Enhancing Technological Skills through Case Studies

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This presentation describes the use of a case study that integrates technology with fundamental investment concepts. The case study requires students to utilize several different technological tools. The primary subject of the case concerns calculating portfolio returns and the standard deviation of returns for a portfolio constructed of two funds. The case introduces students to data extraction and analysis techniques. Students must download investment fund values from the Internet, import data into a spreadsheet, and use spreadsheet functions to manipulate and analyze data.

Keywords: technology, spreadsheet skills, collaborative learning, smart classrooms

This paper describes the use of technology in the classroom to enhance student understanding of financial concepts and to increase student expertise with spreadsheet and Internet applications. The paper begins with a justification of the pedagogy, describes the classroom setting, presents the case material, discusses student assessment of the format and concludes by summarizing the strengths and weaknesses of the approach.

Pedagogy

Educators acknowledge the value of a collaborative, learner centered teaching approach, which ". . . reforms classroom learning by changing students from passive recipients of information given by an expert teacher to active agents in the construction of knowledge" (Goodsell et al., 1992, p. 4). The collaborative approach has been recognized for its benefits, such as increased participation and achievement.

The integrated case approach is designed to combine collaborative learning with the teaching of technology skills. Technology proficiency is increasingly viewed as critical for the success of college graduates. As noted by Oblinger and Maruyana (1996), 95 percent of employed workers will need to use common software packages. Lambrecht (1995) argues convincingly that teaching applications software in college is important. Some educators, like Rebele (2000), view the increased use of technology in the classroom as questionable. Rebele advocates assessing the value of technology in teaching and learning before spending on technology acquisition. Although undeniably a small sample, this study assesses the use of a technology-enhanced case and provides guidelines for incorporating technology in the classroom.

The material was used in a junior level Investments course with third and fourth year Finance majors. Most of the students were familiar with basic spreadsheet functions but unaware of more advanced spreadsheet features. Although students use the Internet for personal reasons, most are vaguely familiar with available business and economic resources. The classroom was equipped with computers for every student and an instructor’s console with an overhead projector. The case was distributed to students in the class session before it was worked on in class. Students worked on the case during

two partial class sessions. I began the case assignment with a partial solution projected on the overhead screen and assisted students with problems that they encountered in the solution. The case included a suggested format for the write-up and a series of required questions.

The case had three general skill-building learning outcomes and three concept based learning outcomes. The skill building outcomes were:

1. Using the Internet to identify and download data.
2. Using Excel to manipulate and analyze data.
3. Presenting the results in a written report.

Spreadsheet skills were central to the learning outcomes because both faculty and practitioners ranked spreadsheets first on a list of technology skills classified as critical to new accounting graduates (Albrecht and Sack, 2000).

The concept based learning outcomes were:

1. Distinguish between diversifyable/firm-specific/non-systematic risk and non-diversifyable, market/systematic risk.
2. Demonstrate how assets that are not perfectly correlated can be combined to reduce portfolio risk.
3. Construct efficient portfolios given expected returns, volatility and correlation of assets.
4. Calculate the composition of the optimal risky portfolio.
5. Understand the concept of the Efficient Frontier of Risky Assets

Outcomes

Student feedback regarding the exercise was quite positive as summarized with a questionnaire distributed after the graded case write-ups were returned. Most students found that the case improved their use of spreadsheet skills and increased their understanding of risk reduction through diversification.

Table 1. Student Survey Results, 1=Strong Agree, 5=Strongly Disagree

Question	Mean	Standard Deviation
Before this course, I rate my experience with Excel software as strong.	3.5	.9
The case study increased my general expertