important ways. First, final course grade includes a specific effort component through the quiz and THPS averages. In general, greater time spent and effort exerted on quizzes and problem sets should result in a higher final course grade. Though greater effort may also lead to increased learning and thus a higher grade on the comprehensive final exam, the effort component of the final course grade is probably more direct.

Second, there may be a cheating component to the final course grade that is most likely not present in the final exam grade. The literature on cheating in online courses is extensive (see Harbin and Humphrey (2013) and Aaron and Roche (2013) for excellent reviews of this topic). As noted above, significant effort is made to prevent cheating on the in-class final exam. Whereas techniques to minimize cheating are used for the online exams during the term, these are limited in their effectiveness.

Finally, there may be an anxiety factor associated with the in-class exam over and above what a student normally experiences when taking a final exam. For online students, all activities prior to the final exam are completed at a time that is convenient to their schedule and in a setting in which they are most comfortable. In contrast, the final exam is held in an unfamiliar classroom at a specific time. Because the university is an urban campus, many students must drive to campus, park, and find the classroom. These additional stress factors will most likely impact students who do not understand the material, or perhaps who are just poor test takers, to a greater degree than usual.

Table 2 shows the results of our model with Final Exam Grade as the dependent variable. We note that final exam grade, which is more closely linked to a student's technical abilities, is significantly positively related to the accounting pre-test score, math pre-test score, math self-perception Likert score, college GPA, finance/accounting major, and both measures of student satisfaction and negatively related to work hours. It is interesting to note that previous online experience, effort, outside distraction, age, and gender are all insignificant with this model. We surmise that ability (math and accounting knowledge) and student satisfaction measures dominate when the dependent variable is the final exam grade, since students are not able to use notes, books, or to cheat, and they must rely solely on their native and course acquired skills, with financial concepts and math, while taking this test.

Table 2: Determinants of Final Exam Grade Regression

$$\text{FinExam}_i = \beta_0 + \beta_1 APT_i + \beta_2 MPT_i + \beta_3 MSP_i + \beta_4 POE_i + \beta_5 EFF_i + \beta_6 WH_i + \beta_7 AGE_i + \beta_8 GPA_i + \beta_9 THRS_i + \beta_{10} USCH_i + \beta_{11} APP_i + \beta_{12} SAT_i + \beta_{13} PIE_i + \beta_{14} GEN_i + \beta_{15} FINNACCT_i + \varepsilon_i$$

Coefficients and Statistics		
Variable	*Coefficients*	*t-Stat*
Intercept	-0.564	-0.068
Accounting Pretest (*APT*)	0.129[a]	2.058
Math Pretest (*MPT*)	0.102[a]	2.365
Math Self-perception (*MSP*)	2.788[a]	3.307
Previous Online Experience (*POE*)	0.031	0.114
Effort (*EFF*)	-0.212	-0.628
Work Hours (*WH*)	-0.102[b]	-1.839
Age (*AGE*)	-0.060	-0.473
College GPA (*GPA*)	14.733[a]	6.746
Term Hours (*THRS*)	-0.262	-1.173
Unpredictability of Schedule (USCH)	0.706	0.296
Apprehensive (APP)	2.831	1.007
Satisfaction (SAT)	3.675[b]	1.908
Perceived instructor effectiveness (PIE)	4.490[a]	2.704
Gender (F=1) (*GEN*)	-1.702	-1.044
Finance/Accounting Major (*FINACCT*)	3.340[b]	1.808

[a] significant at .01 level, [b] significant at .05 level, [c] significant at .10 level

Regression Statistics	
Multiple R	0.6079
R Square	0.3696
Adjusted R Square	0.3363
Standard Error	13.2859
Observations	309

Table 3 presents the results of our model with Final Course Grade as the dependent variable. This broader measure of achievement is significantly positively related to the accounting pre-test score, math self-perception Likert score, effort, college GPA, and perceived instructor effectiveness. It is significantly negatively related to work hours and gender.

Comparing these two regressions produces several interesting observations. First, accounting, math, work hours, perceived effectiveness of instructor, and GPA are major determinants of performance in an online core course in finance for both the final exam and the final course grade.

Second, quite interestingly, whereas both math skill and math perception are important on the final exam, a student's perception of their math skills is the dominate math variable for overall performance in the course. That is, if a student perceives that they are poor in math, regardless of whether they have the basic math skills needed to understand finance or not, they tend to perform poorly in an online finance course. This finding has significant implications for the types of math refresher programs that should be offered to students prior to taking an online core finance course. Specifically, such courses need to address a student's perception of their math abilities as well as provide students with math practice.

Table 3: Determinants of Final Course Grade Regression

$$\text{FinGrade}_i = \beta_0 + \beta_1 APT_i + \beta_2 MPT_i + \beta_3 MSP_i + \beta_4 POE_i + \beta_5 EFF_i + \beta_6 WH_i + \beta_7 AGE_i + \beta_8 GPA_i + \beta_9 THRS_i + \beta_{10} USCH_i + \beta_{11} APP_i + \beta_{12} SAT_i + \beta_{13} PIE_i + \beta_{14} GEN_i + \beta_{15} FINNACCT_i + \varepsilon_i$$

Coefficients and Statistics		
Variable	*Coefficients*	*t-Stat*
Intercept	26.552	6.855
Accounting Pretest (*APT*)	0.256[a]	8.786
Math Pretest (*MPT*)	0.017	0.832
Math Self-perception (*MSP*)	1.266[a]	3.234
Previous Online Experience (*POE*)	0.052	0.419
Effort (*EFF*)	0.656[a]	4.175
Work Hours (*WH*)	-0.057[b]	-1.987
Age (*AGE*)	-0.007	-0.119
College GPA (*GPA*)	7.969[a]	7.859
Term Hours (*THRS*)	-0.070	-0.677
Unpredictability of Schedule (USCH)	0.265	0.240
Apprehensive (APP)	0.891	0.682
Satisfaction (SAT)	1.171	1.310
Perceived instructor effectiveness (PIE)	2.123[a]	2.753
Gender (F=1) (*GEN*)	-1.572[a]	-2.076
Finance/Accounting Major (*FINACCT*)	1.257	1.465
[a] significant at .01 level, [b] significant at .05 level, [c] significant at .10 level		

Regression Statistics	
Multiple R	0.8188
R Square	0.6582
Adjusted R Square	0.6391
Standard Error	6.1683
Observations	309

Third, because online courses are probably more difficult than students expect, outside distractions may prevent them from achieving their maximum potential in an online finance course. On the other hand, effort and effective instructor participation in the course can positively impact student grades. Accordingly, students should be properly advised about the rigors of an online course during the course registration period and instructors should be properly trained in effective online teaching procedures.

Finally, for reasons not particularly obvious, females tend to struggle more than males in an online core finance course, despite controlling for perceived math ability. This may be due to omitted variables in our study such as family responsibilities or significant work experience (i.e., internships) in the finance field. Wooten (1998) notes that family responsibilities may be a more significant issue for female students than for males. Guney (2009) finds that significant work experience positively influences student learning outcomes in accounting courses. Eldridge, Park, Phillips, and Williams (2007) discuss female gender discrimination in the business world. Based on this discussion, it is possible that females seek and are provided fewer internships than males and male opportunities in finance may enhance their academic performance. Further investigation of the effect of these variables on performance in an online finance course represents an interesting area for future research.

Conclusion

Over the past decade, there has been tremendous growth in online higher education, with much of this growth occurring in business courses. Within business schools, introductory core courses are the most common classes to be offered online. Such classes often include students with broadly divergent characteristics, interests, and abilities. However, due to the lack of personal contact within an online course, teachers cannot directly observe student struggles

as they can in a traditional face-to-face course. Accordingly, instructors who design and teach online classes need to understand the characteristics of students who are most likely to struggle in an online course in order to provide them with the best resources possible to increase their chances of success. In this paper, we examine the characteristics that most influence student performance in an online core finance course.

Our findings suggest that students with low GPAs and/or significant outside distractions should be discouraged from taking an online finance class unless they are willing and able to devote significant effort to the course. Female students should also be warned that they may be more likely to struggle in an online class in finance than their male counterparts. We also find that students with poor math abilities, and in particular a poor perception of their math abilities, should be offered remedial programs to refresh their math skills and perhaps some sort of emotion achievement training (for example, see Pekrun (2006)) to overcome their lack of confidence in math. Indeed, this is an interesting area for future research.

For those currently involved in curriculum development for online courses, this research provides insight into steps that can be taken to increase success in an online undergraduate finance course. First, evaluating a student's technical abilities in math and accounting clearly provide academics an improved understanding of potential deficiencies and remediation efforts that can be undertaken to improve student success and outcomes. Such steps can improve student retention, speed progress towards graduation, and enhance student evaluation of online course instructors. Second, by tailoring the course to incentivize effort, students who might be lacking in technical ability can potentially enhance their final overall grade and successfully pass the course. Finally, proper advisement is important to maximize student success, especially in schools where students can choose between taking the core finance course in-class or online.

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Use of Review Videos to Reinforce Basic Concepts in Economics

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Abstract

Short, weekly review videos were incorporated into two sections of introductory Microeconomics. These videos represent a form of technology for students to review concepts already covered, rather than in the initial teaching of material. The purpose of these videos was to improve the knowledge and comprehension levels of learning for the material, thus providing space for increased breadth and depth in the classroom. Students in the class had a positive reception to the video, as show in the high level of utilization throughout the semester. Additional analysis did not find a statistically significant impact on student performance.
Keywords: Teaching effectiveness, multimedia

Introduction

The lowest levels of learning of Bloom's Revised Taxonomy are knowledge and comprehension which serve as the foundation for higher-order learning. University students in introductory economics need to have a strong grounding in these lower-level skills in order to complete higher-order tasks. Given limited time in the classroom, how can instructors use in-class and out-of class materials to establish this strong grounding? Evidence-based teaching practices should direct instructor effort.

In the fall of 2012, I used short, weekly review videos to enhance the learning in introductory microeconomics. This paper will review the motivation, development, and early data results on utilization and effectiveness of this innovation.

Broadly speaking, teaching innovations are meant to improve two dimensions of student learning, depth and breadth. The depth of learning refers to deeper level of learning (according to Bloom-type taxonomy of levels of learning). Breadth of learning refers to exposure to additional concepts in a given course.

This innovation is targeted to the faculty who are willing to incorporate some technological advance without large scale resources to implement a technological overhaul of their course. Short videos posted online reviewing basic course concepts have the potential to allow for a reorganizing of classroom time to create both greater breadth and depth of classroom learning.

This article lays out a motivation and description of the innovation incorporated into the fall of 2012 sections of introductory microeconomics. This article then follows with preliminary results of effectiveness and consequences on other measurable classroom outcomes. Finally, additional considerations and next steps are presented.

Literature Review

Becker and Watts (2001) report the exponential growth in the interest of teaching economics and the scholarship of teaching economics. While they find an increase in the median reported time devoted to teaching from 1995 to 2000, there was not a corresponding, widespread movement away from traditional "chalk and talk". Goffe and Sosin (2005) compile an excellent summary of major research related to recent uses of technology in the classroom, noting the more successful uses of technology are those that encourage active involvement of the student.

A recent technology innovation in the economics classroom gaining attention is the use of student response systems. Salemi (2009) used clickers to engage students in a large economics sections with an emphasis on economic

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literacy. Clicker strategies for engagement can include gathering student opinion, assessing understanding of materials recently covered, to complement data-generating classroom experiments, as a support to peer instruction, and supporting games and simulations in the classroom.

Ghosh and Reena (2009) describe the findings of a pilot program that combined peer instruction with an in-class student response system. This technology and teaching method attempts to capitalize on both cooperative and active learning methods to improve student outcomes in a way to improves learning on in a larger scale setting.

The use of video in the economics classroom is not a new phenomenon. Video has been used in teaching economics in a number of different ways. Grimes et al (1989) use pre- and post-test experimental design to investigate the impact of a telecourse, *Economics U$A*, on student performance, measured with the TUCE, while including variables for stock of knowledge, aptitude, and demographics. Of note, the intent of *Economics U$A* was as a primary medium of instruction, rather than a support to instructors.

Sexton (2006) describes using shorter video clips of particular scenes in movies and television to guide students to discover an application of economic concepts. Discovery of application is done by the student. In other examples of the power of television to facilitate understanding of economic concepts, Gillis and Hall (2010) and Hall (2005) describe use of *The Simpsons* to highlight economic concepts and policy alternatives. Active learning by the students is enhanced through this engagement with a widely known, popular series.

Videos also have been a technology to enhance learning in a more integrated way with the teaching process. Stone (1999) describes the use of a computer-based lecture design that incorporates video, graphics, a note outline, sound, and the World Wide Web. This uses video as part of the initial delivery of material instead of as a method of reviewing material. Goma (2010) describes the use of web-based, interactive modules focused on historic economic events to highlight economic theories. These modules also use video as one of the multimedia components of the platform to engage students.

Mateer (2012) reviews a website that brings together media clips that highlight application of concepts from basic economics. These appear to be new applications of concepts students learn rather that reviewing previously covered materials. In describing the advantages of inverting the classroom to accommodate a wider variety of learning styles, Lage et al (2000) note the significant role that a video presentation of a concept may have for a particular type of learning style.

Videos can be used either to introduce new material or to review material previously introduced. Rhodes and Cerveny (1984) note the historical development of video as part of economic instruction. They note effective use of video would focus on "interactive viewing" rather than "passive viewing". An advantage to these videos is the ability of students to vary pace and repetition of information[2]. Their description of videos as a supplement to course instruction is similar to the review videos considered here.

Chen and Lin (2012) also consider the impact of online vides to aid student learning. They use panel data to explore the relationship between recorded lectures on examination grades. Both OLS and fixed effects model indicate a positive impact examination grades. However, their videos were of full lectures, rather than the short review videos considered here. As expected, a significantly lower percentage of students viewed their full lecture videos compared to the percentage of students who viewed the shorter review videos.

Description of the Review Videos - Form and Structure

The review videos were short videos, typically from three to five minutes long and focused on a single topic for review. A brief description of the concept was followed by a simple example of a basic application of the concept.

Both student perception of important concepts to review and faculty insight into the most important concepts to review drove the choice of topic for review. At the end of each week I polled the class for the topics from the most recent class materials they would like reviewed in a short video. The class preferences for topics were balanced against my perception of the most useful topics to be reviewed.

Given the ubiquity of free software available online, relatively simple production does not require sophisticated skills. Informal feedback from students strongly suggests avoiding low quality production is essential (but easily achieved). Once a threshold of adequate quality is achieved, additional emphasis on quality does not add much value.

Some of the "low hanging fruit" in terms of improving quality include an external microphone for record (usually included as part of a low-cost headset) and a dedicated program to record audio (e.g., Audacity).

[2] As pointed out by a helpful anonymous reviewer, this benefit is clearly helpful for those who need a longer time to review a concept, as well as ESL students (another set of students that could benefit).

Motivation of the Particular Innovation

These review videos were meant to engage a larger number of students with mastery of the basic economic concepts with a straightforward application of the material. This format provides students with an opportunity to control both repetition and pace of material which has been shown to be important for student learning (Griffiths, Oates, and Lockyer 2007).

One of my prior assumptions was that this type of innovation would be utilized most (and have the greatest impact) by students on the margin. A significant concern with this type of innovation was the potential negative impact on attendance. Would students use these review videos as a complement to classroom discuss or as a substitute for regular attendance? If these videos were used as a substitute for regular attendance, then the overall quality of the learning experience could be significantly diminished. These review videos were intended not as a repetition of lectures, but rather as a complement to mastery of basic concepts.

Given that the time in the classroom is scarce, review videos have the potential to free up time from review of root repetition for a deeper level of learning (with more of a focus on application, etc.). Many inputs in the classroom environment create learning. The primary goal of this innovation was to build a more solid foundation of knowledge and comprehension levels of Bloom's Revised Taxonomy. The innovation was not intended to provide direct, additional breadth or depth, but rather to provide a firm level of knowledge and comprehension so that additional time in the classroom could be used to develop depth and breadth of learning.

An advantage of review videos is the ability of students to control the repetition and pace of information. Students were able to replay videos as much as they like. Additionally, students could pause a video and take as much time as they please to more slowly process the material. I anticipated that the lower-performing students (earning a C or lower as their final grade) could most benefit from the short review videos.

An expected benefit of the innovation was an increase in the performance of lower-performing students. In my past experiences of teaching this level of microeconomics, 40-65% of the students earn either an A or B as their final grade. Generally speaking, these are students who, at a minimum, successfully master the knowledge and comprehension of basic microeconomics. For these high-performing students, the review videos could reinforce their existing command of the material.

One advantage of posting the videos on the learning management system (Moodle) for this course was the ability to track student use of the materials. Each time a student accesses the folder that contained the review videos, the date, time, and student id was recorded in the system. This utilization data is key to analyzing the effectiveness of the innovation.

Impact on Learning and the Learning Environment

The learning management system used in the delivery of the classes captures a wide array of student data, including the time and date of each time each student access the area of the course site that contained the review videos. This information is easily translated into utilization data to assess the role of these review videos on the learning and the learning environment.

Student utilization of videos was significantly higher than I anticipated across both sections of microeconomics (Table 1). Additionally, a large portion of students chose to access the videos multiple times with an average of accessing the videos 4.58 times. The data indicates broad and frequent utilization of online review videos.[3] There were no statistically significant differences between the sections in terms of common observable characteristics (major, course GPA, ratio of males-to-females, number of credit hours, etc.).

One potential concern was the use of these videos as a substitute for attending lectures. Students could views the videos as a low-cost alternative to acquiring information obtained in regular class lectures. However, there is a statistically significant, *negative* relationship between multiple utilizations of the videos and absences (see Table 2). In general, the average number of absences was small for both sections. However, as the number of absences increased, the probability of multiple utilizations of videos decreased. This evidence suggests student were not using the videos as an alternative to regular lecture attendance.

[3] There are some qualifications that should be acknowledged with this utilization data. First, while the data indicates that a student has accessed the folder that contains the video, it does not indicate which video was viewed or how many times a given video was viewed. Secondly, once a student downloads a video, there is no way to observe how many students watch that specific download; a single student may download the video and watch it on their laptop with a group of students in a study session.

Table 1 Student Utilization of Videos

	Overall (n= 64)	Section A (n = 33)	Section B (n= 31)
Any Utilization of Videos	84.38%	78.79%	90.32%
Multiple Utilization of Videos	71.88%	72.73%	70.97%
Average Utilizations of Videos	4.58 (4.23)	4.72 (4.23)	4.41 (4.30)
Couse GPA (out of 4.0)	2.44 (1.02)	2.61 (1.03)	2.26 (1.00)

Table 2 Probit of Absences on Multiple Utilizations

Parameter	Estimate	Standard Error	p-value (Chi-Sq)
Intercept	0.832	0.217	0.001
Absences	-0.072	0.038	0.061

The data strongly indicates that many students accessed the videos, often repeatedly, and did not use them as a substitute for regular classroom attendance. The clear inference is that students, by their actions, believed accessing the videos to be a benefit to their learning. But did accessing the videos have a *measurable* impact on student performance? Unfortunately, the evidence here is positive, but less convincing.

Measurable student success can take a number of different forms. Table 3 presents the average of different measures of success for the overall student population, those that ever accessed the videos, and those with who accessed the videos multiple times. While these results indicate a slight improvement along most of the definitions of student success for any or multiple video access, none of the differences are statistically significant.

Table 3 Different Measurements of Student Performance by Different Measurements of Use

	Overall Mean (n=64)	Any Video Access (n = 54)	Multiple Video Access (n = 46)
Course Grade (100 point scale)	0.791 (0.057)	0.794 (0.096)	0.803 (0.019)
At least an A Grade	0.141 (0.350)	0.129 (0.339)	0.152 (0.363)
At least a B Grade	0.516 (0.504)	0.556 (0.502)	0.587 (0.498)
At least a C Grade	0.812 (0.393)	0.833 (0.376)	0.848 (0.363)
Course GPA (4 point scale)	2.438 (1.022)	2.482 (1.005)	2.565 (0.981)

A more sophisticated investigation of the impact of video access on student performance was conducted. The general specification described different forms of student performance as a function of different levels of access (any, multiple, count) and a limited number of observable characteristics (**X**).

$$Performance_i = \beta_0 + \beta_1 Access_i + \beta_2 \boldsymbol{X} + u_i$$

Table 4 presents a sampling of regression results. Absences and enrollment in the College of Business were statistically significant predictors of student course GPA; no measurements of utilization (any, multiple, number of times accessed) were statistically significant. This general pattern held for other definitions of student performance.

Table 4 Regression of Video Access on Course GPA

Constant	Any Video Access	Multiple Video Access	Number of Times Accessed	Absences	Student in the College of Business	Adjusted R^2
2.20	0.28					-0.006
(0.324)	(0.353)					
2.11		0.45				0.025
(0.454)		(0.280)				
2.35			0.02			-0.010
(0.019)			(0.031)			
2.72	0.05			-0.10 ***		0.158
(0.330)	(0.329)			(0.028)		
2.58		0.23		-0.10 ***		0.168
(0.260)		(0.267)		(0.028)		
2.81			-0.01	-0.10 ***		0.159
(0.213)			(0.029)	(0.028)		
3.35	-0.06			-0.11 ***	-0.82 ***	0.306
(0.344)	(0.300)			(0.025)	(0.220)	
3.17		0.14		-0.11 ***	-0.81 ***	0.309
(0.286)		(0.225)		(0.026)	(0.220)	
3.34			-0.01	-0.11 ***	-0.82	0.306
(0.240)			(0.026)	(0.026)	(0.219)	

Given the nonexperimental nature of the data, it possible that the measure of the effect of the videos on student performance is biased (i.e., violation of the assumption $E(X_i u_i) \neq 0$). Potential bias was invested with estimation of instrumental variables and inverse propensity weighting. The results of the estimation were not conclusive.

Additional Considerations for Adoption

In assessing the value of any innovation in the learning environment, the potential benefits should be weighed against potential costs. While the limited data presented here does not provide a statistically significant justification for adopting this innovation, previous work would seem to support an innovation of type. Additionally, the sustained interest in these review videos indicates students perceive them to have value. This teaching innovation could easily scale to a larger class size where the effect could be stronger.

In terms of costs for this incorporating this type of innovation, the requirements for technology are minimum and certainly fall within the bounds of possible for higher education. While there is a high initial fixed costs with learning any new system, the low marginal cost of periodic production are very small. Additionally, once created, a library of review videos can be reused in later semesters or across instructors.

Not surprising, there was a significant uptick in the review of videos prior to each exam. From an administrative perspective, it might be helpful to assess class needs and create review videos on a weekly basis, but utilization clearly did not follow this pattern.

While these review videos by design are backwards-looking, they may complement forward-looking videos in a course organized around just-in-time teaching or an inverted ("flipped") classroom (Lage, Platt, and Treglia 2000).

Conclusion

Short, weekly review videos were incorporated into two sections of introductory Microeconomics. The purpose of these videos was to improve the knowledge and comprehension levels of learning for the material. Students in the class had a positive reception to the video, as show in the high level of utilization throughout the semester. The data suggests students did not use the videos as a substitute for regular classroom attendance. While anecdotal evidence suggests the videos were successful, observable impacts on classroom learning were weak.

Ideally, the value of this sort of innovation would be evaluated under experimental setting in which a class without videos is used as a control group and the innovation is applied to the treatment group. As a second best outcome would be to observe implementation in a class and use some empirical methods to attempt to mitigate the potential self-

selection bias of the effectiveness of video utilization; those most likely to benefit from using the videos will have a higher probability of utilizing the video.

A valid instrument would be a factor that is correlated with the decision to use the innovation, but is uncorrelated with outcomes. Potentially, something that is correlated to student use of the videos but not correlated with how well they help students retain the information could be used as a valid instrument. A measure of intensity of use of the learning management system as a proxy for openness to technology might be used in future analysis of the effectiveness. However, as with most instruments, instrument may not satisfy the two necessary conditions of a valid instrument (or might represent something else as well).

Alternatively, inverse propensity weighting on the probability of using the innovation using with a matching process might be another avenue for exploring the true effectiveness. Unfortunately, with the relatively small sample size, there was inadequate common support to implement this empirical strategy. Hopefully, with additional future observations, a more robust empirical strategy can be implemented to access effectiveness.

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Using Student Produced Video Clips in Class

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Abstract

The author describes a teaching method using video clips of students teaching other students important economic concepts in class. This paper discusses the use of student- made videos to explain difficult concepts in economics. This simple exercise may offer an effective learning tool for a number of difficult concepts that students often struggle to master in the principles class.

Introduction

Empirical work suggests that most economists rely exclusively on lecturing in the classroom (Becker and Watts 1996; Becker 1997). In some other fields of higher education, class discussion and other forms of active learning have supplemented the exclusive lecturing method (Sax, et al. 1996). Although classroom teachers could incorporate movies, novels, videos, mock hearings, and radio broadcasts into their instruction, typically they do not (Siegfried et al. 1991). The cost of sole reliance on conventional chalk and talk, rather than including more contemporary outcome-based methods, may be significant in the long run, as students choose to move away from economics and into more lively and interesting classes (Becker and Watts 2001). According to McKeachie (1969), students will learn what they want to learn and will have great difficulty in learning material in which they are not interested. "Retention depends on how well students understand ... Understanding, in turn, depends on organizing this material into a personally meaningful form. This integrating process is the means by which knowledge is stored in memory to become accessible later" (Ericksen 1984).

Some economists have adopted teaching techniques that deviate from the pure lecture method, but most have been slow to change (Watts and Becker, 2008). Some, however, have created unique courses, such as teaching economic principles using classic films (Leet and Houser 2003). Others have created unique books. Watts (2003) brought literature and economics together in his book, *The Literary Book of Economics*. But more can be done.

According to learning theorists, imagery is important for learning and remembering. In fact, imagery (visual encoding) is at the very heart of many memory aids (Myers 2004). Medina states, "if information is presented orally, people remember about 10 percent, tested 72 hours after exposure. That figure goes up to 65 percent if you add a picture" (Medina 2009). Video clips provide visual stimuli to reinforce valuable concepts and ideas. Because information is often stored in visual form, pictures and movie clips may be very important in helping students retain important ideas and retrieve them from their long-term memories. Because of the strong effects of visual stimuli, some economics principles tests have added a number of pictures (visual cues) with rich captions that create a welcoming retention and retrieval environment (Sexton 2015).

Using Short Video Clips

In an effort to attract greater student involvement and interest, I have incorporated short video clips into my classroom. The video clips (usually 3-5 minutes in length) highlight particular economic principles. The film clips are done by students; sometimes just using their smart phones. Students get extra credit for their projects.

There is generally no better way to learn something than by teaching it to others. But filmmaking may take this one step further.

A good illustration involves the distinction between a change in demand and a change in quantity demanded (and similarly for a change in supply and a change in quantity supplied), which most teachers spend a disproportionate

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amount of time communicating yet yielding mixed results. In the article, "Repeat after Me: An Experiment in Learning" the author states that verbal repetition might work in helping students solidify their understanding of important economic concepts (Stonebraker 2014). Professor Stonebraker has collected survey data from classes where he has experimented with having students stand and recite: "if the price of a good changes, we move along the existing demand curve…the curve will shift only if there is a change in a factor other than the price of the good, that affects willingness to buy." He has had encouraging results with his experiments on repetition. Of course, this technique has been used for years when one is learning a language.

However, what if students were to produce a brief video clip on the difference between a change in demand and a change in quantity demanded? This might make explaining and utilizing concepts more fun and meaningful, enhancing understanding.

Consider one sample video from one of my classes. My student's setting was a lemonade stand on a schoolyard where children are in session. There was a competing Kool-Aid booth nearby. She first showed the movement along a given demand curve by adjusting the price for a cup of lemonade at her stand, revealing the changes in the willingness to consume at different prices. Her experiment suggested that kids would buy more lemonade at the lower price of $.10 cents than they would at $1. In her video, she then emphasizes that this is a relationship between the price of a good and the quantity demanded, holding everything else that could influence how much a buyer wishes to buy constant. In other words, price is what moves you along a given demand curve.

The next part of the film focuses on other things that can change lemonade sales at a given price, but may not remain constant—the so-called demand shifters. The video shows the Kool-Aid stand lowering the price of Kool-Aid. As kids get the word, they begin leaving the lemonade stand. When a fall in the price of one good lowers the demand for another good—the two goods are substitutes, she says. She also showed that when she lowered the price of lemon wedges from $.10 to zero, she faced increased demand for her lemonade at a given price. That leads her to say that when the price of one good falls, and causes the demand for the other good to rise, the two goods are complements. Finally, one of the kids starts showing her friends that she won the lottery, waving a lottery ticket, and then proceeds to buy many cups of lemonade for her friends on the schoolyard, illustrating income (or wealth) as a demand shifter.

Other students in my courses have presented videos on the Prisoners Dilemma (a cheating scandal in class) and Diminishing Marginal Product (too many students on a scooter) and the Changes in Supply and Changes in Quantity Supplied (the building of a log cabin with Lincoln Logs). Other concepts that could lead to classroom videos are: marginal thinking, comparative advantage, protectionism, shortages and surpluses, price controls, elasticities, externalities, the Coase theorem, asymmetric information, common goods, consumer and producer surplus, behavioral economics, price discrimination, unemployment, inflation, banks and the creation of money and more.

The student videos do not have to be correct to be useful illustrations. Where confused understanding is illustrated in a video, it can still be useful in clearing up the confusions of other students. Every video can be a teaching moment.

For example, we assume in the prisoners dilemma that the police, or in a case of student cheating, the principal, does not have enough evidence to convict the students of cheating, that they are placed in separate rooms and that they have no way to communicate with each other. The principal wants to structure the payoff matrix so that confessing is a dominant strategy for each person. That is, each of these students, if acting rationally, should choose to confess. But in one of my students' videos, one student confessed and the other did not. This provides an opportunity to discuss repeated games and tit-for-tat strategies where there is future punishment for defecting from a strategic arrangement.

Conclusion

Intuitively, it is easy to see that having students not only explain something, but go further to create a video clip it illustrate it, can leave a lasting impression on both the creator and the students who view it. Students like to teach others and they are sometimes more aware of the difficulties other students may have with a concept. Since more learning occurs when students are truly engaged, film-making which gets students involved in creating economic content is a potentially powerful learning tool. Teachers can't merely communicate with graphs and diagrams; we must clearly articulate the intuition behind the concepts. Who better than inquisitive students to provide additional means for their classmates to grasp that information?

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Obtaining Consistent Corporate Valuations

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Abstract

In an introductory finance course, students are introduced to the concept of equity valuation in the form of the constant growth dividend discount model. In advanced courses they are exposed to additional valuation approaches such as free cash flows, adjusted present value, residual earnings and economic profit models. Unfortunately students do not have the opportunity to go beyond the calculations and learn the basic assumptions of each model that will lead to consistent valuations regardless of which model they choose. In this paper, we value an example company using 6 models that lead to identical equity values.

Introduction

In a typical introductory finance course, we introduce discounted cash flow (DCF) methodologies. In general, instructors initially apply DCF methods in order to value bonds and then to apply them to stocks. For common stock valuation, the dividend discount model fits nicely into the introductory course due to its simplicity. Most intermediate level texts such as Brigham and Daves (2013) and Brealey, Myers and Allen (2013) include the dividend discount model (DDM) followed later by several corporate valuation models that either discount free cash flows in order to arrive at an enterprise value, or discount cash flows to shareholders to value the company's equity. Overall, we find that undergraduate students can understand the reasoning behind discounted cash flow methodologies but struggle to identify the key assumptions that are necessary such that all valuation models will lead to identical equity values.

Our purpose in this paper is to provide the basics of valuation models such that a finance professor can assign this paper as a reading and readily expect that intermediate-level students will be able to understand and replicate it with other example companies. We present a comprehensive example that demonstrates the equivalence of six valuation models, i.e., free cash flow (FCF), economic profit (EP), adjusted present value (APV), flow-to-equity (FTE), dividend discount (DDM) and residual earnings (RE) models. Rather than demonstrating how different models can lead to different valuations, we have consistent assumptions across all models resulting in all models having consistent and identical outcomes.

Fernandez (2013) provides a compendium of valuation methods. He values a company by applying 10 different models and 9 theories. While Fernandez is thorough, he does not provide a level of detailed calculations that we believe would be instructive at the undergraduate level. We find that most undergraduates encounter significant difficulties while attempting to follow his calculations. Accordingly we provide in-depth details in our calculations that will enable undergraduate students to learn the basics of valuation models. We build upon the valuation methods found in Koller, Goehart and Wessels (2010). They value a company by applying free cash flow (FCF), economic profit (EP) and adjusted present value (APV) valuations of a company's equity. The three models independently estimate the same value. In appendices, Koller *et. al*. also demonstrate the algebraic equivalence of equations for APV, EP, and FCF. For our exercise, we include a larger variety models that students are likely to encounter in their upper level courses (or eventually to prepare for the CFA exam). Our models include EP and RE that begin with the book values and add to them by discounting cash flows; FCF and APV that solve directly for enterprise value; and DDM and FTE that solve directly for equity value. In addition, APV separates the after tax operating profits and the interest tax shields and discounts them to find the enterprise value. Understanding the basics of valuing tax shields (in order to arrive at valuations that are consistent with the other models) will provide a foundation for studying the numerous other treatments of interest tax shields (that do not always lead to consistent valuations with the other models).

Obtaining consistent valuations among models requires basic assumptions. In the next section we describe them.

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Assumptions

Consistent valuations result from consistent assumptions. We use the following set of assumptions across all valuation models:

1. Capital structure is rebalanced to maintain a constant debt/value ratio based on market values.

Papaioannou (2014) shows the calculations that are necessary for consistency among valuation models for a company that maintains a constant debt value rather than a constant debt/value ratio[3].

2. The company pays a dividend that is equal to its net income plus the change in debt less its investment in net operating working capital and operating long-term assets.

In our example, the change in debt is the amount the company must either issue or retire in order to maintain a constant debt-to-value ratio. Operating working capital refers to operating current assets net of operating current liabilities. Operating assets refer to those real assets that pertain solely to operations and creating wealth.

3. The company's debt sells at par.

Fernandez (2013) and Papaioannou (2014) provide adjustments to basic models if debt does not sell at par. These adjustments are not necessary to accomplish our purpose.

Valuation Models

The following provides a brief description of the six valuation models that we will use:

Free Cash Flow (FCF)

The FCF model finds the enterprise value by discounting the unlevered free cash flows at the company's weighted average cost of capital (WACC). Free cash flow is the difference between after-tax operating income and the investments made in net operating working capital and net fixed assets. Net operating working capital is essentially the difference between current assets that do not bear interest and current liabilities that do not bear interest.

FCF = EBIT(1-T) – Δ Net Operating Capital, where
Δ Net Operating Capital = Δ Net operating working capital + Δ Net Fixed Assets.

Alternatively, free cash flow can be calculated as:

FCF = EBIT(1-T) + Depreciation - Δ Net operating working capital - Δ Gross Fixed Assets.

Economic Profit (EP)

The EP model begins with the value of the company's investor capital and adds to it the present value (discounted at the company's WACC) of the company's future expected economic profits. Investor capital is the book value of the company's debt (short-term and long-term debt) and equity. Economic profit is the difference between after-tax operating profits and the capital charge. Investor capital can also be found from the left side of the balance sheet as the sum of net fixed assets and net operating working capital. The left side investor capital is also referred to as operating assets. Thus, we have an identity: Operating Capital = Investor Capital. The capital charge is assessed against the company's after-tax operating profits and represents the cost to the company of using its investors' capital for the past year. The difference between the after-tax operating profits and the capital charge is the economic profit.

EP = EBIT(1-T) – Capital Charge
Capital Charge = Beginning Investor Capital X WACC.

[3] Papaioannou (2014) highlights the robustness of the APV method and the importance of rebalancing a company's capital structure as it relates to estimating the cost of capital.

Adjusted Present Value (APV)

The APV method separates the operating cash flows and the interest tax shields. To arrive at enterprise value, the APV model adds the present value of the company's free cash flows and the present value of the interest tax shields, both discounted at the cost of unlevered equity since the company rebalances in order to maintain a constant debt/value ratio based on market values. The unlevered free cash flows and the interest tax shields are equally risky and accordingly, we discount them at the same rate. Brealey, Myers, and Allen (2013) discount the unlevered cash flows at the cost of unlevered capital and the interest tax shields at the cost of debt for companies that do not maintain a constant debt/value ratio. Without constant rebalancing and discounting the interest tax shields at the cost of unlevered capital, the resulting APV valuation will not be consistent with the other models in this paper. The enterprise value is found as:

V (APV) = PV unlevered free cash flows + PV interest tax shields,

For both terms, the discount rate r = cost of unlevered capital

Flow to Equity (FTE)

The flow to equity (FTE) model values the portion of the unlevered cash flows that is available to the equity shareholder. The FTE model calculates the present value of what remains of the company's free cash flows after adjusting for changes in debt and deducting interest (on an after-tax basis). The flows to equity are discounted at the cost of equity.

FTE = FCF + Δ Debt – interest + interest tax shield.

Dividend Discount Model (DDM)

The dividend discount model (DDM) is typically presented in an introductory finance course as a model for stock valuation. Stock value is found as the present value of the company's expected dividends discounted at the cost of equity. The dividend policy that provides valuations consistent with the other models is:

Dividend = Net Income + Δ Debt - Δ Operating Assets.

Residual Earnings (RE)

The residual earnings (RE) model assesses a capital charge against the company's after-tax earnings. The cost of using shareholders' capital for a year we call the equity capital charge. Residual earnings are the difference between book earnings and the equity capital charge. The RE model adds beginning book equity plus the present value of residual earnings (discounted at the cost of equity) to obtain the market value of equity.

RE = Net Income – Equity Capital Charge
Equity Capital Charge = Cost of Equity X Beginning Book Equity

The above models provide sufficient variety of valuation approaches that a student can learn the relationships among them while becoming familiar enough with them to understand the effects of altering the basic assumptions that we make. As an example, Myers (1974) discounts interest tax shields at the company's cost of debt (appropriate for a company that does not rebalance to maintain a constant Debt/Value ratio); Fernandez (2007) calculates the interest tax shield by multiplying the unlevered cost of capital times the value of the company's debt times the corporate tax rate. He then discounts the tax shields at the unlevered cost of capital. Ruback (2002), Papaioannou (2014) and Fernandez (2013) present valuations that require that the cost of equity and the weighted average cost of capital be recalculated each year and cash flows be discounted using multiple discount rates each period beyond one year out.

We value an example company by applying each of the above valuation models and arrive at the same equity value for all models. In the following section, we describe the operating characteristics of the example company.

The S. Walker Company Example

S. Walker is a manufacturing company in northern Indiana that had sales of $85 million this year. The sales forecast is 7% growth for the next three years and 4% thereafter. The company's operating forecasts are based on the following ratios:

Cost of Goods Sold/Sales:	75%
Net Operating Working Capital/Sales:	15%
Net fixed assets/Sales:	65%
Depreciation/Net Fixed Assets:	12%

The company uses the following values for its cost of capital calculations:

	Symbol	Rate
Interest rate on debt	r_D	6%
Tax rate	T	35%
Leverage ratio	L (debt/value)	20%
Unlevered cost of capital	r_U	9.840%

S. Walker has 1.5 million shares of equity outstanding. Based on the given operating ratios, we estimate unlevered cash flow for the next 4 years. We commonly refer to these as unlevered free cash flows or free cash flows. They are shown in Panel A of Table 1.

	Year					
Panel A. Investor Capital	0	1	2	3	4	
Net operating working capital	12.75	13.64	14.60	15.62	16.24	(15% Sales)
Net fixed assets	55.25	59.12	63.26	67.68	70.39	(65% Sales)
Depreciation	6.63	7.09	7.59	8.12	8.45	(12% NFA)
Net Operating Assets	68.00	72.76	77.85	83.30	86.64	(NOWC + NFA)
Panel B Free Cash Flows	0	1	2	3	4	
Sales	85.00	90.95	97.32	104.13	108.29	
Operating Costs		68.21	72.99	78.10	81.22	(75% X Sales)
EBITDA		22.74	24.33	26.03	27.07	
Depreciation		7.09	7.59	8.12	8.45	
EBIT		15.64	16.74	17.91	18.63	
Taxes		5.48	5.86	6.27	6.52	
NOPAT		10.17	10.88	11.64	12.11	
Depreciation		7.09	7.59	8.12	8.45	
Operating cash flow		17.26	18.47	19.76	20.55	
Increase in NOWC		0.89	0.95	1.02	0.62	
Investment in fixed assets		10.96	11.73	12.55	11.15	
Unlevered free cash flows		5.41	5.79	6.19	8.78	
Panel C. FCF Valuation	0	1	2	3	4	
Unlevered free cash flows		5.41	5.79	6.19	8.78	
Continuing value				161.90		
Total Free cash flows		5.41	5.79	168.09		
PV, FCF (r= WACC = 9.42%)	138.09					
Debt	27.62					
Equity	110.47					
Shares	1.50					
Value/share	73.65					

Panel D. Market Value Capital Structure	0	1	2	3	4
Value (PV of FCFs)	138.09	145.69	153.62	161.90	168.38
Debt (20%)	27.62	29.14	30.72	32.38	33.68
Change in debt		1.52	1.59	1.66	1.30
Interest		1.66	1.75	1.84	1.94
Tax shields		0.58	0.61	0.65	0.68

Net operating working capital is operating current assets net of operating current liabilities. "Operating" indicates that they are connected directly to operations (not short-term investments or short-term notes). Net operating assets are the sum of net operating working capital and net fixed assets. Investment in fixed assets is defined as the difference between ending and beginning net fixed assets plus depreciation. For year 1, it is calculated as:

Investment in fixed assets = ending net fixed assets - beginning net fixed assets + depreciation
Investment in fixed assets (1) = 59.12 – 55.25 + 7.09 = 10.96.

The unlevered free cash flows (or free cash flows) are independent of the company's financial leverage. Hence, we do not include interest expense in the calculation. Free Cash Flow (FCF) calculations begin with net operating profits after taxes (NOPAT), add back non cash operating expenses (typically depreciation and amortization) and subtract investments in net operating capital. For year 1, NOPAT and free cash flow equal:

NOPAT (1) = EBIT – operating taxes = EBIT(1-T) = 15.64 - 5.48 = 10.17
FCF = NOPAT + Depreciation – (Increase in NOWC) – (Increase in Fixed Assets)
FCF (1) = 10.17 + 7.09 – (13.64 - 12.75) - (59.12 - 55.25 + 7.09)= 5.41

We complete the FCF calculations for the next 3 years using the same equations that we show above. Having calculated the unlevered free cash flows, we will complete our first valuation using the free cash flow model.

Free Cash Flow (FCF) Valuation

The FCF model finds the enterprise value by discounting the unlevered free cash flows at the company's weighted average cost of capital (WACC). To find the WACC, we first find the cost of levered equity (r_E). Later, r_E will also serve as the discount rate for the dividend discount, the residual earnings and the flow to equity models. At this point, we commit the company to maintaining a constant leverage ratio (Debt/Value) based on market values of 0.20. Maintaining a constant debt ratio leads to all models estimating identical equity values for the company. We employ the cost of equity equation suggested by Harris and Pringle (1985), Brigham and Daves (2013) and Brealey, Myers, and Allen (2013) among others:

$r_E = r_U + (r_U – r_D)(D/E) = 9.840\% - (9.840\% - 6\%)(0.20/0.80) = 10.80\%$

With the debt ratio (debt/value) of 20%, a tax rate of 35%, a cost of debt of 6% and the cost of equity of 10.80%, the weighted average cost of capital (WACC) equals:

$WACC = D/V\ (r_D)(1-T) + E/V\ (r_E) = 20\%\ (6.0\%)(1-35\%) + 80\%\ (10.80\%) = 9.42\%.$

We have estimated that the S. Walker Company will grow at a constant rate of 4% after year 3. To find the value of free cash flows that occur after year 3, we calculate the company's continuing value (also referred to as the horizon value) in year 3 as:

CV (3) = FCF4/(WACC - g) = 8.78 / (9.42% - 4%) = 161.90

As shown in Panel C of Table 1, we add the continuing value to the year 3 free cash flow to obtain a total year 3 free cash flow of 161.90 + 6.19 = 168.09. Discounting the total free cash flows at the WACC results in an Enterprise Value = Debt + Equity (at market values) of 138.09. Given a debt/value ratio of 20%, the free cash flows will support an initial debt level of:

Debt (0) = 20% (138.09) = 27.62.

Subtracting debt from the enterprise value results in an equity value of:

138.09 - 27.62 = 110.47, or 110.47 / 1.5 (shares) = 73.65 per share.

In order to value the company with the other 5 models, we need to find the market value of the company and its debt for the following 4 years. We present these values in Panel D of Table 1.

Value is found by discounting the future free cash flows at the WACC as follows:

Value (1) = [PV(r = 9.42%, 5.79, (6.19+161.90)] = 145.69
Value (2) = [PV(r = 9.42%, (6.19+161.90)] = 153.62
Value (3) = CV(3) = 161.90 (the continuing value)
Value (4) = Value (3) (1+g) = 161.90 (1.04) = 168.38.

Interest tax shields are the product of interest and the tax rate. For year 1, interest is:

Interest (1) = beginning debt X before-tax interest rate = 27.62 (6%) = 1.66

The resulting interest tax shield is:

Interest tax shield (1) = interest X tax rate = 1.66 (35%) = 0.58

Each year, the company maintains a debt/value ratio equal to 20% of market value. Rebalancing is essential in order to produce consistent valuations across all models. In the next section, we present an Economic Profit (EP) valuation.

Economic Profit (EP) Valuation.

The EP model begins with the value of the company's investor funds and adds to it the present value (discounted at the company's WACC) of the company's future expected economic profits. Economic profit is the difference between after-tax operating profits and the capital charge. The capital charge is assessed against the company's after-tax operating profits and represents the cost to the company of using its investors' capital for the past year. The difference between the after-tax operating profits and the capital charge is the economic profit. The capital charge emphasizes the importance of capital being productive. If investor capital is employed unproductively, it generates relatively low economic profits. Knowing that the capital charge will be assessed against after-tax operating profits dissuades managers from investing large amounts of capital in order to generate higher levels of book earnings (at the cost of high capital charges and the resulting low economic profits).

The EP model is one of two presented in this paper that begins with the book value of the employed capital. The other is the residual earnings model which begins with the book value of equity. From Panel A of Table 2, we have employed initial values of net operating working capital (NOWC) and net fixed assets (NFA) of 12.75 and 55.25, respectively for a total net operating assets of 68.00. The unlevered free cash flows are sufficient to support an initial debt level of 27.62 (from Panel D of Table 1). We use the book value of debt as an estimate of its market value. Net operating assets are equal to invested capital. We find the book value of the company's equity by subtracting the initial debt from the initial invested capital, resulting in a "book" equity amount of 68.00 – 27.62 = 40.38. The EP valuation is presented in Panel B of Table 2. For year 1, the company had employed 68.00 of investor capital. The capital charge for the use of that capital for year 1 is:

Capital charge (1) = Invested capital (T = 0) X WACC = 68.00 (9.42%) = 6.41.

Subtracting the capital charge from the year 1 NOPAT results in an economic profit of:

$EP(1) = NOPAT_1 – Capital\ charge_1 = 10.17 – 6.41 = 3.76.$

For year 3, the continuing value is:

$CV(3) = EP_4 / (WACC – g) = 4.26 / (9.42\% - 4\%) = 78.60.$

We add the present value of the economic profits (70.09) to the beginning investor capital (68.00) to arrive at the enterprise value of 138.09, which is the precise value that we found by discounting the free cash flows at the WACC. As with the FCF method, we subtract the T= 0 debt value (27.62) to find the equity value of 110.47.

In the following section, we present the Adjusted Present Value model, which also solves for enterprise value but discounts the unlevered cash flows and the interest tax shields at the unlevered cost of capital (r_U).

Adjusted Present Value (APV)

The APV method separates the operating cash flows and the interest tax shields. Most commonly the unlevered cash flows are discounted at the cost of unlevered capital and the tax shields at the cost of debt (Brealey, Myers, and Allen 2013). However, in our example we maintain a constant debt / value ratio based on market values. Debt is tied directly to the enterprise value, which is determined by the unlevered cash flows. Thus, the interest tax shields are equally risky as the unlevered cash flows and are also discounted at the unlevered cost of capital. If the company does not maintain a constant debt / value ratio, several discount rates have been suggested for the interest tax shields. As an example, Myers (1974) argues that the tax shields are equally risky as the debt itself and should therefore be discounted at the cost of debt. Very similar to APV is the capital cash flow model (CCF) from Ruback (2002). Capital cash flows are equivalent to the sum of the unlevered free cash flows and the interest tax shields; in the CCF model, the capital cash flows are discounted at the unlevered cost of capital (regardless of the debt/value ratio). Here, we will discount the unlevered cash flows and the tax shields separately, which is the conventional APV approach.

The APV begins by calculating the "base case" value. This is the enterprise value if the company was financed completely with equity. We find the base case value by discounting the unlevered cash flows at the unlevered cost of capital (r_U). In order to estimate the enterprise value of a levered company, we add the present value of the interest tax shields (in our example, also discounted at the cost of unlevered capital) to the base case value.

Panel C of Table 2 presents the APV valuation of the S. Walker Company. The continuing value in year 3 is similar to that of the FCF model except the discount rate is the unlevered cost of capital (r_U) rather than the WACC:

$CV\ (3) = FCF4 / (r_U - g) = 8.78 / (9.84\% - 4\%) = 150.26.$

Similarly, the continuing value for the interest tax shields is:

$CV3 = \text{Interest tax shield4} / (r_U - g) = 0.68 / (9.84\% - 4\%) = 11.64$

The enterprise value is the sum of the base case value and the present value of the interest tax shields. We find the equity value by subtracting the initial debt value from the enterprise value resulting in an equity value of 110.47, again equaling what we found using the other models.

Up to this point, we have presented valuation models in which we find the enterprise value and subtract the debt value to arrive at the equity value. In the next section, we present the flow to equity model – the first of three valuation models that directly estimates equity value without first estimating enterprise value.

Flow-to-Equity

The flow-to-equity (FTE) model values the portion of the unlevered cash flows that is available to the equity shareholder. The FTE valuation is shown in Panel A of Table 3.The calculation for flow to equity is:

FTE = Unlevered cash flow + change in debt – interest + interest tax shield.
FTE (1) = 5.41 + 1.52 - 1.66 + 0.58 = 5.85.

The unlevered cash flows, the changes in debt, interest, and interest tax shields are taken from Panels B and D of Table 1. The continuing value calculation is:

$CV\ (3) = FTE_4 / (r_E - g) = 8.81 / (10.80\% - 4\%) = 129.52.$

We discount the FTE cash flows at the cost of levered equity (r_E) of 10.80% (calculated previously as a component cost of the WACC). The FTE model equity value of 73.65 is identical to equity valuations from the other models. Similarly to FTE, the next two models, the dividend discount and equity residual models also directly estimate equity value.

Table 2. Economic Profit and Adjusted Present Value Models

	Year				
Panel A. Initial Balance Sheet (book values)	0	1	2	3	4
Net Operating Working Capital	12.75	13.64	14.60	15.62	16.24
Net Fixed Assets	55.25	59.12	63.26	67.68	70.39
Investor Capital	68.00	72.76	77.85	83.30	86.64
Debt	27.62	29.14	30.72	32.38	33.68
Equity	40.38	43.62	47.13	50.92	52.96
Investor Capital	68.00	72.76	77.85	83.30	86.64
Panel B. Economic Profit Valuation	0	1	2	3	4
NOPAT		10.17	10.88	11.64	12.11
Net Operating Capital	68.00	72.76	77.85	83.30	86.64
Capital charge		6.41	6.85	7.33	7.85
Economic profit		3.76	4.03	4.31	4.26
Continuing value				78.60	
Total economic profit		3.76	4.03	82.91	
PV EPs, r = WACC=9.42%	70.09				
Beginning operating capital	68.00				
Enterprise value	138.09				
Debt	27.62				
Equity	110.47				
Shares	1.50				
Value / share	73.65				
Panel C. Adjusted Present Value (APV) Valuation	0	1	2	3	4
Unlevered cash flows (from Table 1)		5.41	5.79	6.19	8.78
Continuing value				150.26	
Total unlevered cash flows		5.41	5.79	156.45	
PV, r = rU = 9.84%	127.78				
Tax shields (from Table 2)		0.58	0.61	0.65	0.68
Continuing Value				11.64	
Total tax shields		0.58	0.61	12.29	
PV tax shields	10.31				
Total value	138.09				
Debt	27.62				
Equity	110.47				
Shares	1.50				
Value / share	73.65				

Up to this point, we have presented valuation models in which we find the enterprise value and subtract the debt value to arrive at the equity value. In the next section, we present the flow to equity model – the first of three valuation models that directly estimates equity value without first estimating enterprise value.

Flow-to-Equity

The flow-to-equity (FTE) model values the portion of the unlevered cash flows that is available to the equity shareholder. The FTE valuation is shown in Panel A of Table 3.The calculation for flow to equity is:

FTE = Unlevered cash flow + change in debt – interest + interest tax shield.
FTE (1) = 5.41 + 1.52 - 1.66 + 0.58 = 5.85.

The unlevered cash flows, the changes in debt, interest, and interest tax shields are taken from Panels B and D of Table 1. The continuing value calculation is:

CV (3) = FTE_4 / (r_E-g) = 8.81 / (10.80% - 4%) = 129.52.

We discount the FTE cash flows at the cost of levered equity (r_E) of 10.80% (calculated previously as a component cost of the WACC). The FTE model equity value of 73.65 is identical to equity valuations from the other models. Similarly to FTE, the next two models, the dividend discount and equity residual models also directly estimate equity value.

Dividend Discount Model

The dividend discount model (DDM) is typically presented in an introductory finance course. Here we will demonstrate that with the appropriate dividend payout policy, DDM will arrive at the exact equity value as the other models. The DDM valuation is presented in Panel B of Table 3. In order to arrive at a valuation that is consistent with our other models, we specify the dividend policy as:

Dividend = Earnings after taxes + change in debt – invested capital.

For year 1 the dividend is:

Dividend (1) = 9.09 + (29.14-27.62) – (72.76 – 68.00) = 5.85.

After estimating the dividends, we discount them at the cost of levered equity (r_E). Alternatively, we can estimate the dividend by subtracting the change in book equity from the after-tax earnings. This is referred to as "clean surplus" relation (Pinto, Henry, Robinson, and Stowe 2010). Between year 0 and year 1, book equity increased by 43.62 – 40.38 = 3.24. This leads to a dividend of:

Dividend (1) = 9.09 – 3.24 = 5.85.

The DDM continuing value is calculated as:

CV (3) = $Dividend_4$ / (r_E – g) = 8.81 / (10.80% - 4%) = 129.52.

Dividends are discounted at the cost of levered equity (r_E). The equity value is 110.47, as it has been for all models. By no coincidence, the dividends are equal to the flows to equity from Panel A. They will be equal as long as the company pays out a dividend that is consistent with maintaining a clean surplus relationship between earnings and dividends and rebalancing debt to maintain a constant debt/value ratio. In the following section, we present our final model that estimates equity value directly - the residual earnings model.

Residual Earnings

The economic profit model assessed a capital charge against the company's net after-tax operating profit. The residual earnings model is similar except it assesses a capital charge against the company's after-tax earnings rather than against the net after-tax operating profit. We call the cost of using equity shareholders' capital for a year the equity capital charge. Panel C of Table 3 presents the residual earnings valuation of the S. Walker Company. We calculate the equity capital charge for year 1 as follows:

Equity Capital Charge = Beginning book equity X Cost of levered equity.
Equity Capital Charge (1) = 40.38 X 10.80% = 4.36.

Residual earnings are the difference between net income and the equity capital charge. For year 1, we calculate residual earnings (RE) as follows:

RE (1) = Earnings after taxes – Capital charge = 9.09 – 4.36 = 4.73

We calculate the year 3 continuing value as follows:

CV (3) = RE_4 / (r_E – g) = 8.81 / (10.80% - 4%) = 78.60.

After calculating each year's total residual earnings, we discount them at the cost of levered equity (r_E) to find the additional equity value that the company will create beginning in year 1. To find equity value at year 0, we add beginning book equity (40.38) and the present value of the residual earnings (70.09) to arrive at an equity value of 110.47 and a share value of 73.65.

Table 3. Direct Equity Valuations

	Year				
Panel A. Flow to Equity Valuation	0	1	2	3	4
Unlevered cash flows		5.41	5.79	6.19	8.78
Change in debt		1.52	1.59	1.66	1.30
Interest		1.66	1.75	1.84	1.94
Tax shields		0.58	0.61	0.65	0.68
Flow to equity (FTE)		5.85	6.24	6.65	8.81
Continuing value				129.52	
Total FTE		5.85	6.24	136.17	
PV, FTE, $r = r_E = 10.80\%$	110.47				
Shares	1.5				
Value / share	73.65				
Panel B. Dividend Discount Model	0	1	2	3	4
Sales	85.00	90.95	97.32	104.13	108.29
Operating Costs		68.21	72.99	78.10	81.22
EBITDA		22.74	24.33	26.03	27.07
Depreciation		7.09	7.59	8.12	8.45
EBIT		15.64	16.74	17.91	18.63
Interest (from Table 1, Panel C)		1.66	1.75	1.84	1.94
Before-tax income		13.99	14.99	16.07	16.68
Taxes (35%)		4.90	5.25	5.62	5.84
Earnings after taxes		9.09	9.74	10.44	10.84
Invested capital	68.00	72.76	77.85	83.30	86.64
Book Value Debt	27.62	29.14	30.72	32.38	33.68
B00k Value Equity	40.38	43.62	47.13	50.92	52.96
Increase in book equity		3.24	3.51	3.79	2.04
dividends		5.85	6.24	6.65	8.81
Continuing value				129.52	
Total dividend cash flows		5.85	6.24	136.17	
PV dividends, $r = r_E = 10.80\%$	110.47				
Shares	1.50				
Value / share	73.65				
Panel C. Residual Earnings Valuation	0	1	2	3	4
Earnings after tax (from Panel B)		9.09	9.74	10.44	10.84
Equity at book value	40.38	43.62	47.13	50.92	52.96
Equity capital charge		4.36	4.71	5.09	5.50
Dividend		5.85	6.24	6.65	8.81
Addition to retained earnings	3.24	3.51	3.79	2.04	
Residual earnings		4.73	5.03	5.35	5.34
Continuing value				78.60	
Total residual earnings		4.73	5.03	83.95	
PV, residual earnings, $r = r_E = 10.80\%$	70.09				
Equity value	110.47				
Shares	1.50				
Value / share	73.65				

Conclusion

For undergraduate students, learning and becoming proficient with corporate valuation models can be challenging. We value an example company with 6 models that students can expect to see again in their advanced finance courses and in their graduate programs. With the assumptions that we specify, students can be confident that they are applying the models correctly if the resulting equity values from all models are equal. We can assure that our students are proficient with the models by assigning exercises that are similar but different enough to prevent mechanical replication of our example. One such variation is to initially provide a levered beta rather than the unlevered cost of capital. Numerous other variations are possible. Once students are familiar with the basics of the models, they will be in a stronger position to begin changing our initial assumptions and making appropriate adjustments.

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Simulation of Binomial Trees for Exotic Option Pricing Using Excel

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Abstract

Option pricing can be presented in a variety of ways to students learning the subject for the first time, ranging from solution of the Black Scholes formula to approximations using Binomial trees. This article shows how an Excel spreadsheet may be used to illustrate the principle of risk neutral pricing through the simulation of random share price paths through the nodes of Binomial trees. By observing such random path prices through a binomial tree, the particular features of different types of options may be more readily appreciated. The method is illustrated with an application to plain vanilla calls and puts, and extended to an analysis of barrier options.

Keywords: Option Pricing, Simulation, Excel, Binomial Tree

Introduction

Binomial trees are often used to illustrate the process of option pricing. Such trees may be used to illustrate the evolution of possible share prices and the value of the option found as the discounted expected value of the option payoff. Binomial trees may also be used to illustrate the pricing of a variety of different options in which the payoff functions may themselves be path dependent, such as Asian and barrier options. However, the manner in which the payoff functions for path dependant options depend on the actual path taken can sometimes be difficult to convey when the set of possible paths are presented in a static fashion. In order to overcome this drawback, the readily available and widely used software package Excel is used to generate random share price paths through a Binomial tree. It is hoped that such an approach will enable students of finance to observe in detail the implications of individual paths through such trees in terms of option features such as barriers. Moreover, as simulations progress, the concept of risk-neutral pricing can be illustrated in a dynamic fashion.

Motivation

Various studies have shown that effective learning is stimulated by interaction between the educator and students, and further enhanced by co-operative activities amongst students (Boethel and Dimock, 1999; Maddox, Johnson and Willis, 1997). An important motivation for the present spreadsheet based exercise is that it enables students to acquire and analyse difficult concepts relating to exotic option pricing in an interactive and engaging environment. The use of such "hands-on" spreadsheet based modelling of financial concepts in order to improve understanding has been advocated by a number of authors (Hess, 2005; Holden and Womack, 2000)

The use of Binomial trees as a way of pricing vanilla call and put options is well established and often represents the first taste of option pricing for many students of finance. However, when used to illustrate the pricing of more exotic options, in particular, path-dependent options, such trees face a number of drawbacks. Firstly, in order to provide a realistic scenario for the pricing mechanism, the number of steps in the tree generally needs to be greater than for a vanilla option, an issue that tends to make the hand calculation of the pricing process difficult. Secondly, the effect of a particular option feature, such as a barrier or a cap, on an individual option path may be difficult to highlight with the greater number of possible paths in a larger tree. For these reasons, a software-based approach is likely to offer a greater insight into the added difficulties of pricing such exotic options.

In a recent article, Johnson and Stretcher (2013) used Excel to introduce students to pricing exotic options using Binomial trees and the concept of risk neutral pricing. The approach taken in that article was to list all possible paths in the tree and then to focus on those paths that illustrated particular features of the option type being studied.

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In the present article, the approach is somewhat different in that, option pricing is illustrated within the spreadsheet by simulating individual random paths for the share price and calculating the subsequent option payoff. In this way, the student of finance can dynamically observe the implications of a particular path on the final payoff of the option. As well as providing graphic illustrations of random paths generated, the spreadsheet also enables the empirical discounted mean value of the payoff function to be calculated and its convergence properties studied in real time. In this way, students can also gain an insight into the simulation process.

Methodology

The spreadsheet shown in the various exhibits shows a Binomial tree with five time steps. This number seems sufficient to illustrate the basic ideas for examples such as barrier and Asian options. The number of steps in the tree can be readily increased if required. The construction of the tree follows the procedure that can be found in various textbooks (Hull 2000 is a standard reference for all the options discussed in this paper), and can be briefly summarised as follows.

We begin by illustrating the spreadsheet simulation for vanilla call and put options. The value of a vanilla call option at the final node is given by max $(S_T - K, 0)$, where K is the strike price of the option and S_T is the value of the stock at the expiration of the option at time T. The corresponding value of a vanilla put option is max $(\mathrm{K} - S_T, 0)$. We assume that the risk free rate is r, the volatility of the stock return is σ and that the duration of each time step is δ_t.

At each step in the tree, the stock price may increase by a factor u or decrease by a factor $d = u^{-1}$, where $u = e^{r\sqrt{\delta_t}}$. The risk-neutral probability of an increase in the stock price is

$$p = \frac{e^{r\sqrt{\delta_t}} - d}{u - d}$$

The values of r, σ, K and T may all be set as input parameters to the spreadsheet, with the other quantities required for the simulation being automatically calculated from these.

The value of the option may be calculated as the discounted expected value of the option payoff, the expectation being taken with respect to the Binomial distribution probabilities of the stock price at expiration.

The approach adopted here is to simulate the operation of the tree by observing a random stock price path through the various nodes. Such simulation-based approaches are often very useful for enhancing the students' understanding when encountering statistical concepts such as parameter estimation, hypothesis testing or confidence intervals (Wood 2005, Barr and Scott 2014). It is to be hoped that the approach presented here will similarly enhance students' understanding of the concept of risk-neutral pricing.

Implementation

The implementation is deliberately kept as simple as possible in order to make their use straightforward and to enable extensions to be easily programmed. The spreadsheets make use of Excel's ability to perform iterative calculations by assigning circular references to certain cells. To enable this, the user must first click on the Excel menu sequence **File-Options-Formulas-Enable Iterative Calculations** and tick the appropriate box.

Cell F7 enables the user to choose between modelling a call or a put option. In this example, a put option with a strike price of 10.5 and initial share value of 10 is being modelled. The risk-free rate is 5% and the assumed volatility of the stock return is 20%.

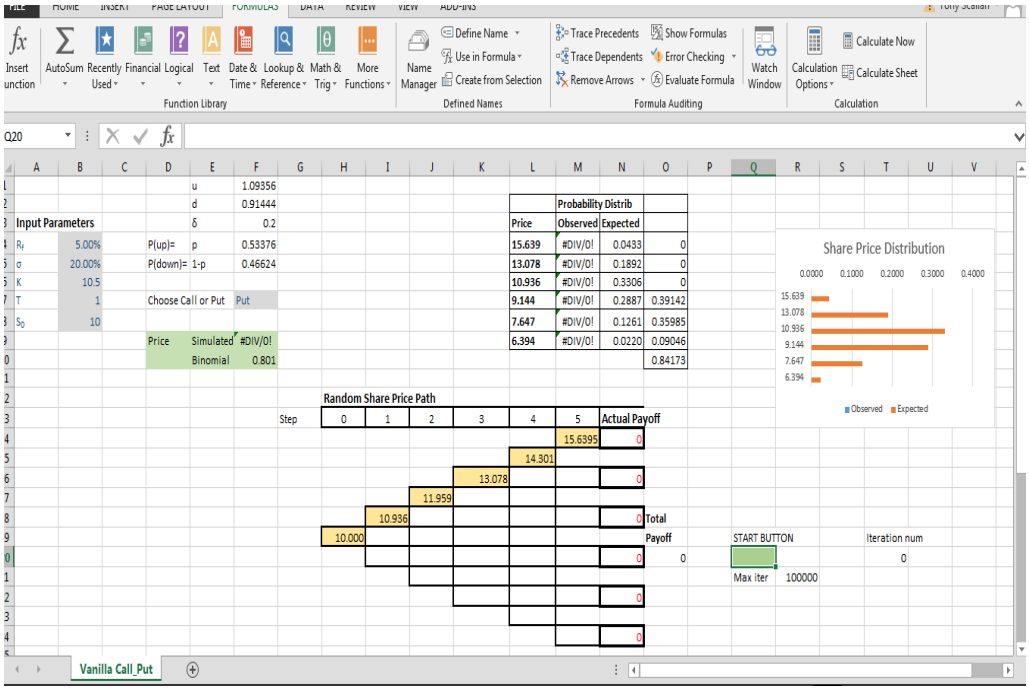
In order to start the iterative process, the spreadsheet must first be initialised. This process is illustrated in Exhibit 1 for a vanilla put option. The contents of cell Q20 must first be deleted and the Calculate Sheet button (on the Formulas menu tab) clicked. This has the effect of resetting all existing values ready for the simulation to begin.

To start the simulation, simply type any text in Q20 and press Enter. This will generate the first random stock price path and the corresponding option payoff. The simulation is carried out by generating a random number for each branch of the tree using Excel's RAND() function and, dependent on the value of p, translating this into an up or down step. The up or down step is equivalent to the outcome of a Bernouilli random variable that can be simulated using the inverse CDF technique. The observed random path through the tree is illustrated by making use of some Conditional Formatting instructions for the appropriate cells in the table.

The graph of the stock price distribution at the top right of the sheet shows the theoretical Binomial distribution of the stock final prices alongside the simulated distribution as it evolves. For example, for the stock to end at price 15.639 would require 5 "up-steps", each with probability p=0.53376, to give $P(S_5=15.639)=0.53376^5=0.0433$. These

values are easily calculated using the Excel's BINOM.DIST function. This theoretical distribution can be usefully compared with the results produced by the simulation model as the simulation progresses.

Exhibit 1. Initialisation of the Spreadsheet



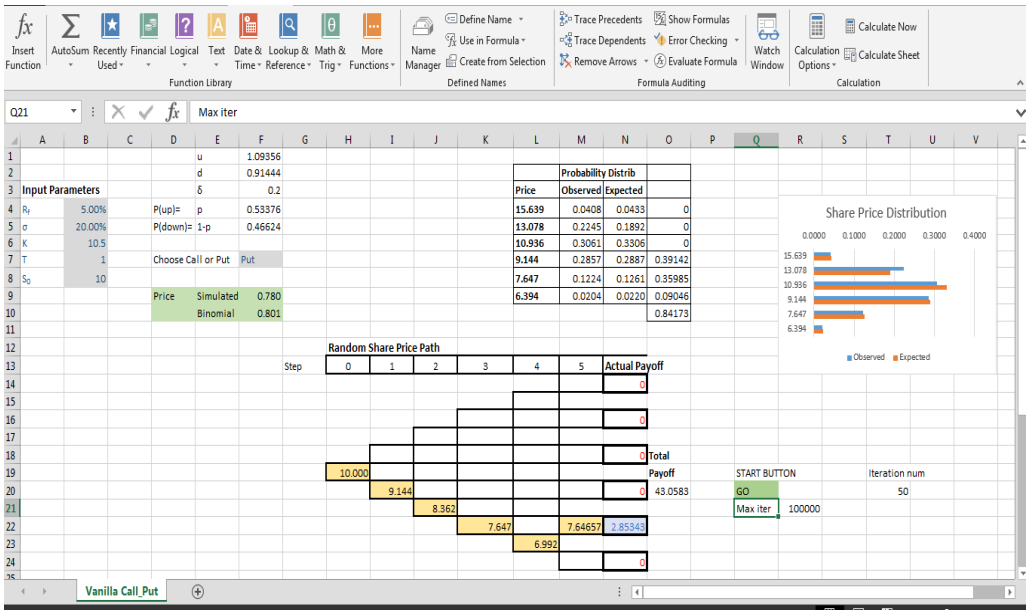
Each subsequent click on the Calculate Sheet button will produce another random price path and, hence, random payoff. The total payoff for all paths is stored in cell O20 and then divided by the number of iterations to give the mean sample mean payoff for the option. This quantity, discounted at the risk-free rate over the option duration, is stored in cell F9. To compare the simulated value with the theoretical expected value, the discounted expected payoff is stored in cell F10.

Exhibit 2 shows the simulation in progress after 50 iterations. At this stage, as illustrated in the bar chart, the observed distribution of the final values of the stock price is beginning to resemble the theoretical distribution. The current simulated path has the stock price taking steps *ddddu* resulting in a final stock value of 7.647 and, hence, a payoff of $(K-S_T)$ =10.50-7.647=2.853. The current mean discounted payoff is 0.780 compared to the theoretical value from the tree of 0.801.

Iterations can be performed singly by clicking on the Calculate Sheet button, or, more rapidly, by holding down the F4 button. Although, in principle, it is possible to program Excel to perform a fixed number of iterations, experience has shown that the results so obtained can be somewhat unpredictable. However, the hands-on nature of the spreadsheet presented here enable students to observe the simulation in action and to quickly build up a large enough number of iterations to observe the evolution of the process to its theoretical value, or close to it. The speed of convergence will obviously depend on the values of the input parameters, although this in itself is something that can be usefully explored in the classroom setting.

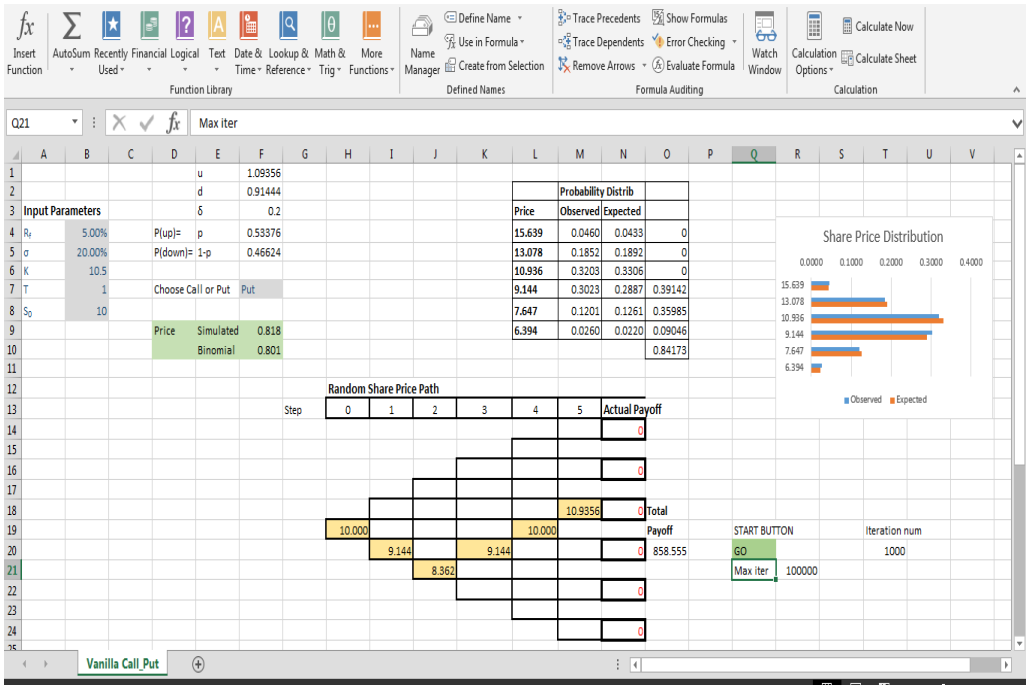
The time taken to perform simulations appears fairly consistent, with testing on several laptops running different versions of Windows, suggesting that 1000 simulations take approximately 45 seconds to perform.

Exhibit 2. Simulation in Progress



After 1000 iterations, we arrive at the Sheet shown in Exhibit 3. Here the final distribution of the observed share price is very close to its expected distribution, and the simulated option price of 0.818 is close to the theoretical value of 0.801. The bar chart at the top right of the spreadsheet shows how the simulated distribution compares to the theoretical distribution.

Exhibit 3. Simulation near convergence



Extensions to Exotic Options

The spreadsheet presented here can be easily adapted to model exotic and, in particular, path dependent options. For example, an Asian option is a path-dependent option in which the payoff depends on the mean stock price during the lifetime of the option rather than its final value. It is a straightforward extension to calculate the mean stock price, arithmetic or geometric, for any particular random path and, therefore find the payoff for an Asian type option.

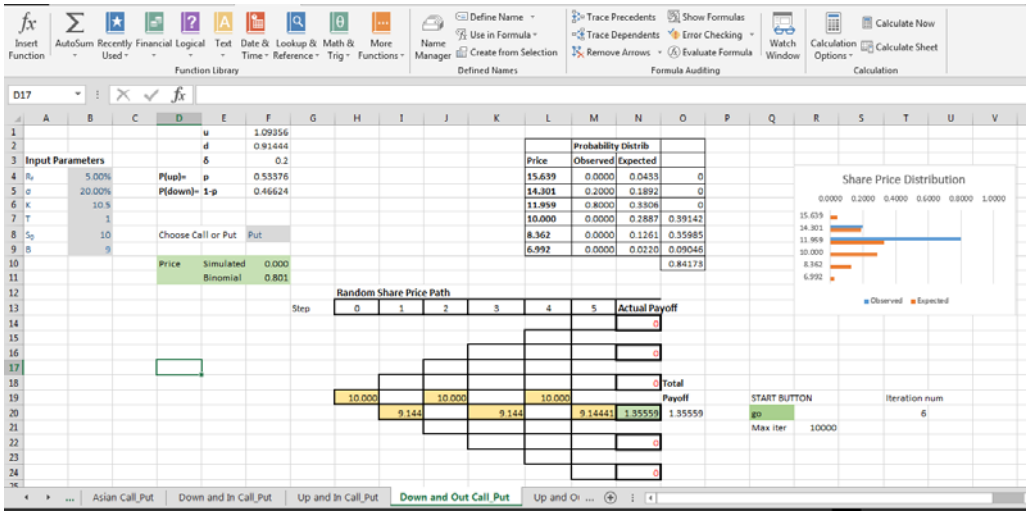
With some extra programming, it is also possible to model, for example, barrier options. Here, a barrier is introduced that the stock price must breach (knock-in) or must not breach (knock-out), with the final option payoff being dependent on whether or not the barrier was breached. With the simulation approach, the student can observe for a particular path whether the barrier is breached and, conditional on that event, the eventual payoff for the option.

As an illustration of simulating exotic options, we make use of the familiar result that, in general,

Down and Out + Down and In ≡ Vanilla

and apply the result to modelling the Vanilla put in Exhibit 1 as the sum of two barrier options. Exhibits 4 and 5 illustrate a spreadsheet to simulate a Down and Out call or put option. The input parameters and use of this spreadsheet are the same as before except for the addition of a lower barrier, B, value specified in cell B9 at a value of 9.

Exhibit 4. Down and Out Barrier Option



In Exhibit 4, the particular path illustrated results in a payoff in the same way as a Vanilla put option since the path of the share price did not breach the lower barrier set at 9. Exhibit 5, however, illustrates a path in which the share price breached the barrier at step 4, when the share price reached a low of 8.362, and is emphasised by the step number being coloured red at this stage. The final payoff for this option is necessarily zero, even though the final share price is below the strike price, and would normally result in a positive payoff for a put option.

Finally, Exhibit 6 illustrates the implementation of a Down and In put option with the same input parameters. The particular path illustrated shows one in which the barrier is reached so that the option becomes active and, in this case, results in a payoff at the final node. In a similar fashion to the Down and out option, the step number at which the barrier is reached, step 4 in this case, is again highlighted, this time in green.

After 1000 iterations in each case, this particular simulation reached prices of 0.622 and 0.180 for the Down and In and Down and Out options, respectively. This compares with the expected total price of 0.801 for the sum of these two options.

Exhibit 5. Down and Out Barrier Put Option with Barrier breached

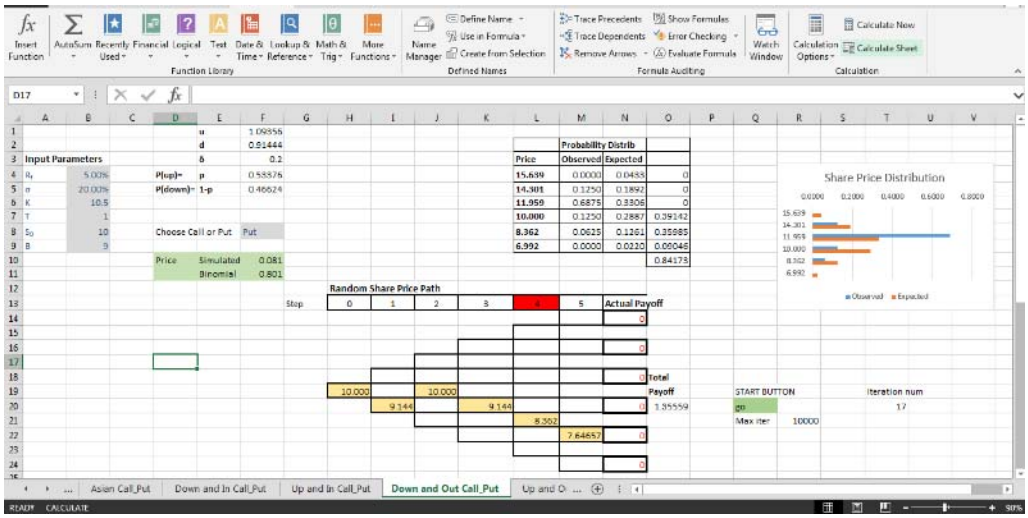
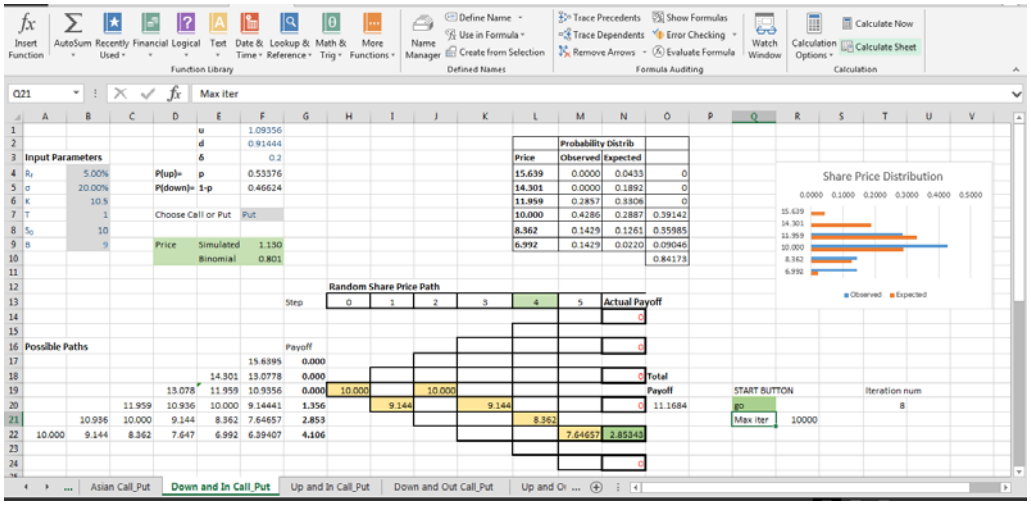


Exhibit 6. Down and In Barrier Put Option



Conclusions

Understanding the risk-neutral pricing of options essentially means understanding the statistical concept of expectation. The model presented in this paper illustrates the concept using a simple simulation model that incorporates the essential financial framework underpinning the theory of option pricing. The wide availability of Excel and the minimal use of any complicated programming structures make the methods presented here a useful tool for classroom use. The spreadsheets and extensions are available from the author.

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Finding the Efficient Frontier: An Exercise for Finance Students

William A. Reese, Jr.[1] and Russell P. Robins[1]

Abstract

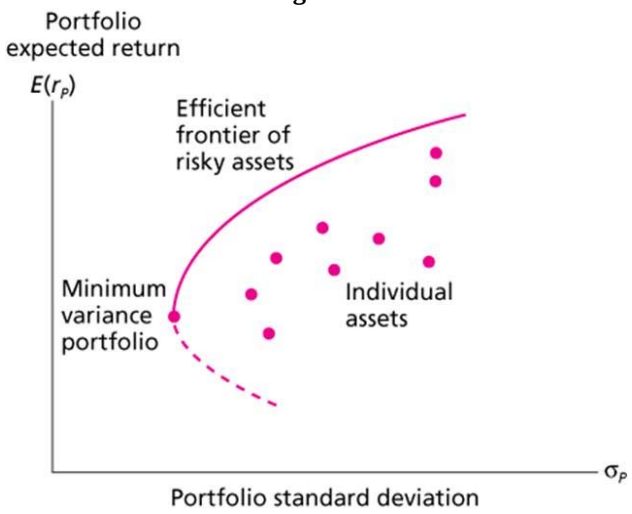
Finance textbooks and classroom instructors often show that the set of mean/variance efficient portfolios can be plotted on a graph with the outer edge forming a hyperbola. Our exercise does this on an Excel spreadsheet with real-world data from asset classes that students get to choose. The spreadsheet calculates minimum portfolio standard deviations, the minimum variance portfolio, and the mean/variance efficient portfolio. These values are all graphed in mean/variance space, resulting in the familiar hyperbola. Portfolio constraints can be inserted as well. Students learn how to construct efficient portfolios and the effects of constraints while using real-world data.

Introduction

Harry Markowitz (1952) ushered in the era of Modern Portfolio Theory in his groundbreaking paper on Portfolio Selection. In it, he established what has since come to be known as Mean/Variance Analysis. Mean/Variance Analysis tells us that risk-averse investors prefer higher expected returns and lower standard deviations. Further, investors are concerned with the expected return and standard deviation for their portfolio, and are only concerned with the expected returns and standard deviations of the securities which comprise the portfolio to the extent that they contribute to the expected return and standard deviation of the entire portfolio.

Merton (1972) proved that when assets with various expected returns, standard deviations, and correlations between them are combined into the set of all feasible portfolios, those portfolios which have the lowest standard deviation for any given expected return form a hyperbola in mean/variance space. A graph of this "Efficient Frontier" can be found in almost any Investments or Financial Management textbook. Figure 1 shows an example.

Figure 1



The purpose of this exercise is to give students in an Investments or Portfolio Theory course the tools to easily graph the efficient frontier for a portfolio of securities or asset classes with and without self-imposed constraints. Students have the opportunity to select any eight securities that have at least five years of price history in the Yahoo!

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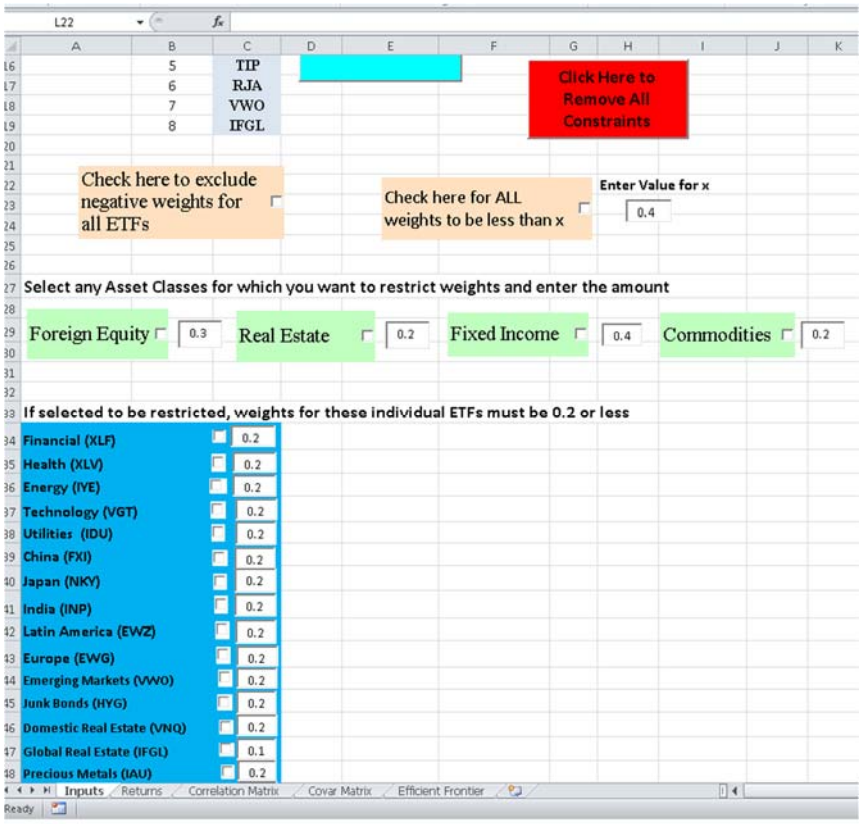
Finance database. Though the spreadsheet will work with any eight securities (stocks, indexes, mutual funds, etc.), the exercise is designed for the students to select eight Exchange Traded Funds (ETFs) from a list of 27 ETFs which we provide to the students. Once the student enters the securities' ticker symbols on the first page of the spreadsheet and clicks the "download" button, the spreadsheet downloads the necessary data on those securities to graph an efficient frontier in mean/variance space along with the minimum variance portfolio and the mean/variance efficient portfolio. This is done without students having to first learn how to form a matrix, draw a graph, or even use solver. Generally, the graph is completed about 15 seconds after the student clicks on the "download" cell and results in the familiar hyperbola in mean/variance space that instructors typically draw on the board and is frequently seen in textbooks.

Though the exercise allows for the selection of individual stocks, we have found that it works best when students work with asset classes (such as large-cap growth stocks, long-term bonds, or emerging market equities) rather than individual stocks. This can be easily done through the use of ETFs which track an entire asset class but are traded like individual stocks. Popular cases such as The Ontario Teachers' Pension Plan Fund and The Harvard Management Company (2001) demonstrate that investment managers often choose target weightings on asset classes before selecting individual securities within each asset class to buy or short.

The "Instructions for Students" that we use for this exercise is contained as an appendix. It is designed to teach students the effects of constraints on the efficient frontier and concludes by asking them to select asset classes and weights that they feel will create a "best" portfolio. The selections become an excellent springboard for class discussion.

The ability to select specific constraints (such as no short-selling) allows students to see that a constrained portfolio will at best offer the same solution as an unconstrained portfolio, and will usually produce an inferior solution from a mean/variance perspective. This provides instructors with an opportunity to clearly show that correlations between asset classes often matter more than the expected returns and standard deviations of the individual asset classes when various asset classes are combined into a portfolio. Some of these asset classes can be seen in Figure 2.

Figure 2: Some Asset Classes Listed on the Spreadsheet



Finding the Efficient Frontier without Constraints

The spreadsheet uses solver to find the efficient frontier in the manner shown in Elton, Gruber, and Padberg (1976). A macro contained in the spreadsheet downloads the adjusted monthly closing prices for the most recent 61 months from Yahoo! Finance for eight ETFs that the student selects as well as for the S&P 500 (our proxy for the market). From those 61 prices, 60 monthly returns are calculated (using continuous compounding). The monthly standard deviation of these returns are calculated and annualized (since we will be using annual returns, we want to use annual standard deviations). Correlations with the S&P 500 are calculated for each ETF, and an estimate of the beta for each of the eight ETFs is calculated by multiplying that correlation by the ratio of the ETF's standard deviation to the standard deviation of the S&P 500.

We use the standard Capital Asset Pricing Model: $E(R) = R_f + \beta(R_M - R_f)$ to calculate the expected returns of each of the eight ETFs. We allow the instructor (or the student) to determine what the risk-free rate (R_f) and the market-risk premium ($R_M - R_f$) should be by providing cells for their values to be inserted in the first worksheet. This can be seen in Figure 3.

Figure 3: Calculating Expected Returns using the CAPM

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1		PRICES									RETURNS								
2	Date	VTV	XLV	BIV	VAW	TIP	RJA	VWO	IFGL	S&P500	VTV	XLV	BIV	VAW	TIP	RJA	VWO	IFGL	S&P500
36	11/1/2010	46.76	28.9	79.04	72.3	102.4	9.38	42.74	27.18	1180.55	-0.62%	-2.93%	-1.12%	1.67%	-1.70%	-3.66%	-2.88%	-6.14%	-0.23%
37	12/1/2010	50.49	30.23	77.05	79.34	101	10.72	45.97	28.11	1257.64	7.67%	4.50%	-2.55%	9.29%	-1.40%	13.35%	7.29%	3.36%	6.33%
38	1/3/2011	51.93	30.4	77.52	79.49	101	11.33	44.39	28.31	1286.12	2.81%	0.56%	0.61%	0.19%	0.02%	5.53%	-3.50%	0.71%	2.24%
39	2/1/2011	54.02	31.35	77.58	81.83	101.7	11.54	44.31	28.93	1327.22	3.95%	3.08%	0.08%	2.90%	0.72%	1.84%	-0.18%	2.17%	3.15%
40	3/1/2011	54	31.92	77.06	83.91	102.9	11.33	46.74	28.59	1325.83	-0.04%	1.80%	-0.67%	2.51%	1.18%	-1.84%	5.34%	-1.18%	-0.10%
41	4/1/2011	55.6	33.97	78.73	86.07	105.4	11.03	48.31	29.94	1363.61	2.92%	6.22%	2.14%	2.54%	2.34%	-2.68%	3.30%	4.61%	2.81%
42	5/2/2011	54.84	34.81	80.13	83.69	105.7	10.84	46.89	29.83	1345.2	-1.38%	2.44%	1.76%	-2.80%	0.27%	-1.74%	-2.98%	-0.37%	-1.36%
43	6/1/2011	53.68	34.42	79.71	82.67	106.4	9.82	46.42	29.3	1320.64	-2.14%	-1.13%	-0.53%	-1.23%	0.74%	-9.88%	-1.01%	-1.79%	-1.84%
44	7/1/2011	51.8	33.05	81.75	80.64	110.6	10.1	46.14	29.05	1292.28	-3.57%	-4.06%	2.53%	-2.49%	3.82%	2.81%	-0.61%	-0.86%	-2.17%
45	8/1/2011	48.75	32.36	83.79	74.5	111.3	10.74	41.95	27.31	1218.89	-6.07%	-2.11%	2.46%	-7.92%	0.65%	6.14%	-9.52%	-6.18%	-5.85%
46	9/1/2011	45.41	30.9	83.98	61.93	111.3	9.01	34.21	23.49	1131.42	-7.10%	-4.62%	0.23%	-18.48%	-0.01%	-17.56%	-20.40%	-15.07%	-7.45%
47	10/3/2011	50.07	32.69	84.28	73.04	113.6	9.34	39.65	25.85	1253.3	9.77%	5.63%	0.36%	16.50%	2.05%	3.60%	14.76%	9.57%	10.23%
48	11/1/2011	49.79	33	83.76	73.43	114.2	8.77	38.98	24.86	1246.96	-0.56%	0.94%	-0.62%	0.53%	0.53%	-6.30%	-1.70%	-3.91%	-0.51%
49	12/1/2011	51.05	33.98	84.08	71.77	114.4	8.95	37.35	23.73	1257.6	2.50%	2.93%	0.38%	-2.29%	0.16%	2.03%	-4.27%	-4.65%	0.85%
50	1/3/2012	52.82	35.06	85.36	80.33	117	9.09	41.38	25.82	1312.41	3.41%	3.13%	1.51%	11.27%	2.26%	1.55%	10.25%	8.44%	4.27%
51	2/1/2012	54.87	35.44	85.37	80.24	116.3	9.2	43.63	27.64	1365.68	3.81%	1.08%	0.01%	-0.11%	-0.58%	1.20%	5.29%	6.81%	3.98%
52	3/1/2012	56.43	37.02	84.53	80.68	115.3	9.13	42.5	27.22	1408.47	2.80%	4.36%	-0.99%	0.55%	-0.86%	-0.76%	-2.62%	-1.53%	3.09%
53	4/2/2012	55.91	36.92	85.94	79.99	117.4	8.99	41.61	27.63	1397.91	-0.93%	-0.27%	1.65%	-0.86%	1.77%	-1.55%	-2.12%	1.50%	-0.75%
54	5/1/2012	52.61	35.59	87.23	73.09	119.7	8.2	37.17	25.2	1310.33	-6.08%	-3.67%	1.49%	-9.02%	1.93%	-9.20%	-11.28%	-9.21%	-6.47%
55	6/1/2012	55.12	37.62	87.31	76.31	118.9	8.9	39.04	27.44	1362.16	4.66%	5.55%	0.09%	4.31%	-0.67%	8.19%	4.91%	8.52%	3.88%
56	7/2/2012	55.77	37.99	88.87	75.85	121	9.79	39.11	28.63	1379.32	1.17%	0.98%	1.77%	-0.60%	1.73%	9.53%	0.18%	4.25%	1.25%
57	8/1/2012	56.6	38.44	88.96	78.37	120.7	9.91	39.21	28.97	1406.58	1.48%	1.18%	0.10%	3.27%	-0.25%	1.22%	0.26%	1.18%	1.96%
58	9/4/2012	58.24	39.9	89.42	81.36	121.3	9.62	41.29	30.09	1440.67	2.86%	3.73%	0.52%	3.74%	0.51%	-2.97%	5.17%	3.79%	2.39%
59	10/1/2012	58.01	39.81	89.67	80.17	122	9.43	41.07	30.75	1412.16	-0.40%	-0.23%	0.28%	-1.47%	0.62%	-1.99%	-0.53%	2.17%	-2.00%
60	11/1/2012	57.58	40.02	90	81.32	122.4	9.36	41.59	31.52	1416.18	-0.74%	0.53%	0.37%	1.42%	0.32%	-0.75%	1.26%	2.47%	0.28%
61	12/3/2012	58.8	39.88	87.84	84.21	121.4	9.06	44.53	33.13	1426.19	2.10%	-0.35%	-2.43%	3.49%	-0.83%	-3.26%	6.83%	4.98%	0.70%
62	1/2/2013	62.54	42.91	86.85	87.53	120.8	9.33	44.56	33.46	1498.11	6.17%	7.32%	-1.13%	3.87%	-0.52%	2.94%	0.07%	0.99%	4.92%
63	2/1/2013	63.58	43.41	87.14	88.53	120.1	9.06	44.41	33.11	1519.79	1.65%	1.16%	0.33%	1.14%	-0.61%	-2.94%	-0.34%	-1.05%	1.44%
64																			
65	Monthly Standard Deviation										5.76%	4.50%	1.89%	8.25%	2.10%	7.28%	8.65%	7.94%	5.56%
66	Annualized Standard Deviation										19.95%	15.60%	6.53%	28.58%	7.29%	25.23%	29.98%	27.49%	19.27%
67	Correlation with S&P										0.9838	0.8245	0.1204	0.9291	0.3392	0.5741	0.8688	0.899	1
68	Beta										1.0185	0.6674	0.0408	1.3778	0.1282	0.7516	1.3516	1.2824	1
69	Expected Return from CAPM										8.81%	6.80%	3.23%	10.85%	3.73%	7.28%	10.70%	10.31%	8.700%
70																			

Modern Portfolio Theory teaches that all investors are risk averse. This means that an investor is only interested in two things for his portfolio: a higher expected return and a lower standard deviation.

The expected return of a portfolio is simply a weighted average of the expected returns of the securities which comprise the portfolio with the weights being the proportion of the investor's investment in each security. By varying the weights on the eight ETFs that the student has chosen, we can create portfolios with almost any expected return that we want. For this exercise, we have decided to graph portfolios with expected returns in the range of 2% - 13% (in increments of 1%).

The standard deviation of a portfolio is the square root of the sum of the cells in its weighted variance/covariance matrix. With the 60 monthly returns that are calculated for each of the eight ETFs, we build an 8x8 correlation matrix so that students can clearly see each ETF's correlations with the other seven. This is seen in Figure 4.

Figure 4: The Correlation Matrix

			Correlation Matrix						
			_1	_2	_3	_4	_5	_6	_7	_8
			VTV	XLV	BIV	VAW	TIP	RJA	VWO	IFGL
_1	VTV		1	0.8219	0.129686	0.886477	0.305308	0.543806	0.830973	0.888416
_2	XLV		0.8219	1	0.183728	0.738694	0.431736	0.528906	0.681794	0.760297
_3	BIV		0.129686	0.183728	1	0.115725	0.691109	0.244375	0.180562	0.271062
_4	VAW		0.886477	0.738694	0.115725	1	0.384043	0.641794	0.926287	0.862979
_5	TIP		0.305308	0.431736	0.691109	0.384043	1	0.430624	0.421392	0.451964
_6	RJA		0.543806	0.528906	0.244375	0.641794	0.430624	1	0.614107	0.604786
_7	VWO		0.830973	0.681794	0.180562	0.926287	0.421392	0.614107	1	0.921577
_8	IFGL		0.888416	0.760297	0.271062	0.862979	0.451964	0.604786	0.921577	1

We then use the correlation matrix along with the annualized standard deviations of the ETFs to build an (unweighted) variance/covariance matrix as shown in Figure 5.

Figure 5: The Variance/Covariance Matrix

		Var/Cov Matrix						
	VTV	XLV	BIV	VAW	TIP	RJA	VWO	IFGL
VTV	0.039802	0.025578	0.001690	0.050540	0.004437	0.027370	0.049700	0.048723
XLV	0.025578	0.024332	0.001872	0.032928	0.004906	0.020813	0.031883	0.032602
BIV	0.001690	0.001872	0.004268	0.002160	0.003289	0.004027	0.003536	0.004868
VAW	0.050540	0.032928	0.002160	0.081664	0.007995	0.046269	0.079355	0.067793
TIP	0.004437	0.004906	0.003289	0.007995	0.005307	0.007914	0.009203	0.009051
RJA	0.027370	0.020813	0.004027	0.046269	0.007914	0.063643	0.046445	0.041942
VWO	0.049700	0.031883	0.003536	0.079355	0.009203	0.046445	0.089874	0.075948
IFGL	0.048723	0.032602	0.004868	0.067793	0.009051	0.041942	0.075948	0.075568

Next, our spreadsheet creates an 8x8 weighted variance/covariance matrix where solver finds the weights for each of the eight ETFs which are needed to minimize the standard deviation of the portfolio subject to the constraints that the weights of the ETFs must sum to 1.0 and the expected return of the portfolio must equal our first expected return of 2.0%. This is shown in Figure 6.

Figure 6: The Weighted Variance/Covariance Matrix

			Weighted Var/Cov Matrix						
		VTV	XLV	BIV	VAW	TIP	RJA	VWO	IFGL
	Weights	0.226606	0.044126	0.723377	-0.176401	0.4083133	-0.007835	0.161434	-0.37962
VTV	0.226606	0.002044	0.000256	0.000277	-0.002020	0.000411	-0.000049	0.001818	-0.004191
XLV	0.044126	0.000256	0.000047	0.000060	-0.000256	0.000088	-0.000007	0.000227	-0.000546
BIV	0.723377	0.000277	0.000060	0.002233	-0.000276	0.000971	-0.000023	0.000413	-0.001337
VAW	-0.176401	-0.002020	-0.000256	-0.000276	0.002541	-0.000576	0.000064	-0.002260	0.004540
TIP	0.408313	0.000411	0.000088	0.000971	-0.000576	0.000885	-0.000025	0.000607	-0.001403
RJA	-0.007835	-0.000049	-0.000007	-0.000023	0.000064	-0.000025	0.000004	-0.000059	0.000125
VWO	0.161434	0.001818	0.000227	0.000413	-0.002260	0.000607	-0.000059	0.002342	-0.004654
IFGL	-0.379622	-0.004191	-0.000546	-0.001337	0.004540	-0.001403	0.000125	-0.004654	0.010890
Sum	1								
Port. Var	0.005335								
Port. S.D.	7.30%								
Port. E(R.)	2.00%								

Once solver determines this unique solution, the standard deviation and the weights which create that portfolio are recorded on the next page of the spreadsheet. Solver then recalculates the weights necessary to minimize the standard

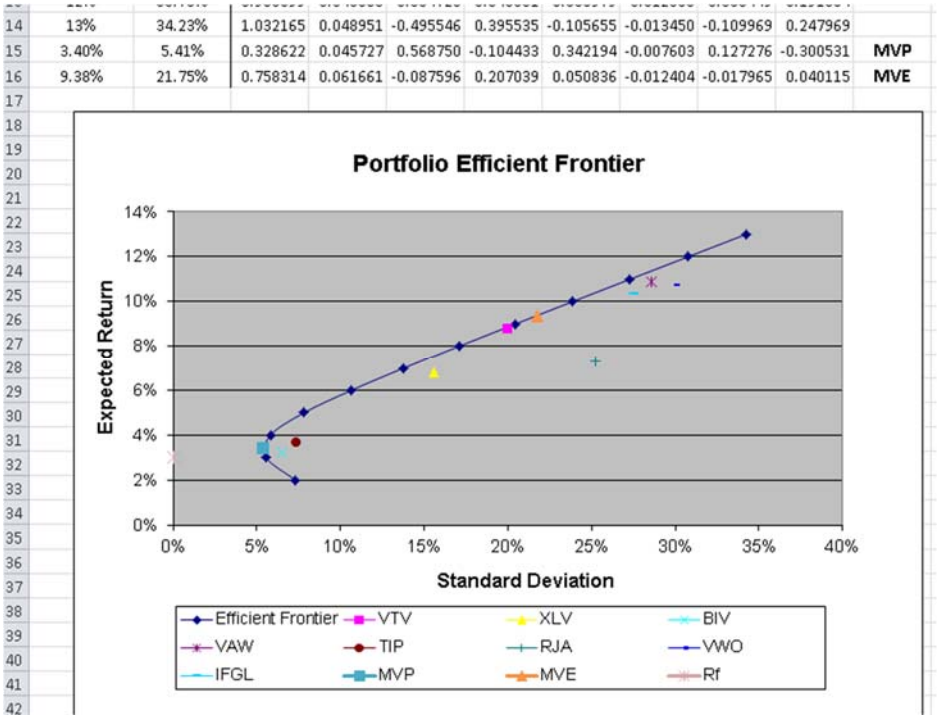
deviation of a portfolio with an expected return of 3%. It records these values in the next row and moves on to iteratively determine the values for each additional 1% expected return for the portfolio up to and including 13% as can be seen in Figure 7.

Figure 7: The Recorded Solutions

					Efficient Frontier					
Expect. Ret.	Stand. Dev.	VTV	XLV	BIV	VAW	TIP	RJA	VWO	IFGL	
2%	7.30%	0.226022	0.045523	0.723801	-0.176772	0.406909	-0.007118	0.161784	-0.380148	
3%	5.58%	0.299308	0.045835	0.612951	-0.124744	0.360312	-0.007694	0.137079	-0.323047	
4%	5.81%	0.372593	0.046147	0.502101	-0.072716	0.313716	-0.008269	0.112374	-0.265945	
5%	7.82%	0.445879	0.046458	0.391252	-0.020688	0.267119	-0.008845	0.087669	-0.208843	
6%	10.64%	0.519165	0.046769	0.280401	0.031340	0.220522	-0.009421	0.062965	-0.151741	
7%	13.79%	0.592451	0.047081	0.169551	0.083367	0.173925	-0.009996	0.038260	-0.094640	
8%	17.08%	0.665737	0.047393	0.058702	0.135395	0.127329	-0.010572	0.013555	-0.037538	
9%	20.45%	0.739319	0.055569	-0.033351	0.183155	0.056141	-0.010456	-0.001837	0.011461	
10%	23.86%	0.815189	0.053400	-0.149489	0.234740	0.015932	-0.011061	-0.026691	0.067979	
11%	27.30%	0.885595	0.048328	-0.273847	0.291478	-0.012462	-0.012299	-0.060559	0.133766	
12%	30.76%	0.958699	0.048636	-0.384723	0.343651	-0.058979	-0.012888	-0.085449	0.191054	
13%	34.23%	1.032165	0.048951	-0.495546	0.395535	-0.105655	-0.013450	-0.109969	0.247969	
3.40%	5.41%	0.328622	0.045727	0.568750	-0.104433	0.342194	-0.007603	0.127276	-0.300531	MVP
9.38%	21.75%	0.758314	0.061661	-0.087596	0.207039	0.050836	-0.012404	-0.017965	0.040115	MVE

The graph on the last page of the spreadsheet reads the expected returns and standard deviations that were found by solver and plots them in mean/variance space. The points are connected to form the familiar hyperbola. Markowitz called this hyperbola the portfolio frontier. Technically, only the portfolios with the highest expected return for any given standard deviation earn the distinction of lying on the efficient frontier. So the hyperbola we graph actually includes more points than are contained in the "true" efficient frontier. However, for simplicity, and as is frequently done, we loosely call the entire hyperbola the efficient frontier. Figure 8 shows this graph.

Figure 8: Graph of the Efficient Frontier



We have programmed Solver to locate two particular points of interest on the efficient frontier. They are the minimum variance portfolio (MVP) and the mean/variance efficient portfolio (MVE). The MVP is the combination

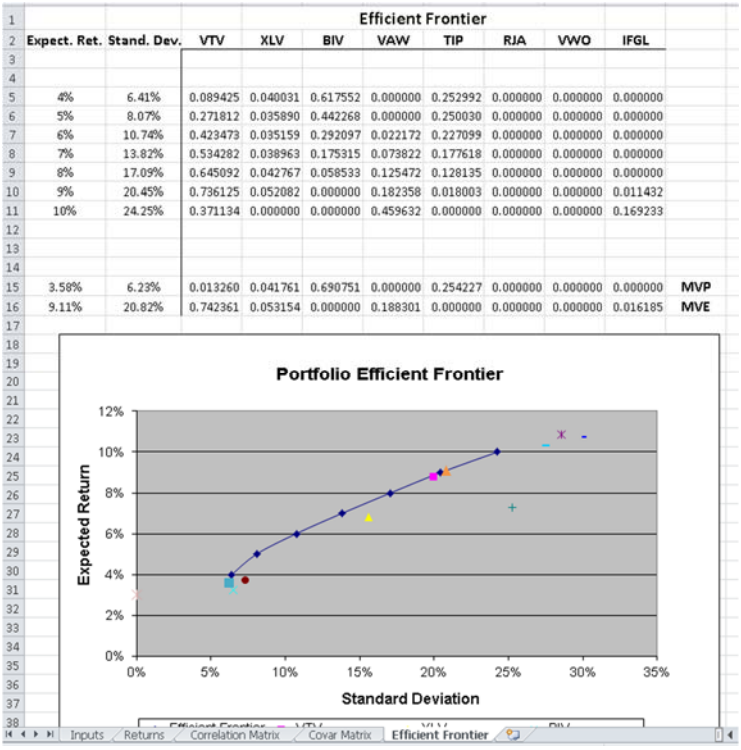
of the eight assets which results in the lowest possible standard deviation regardless of the expected return of the portfolio. The strict definition of the efficient frontier is that portion of the hyperbola which lies on and above the MVP. The MVE is the point on the hyperbola which is tangent to a line running from the location of the risk-free asset (standard deviation of zero and return equal to whatever value the user input as the risk-free rate on the first page of the spreadsheet) to a point on the efficient frontier. Since the MVE is the portfolio with the highest Sharpe Ratio ($(E(R)-R_f)/\sigma$) (Sharpe, 1966), we have programmed solver to maximize this value, subject to the usual constraint that the asset weights sum to one.

Combining the risk-free asset with the MVE creates a capital allocation line (CAL) which immediately becomes the "new" efficient frontier because all points on that line dominate corresponding points on the hyperbola. We have decided not to graph this line as it may too easily encourage students to select the MVE as their "best" portfolio. Instructors who wish to do so can easily make changes to the graph so that the CAL is drawn.

Using Constraints

Once weights have been determined for each of the efficient portfolios and the hyperbola has been graphed, we have found it instructive to require students to re-graph their efficient frontier using the same eight ETFs, but with some constraints being placed on their weights. The most obvious constraint is a "no-shorting" constraint which requires the weights of each ETF to be non-negative (since the weights will still be required to sum to one, this simultaneously requires each ETF's weight to be less than or equal to 1.0). On the first page of the spreadsheet, we have provided a cell that merely needs to be checked in order to apply this constraint the next time the download cell is clicked. When this happens, solver will recalculate the minimum standard deviation for expected returns ranging from 2% through 13%, but this time without allowing any negative weights to be used. It should be noted that this may mean that it is impossible to create a portfolio from these eight ETFs with one or more of the expected returns. With this constraint, the lowest possible portfolio expected return will be the expected return of the ETF with the lowest expected return, and the highest expected return will be the expected return of the ETF with the highest expected return. If these are greater than 2% or less than 13%, some portfolios will not be formed. We have programmed excel to leave blank any portfolio that cannot be formed. This means that that when students apply constraints, the geometric figure being graphed may not be a complete hyperbola. Also, because we have asked excel to find portfolios with exactly 2%, 3%, …13% expected returns, if the asset with the lowest expected return has an expected return of 3.5%, the lowest expected return on the graph will be 4%. This can be seen in Figure 9.

Figure 9: The Efficient Frontier of a Constrained Portfolio



Students often consider some asset classes to be "riskier" than others. Their perception of risk is often anecdotal and usually is based on the risk of an asset class when held by itself rather than as part of a portfolio. As it turns out, assets with high standard deviations can actually reduce the standard deviation of a portfolio when they are added to that portfolio if they have low correlations with the other assets in the portfolio. To help bring this point home to students, we have allowed the user to place constraints on the weights of many of the individual ETFs. The ETFs we have allowed this for are the ones that students typically consider to be "risky", such as Junk Bonds, Emerging Market Equities, and Agricultural Commodities. By placing a check-mark in the appropriate cell for any of these ETFs and specifying the weight the student wants to use as a constraint, solver will find the lowest portfolio standard deviation for each expected return subject to those constraints.

Another way of creating constraints that we have included allows four of the five asset classes (Foreign Equity, Fixed Income, Real Estate and Commodities) to be constrained so that the sum of the weights of all the ETFs within the asset class is less than a selected amount. For example, Precious Metals, Natural Resources and Agricultural Commodities are the three ETFs which comprise the Commodities asset class. If a user checks the Commodities asset class on the first page of the spreadsheet and enters 25% as the constraint, excel will find the minimum standard deviation for each of the expected returns, with the restriction that the sum of those three ETFs must be less than or equal to 25%.

If a student finds that the optimal unconstrained (or less-constrained) solution places a high weight on one asset class or ETF, thus not giving the user a "properly diversified" portfolio, the student can also select an option which constrains the weights of *every* ETF to be less than or equal to an amount selected by the student.

Students often initially think that by placing constraints on "riskier" asset classes or individual ETFs, they will find portfolios with lower standard deviations. Using the constraints available on this spreadsheet allows students to see that this is not the case. If the unconstrained solution is indeed the minimum standard deviation for a given expected return, it is not possible for excel to find a lower standard deviation when we place constraints on the weights.

In our instructions for the students (Appendix), you will see that after students graph the unconstrained efficient frontier, we require them to select the "no shorting" constraint, re-graph the efficient frontier, and then select the "diversified" constraint before re-graphing it again. Following this, we give them the option to constrain any asset classes or categories that they consider to be "risky". We encourage other instructors to make any adjustments to these instructions that they feel will give their students the greatest possible learning experience.

Portfolio Choice

Probably the most important part of the exercise is where we ask students to choose the eight ETFs and weights that they feel will give them the "best" portfolio if they are managing a hedge fund for a variety of individual and institutional investors. We clearly state that there is no right or wrong answer for this question and that we are most interested in the student's explanation of why he chose this particular portfolio. Many students will select the MVE on the unconstrained portfolio is the "best" portfolio, because combining it with the risk-free asset allows an investor to access the entire CAL that passes through it. However, this choice assumes that investors are indeed mean/variance optimizers, that the CAPM gives accurate expected returns, and that the standard deviations and correlations which are calculated from past data are the best estimates of future standard deviations and correlations. Students rarely realize that they are implicitly making these assumptions. Pointing these assumptions out to them allows for the possibility for rich classroom discussion.

Possible Variations in the Exercise

This spreadsheet will graph an efficient frontier for any eight securities which are contained in Yahoo! Finance's database with monthly price-data for the past five years. Yahoo! Finance holds price-data for over 120,000 assets that are traded on 59 different exchanges around the world. It has data on stocks, mutual funds, exchange-traded funds, indices, futures, and currencies. If students enter the ticker symbol for any of these securities, the macro contained in the spreadsheet will download the prices for that security for the most recent 61 months (to produce 60 months of returns). If a student doesn't know the symbol for a particular security, or if he isn't certain if Yahoo! Finance has 61 months of price-data, he can type in the name of the security in the "Get Quotes" box on the Yahoo! Finance website and be taken to the Yahoo! Finance data-page for that asset. The symbol is listed near the top of the page. By selecting "Historic Prices" from the menu on the left, you can find the dates for which Yahoo! Finance has price data. This allows students to use the spreadsheet to graph a near limitless number of efficient frontiers.

For classes that use Stock-Trak® or a similar on-line trading program, our spreadsheet offers students the opportunity to "try out" various combinations of stocks prior to purchasing them in the simulation. More importantly, it encourages students to think of their stock selections as part of a portfolio rather than as individual stocks that they hope will each individually do well during the semester.

We have found that students will often learn more and spend more time with an exercise when there is a measure of classroom competition included. A simple addition to this exercise might be to ask students to put together an eight-asset (or eight-stock) portfolio with the smallest possible portfolio standard deviation that they can arrange. Since the spreadsheet already calculates and clearly shows the MVP for whatever eight securities are selected, this variation becomes a competition in selecting the optimal eight securities. With so many securities to choose from, students will learn to look for those with low individual standard deviations, and (more importantly from a learning standpoint) low correlations with each other. More than anything else, we have found that this drives home the point that correlations have a significant impact on portfolio standard deviation. Students also quickly learn that unconstrained portfolios always offer the lowest possible MVP for any group of eight securities.

As mentioned earlier, we allow users to choose whatever values they want as the risk-free rate and market-risk premium in the CAPM model. Since those two values affect the expected return for each security, changing these values will change the positioning of the efficient frontier and the optimal weights on each asset. A more advanced variation in this exercise can encourage students to examine how the selection of the market-risk premium in particular affects asset selection in a portfolio. Since the market-risk premium means different things to different people (Ibbotson 2011), and we have seen its estimates range anywhere from 1 percent to 12 percent, incorporating different values into this exercise can help students see the importance of not relying too heavily on one value.

Finally, as was mentioned earlier, this spreadsheet uses returns from the last 60 months to calculate the betas, standard deviations, and correlations that are used to come up with the efficient frontier. Just as we know that "past performance does not guarantee future results", past betas, standard deviations and correlations may not equal those in the future. Any parameter obtained from the last 60 months of returns can be over-ridden by entering a different value into its cell. For example, if the user believes that the correlation between the Health ETF and the Long-Term Bonds ETF will be 0.2 in the future, even though it was 0.4 over the past 60 months, he can enter 0.2 into the appropriate cells in the correlation matrix, and when "download" is clicked, the efficient frontier will be graphed based on a correlation of 0.2 between those two ETFs. Using this option can allow students to see the difference between portfolio choices based on past values and those based on expected future values – leading into a worthwhile classroom discussion of estimation error.

Conclusion

"Finding the Efficient Frontier" can be used as either an in-class exercise or an assignment for either undergraduate or graduate finance students in an investments or portfolio theory class. The exercise makes use of a spreadsheet that we have developed which allows students to select eight securities from the thousands for which Yahoo! Finance has at least five years of price data. Once the student types in the symbols for the securities and clicks the download button, the spreadsheet looks up the most recent 61 adjusted monthly closing prices, calculates returns, standard deviations, and correlations, and uses the CAPM to produce expected returns. From there, the spreadsheet builds an 8x8 variance/covariance matrix and determines the optimal weight on each asset to build an efficient frontier where each point on the frontier is the minimum portfolio standard deviation for expected returns ranging from 2% to 13%. The familiar hyperbola of the efficient frontier is automatically graphed. Additionally, our spreadsheet calculates both the minimum variance portfolio and the mean/variance efficient portfolio. Students have the opportunity to place any of several constraints on the portfolio, and can observe how these constraints affect their results from a mean/variance standpoint.

We have included the instructions that we give our students, which have worked well in the classroom for us. However, each instructor is encouraged to modify these instructions and use this valuable tool in whatever method he or she feels will best engage the students and teach the lessons that the instructor wants to impart.

Please Note: The Excel Spreadsheet which accompanies this paper can be found at:

http://ec2-52-11-148-181.us-west-2.compute.amazonaws.com/breese_network/fine7110/finding-the-efficient-frontier/

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Appendix

Finding the Efficient Frontier
Instructions for Students

General Instructions

The objective of this assignment is to graph the efficient frontier for eight Exchange Traded Funds (ETFs) coming from five different asset classes under a variety of constraints and to use that information to decide what weightings you would recommend placing on each ETF and asset class in the portfolio.

At the end of these instructions, you will find a list of five asset classes along with the symbols for 27 different ETFs which track indexes within each of those asset classes. You may select any eight of these 27 ETFs for this exercise.

The spreadsheet that accompanies these instructions will graph the efficient frontier for you after you have selected eight ETFs, a risk-free rate, and a market risk premium. The spreadsheet contains a macro which allows it to go to Yahoo! Finance (if your computer is connected to the internet) and find the adjusted closing prices of the ETFs you select, along with the S&P 500, for the most recent 61 months. From that data, the spreadsheet will automatically calculate the following for each of the eight ETFs: monthly returns, the annualized standard deviation of those returns, correlations and covariances with the other seven ETFs, a beta coefficient, and the expected return for that ETF using the Capital Asset Pricing Model (CAPM). In the CAPM calculations, you have the ability to select whatever risk-free rate (R_f) and market risk premium (R_M-R_f) you choose.

The spreadsheet will then build a weighted variance/covariance matrix where it uses solver to find the smallest possible standard deviation for the eight-ETF portfolio with portfolio expected returns ranging from 2% to 13% (in increments of 1%). Each of these 12 solutions is listed on the last worksheet where they are automatically graphed in mean/variance space – building the familiar-looking hyperbola. Additionally, the spreadsheet calculates both the minimum variance portfolio (MVP) and the mean/variance efficient portfolio (MVE). The graph shows the location of each of the eight selected ETFs, the risk-free asset, the MVP, and the MVE.

The spreadsheet also gives you the opportunity to place various constraints on your portfolio. You can choose a "no-short-sales" constraint which restricts the weights on each ETF to be non-negative. You can also choose a "diversified" constraint which prevents any ETF from having a weight greater than what you choose. You can also choose to restrict the total weighting on four of the five asset classes (Foreign Equity, Fixed Income, Real Estate, and Commodities). Finally, for 17 of the traditionally more risky ETFs, you have the option to constrain any of their weights so that they are something less than or equal to 20%. The spreadsheet allows you to select any combination of the above constraints.

Specific Instructions

For this assignment, use a risk-free rate of 3% and a market risk premium of 5.7%. Select any eight ETFs from the list at the end of these instructions that you would like to include in your portfolio, and then do the following:

1. Enter the ticker symbols for the ETFs you have chosen in the gray-shaded cells
2. Do not place any constraints on the weights
3. Click the "Download" button
4. Study the expected returns and standard deviations of each of the ETFs as well as the correlation matrix
5. Print out the last page of the spreadsheet which includes the graph
6. Place a "no shorting" constraint by excluding negative weights for all ETFs.
7. Repeat steps 3-5 with the "no shorting" constraint
8. In addition to the "no shorting" constraint, select the "diversified" constraint which requires the weight of each ETF to be less than some amount (choose whatever amount you want).
9. Again, repeat steps 3-5
10. In addition to the "no shorting" and "diversified" constraints, if you consider any of the 17 ETFs in the blue cells to be particularly "risky" (use whatever definition of "risky" you feel is appropriate), limit their weights to be something less than 0.2 by selecting that ETF and a weight (less than 0.2) that you want to constrain that ETF to be less than or equal to
11. Again, repeat steps 3-5.
12. Compare the four graphs that you printed in steps 5, 7, 9, and 11. Which graph(s) appears to offer investors the least portfolio risk (as measured by standard deviation) for the given expected returns? Which graph(s) seems to offer the greatest choice among portfolio expected returns? Why?
13. Make some changes in your choice of the eight ETFs and repeat steps 1-12. Did any of your conclusions in step 12 change with this new set of ETFs?
14. Choose the eight ETFs and the weights on those ETFs that you feel will give you the "best" portfolio if you are managing a hedge fund for a variety of individual and institutional investors. Feel free to define "best" however you want. Feel free to choose different asset classes and ETFs from those you used above. There is no right or wrong set of choices for this step, but please explain **why** you decided to select this particular combination of ETFs and their weights for your hedge fund.

List of ETFs

Asset Class	**ETF**
<u>Domestic Equity</u>	
Large-Cap Value	VTV
Large-Cap Growth	IWF
Mid-Cap Value	DVY
Mid-Cap Growth	IJK
Small-Cap Value	VBR
Small-Cap Growth	IWO
Financial	XLF
Health	XLV
Energy	IYE
Technology	VGT
Utilities	IDU

Foreign Equity	
China	FXI
Japan	NKY
India	INP
Latin America	EWZ
Europe	EWG
Emerging Markets	VWO
Fixed Income	
Long-Term Bonds	LQD
Intermediate Bonds	BIV
Short-Term Bonds	CSJ
TIPS	TIP
Junk Bonds	HYG
Real Estate	
Domestic Real Estate	VNQ
Global Real Estate	IFGL
Commodities	
Precious Metals	IAU
Natural Resources	VAW
Agricultural Commodities	RJA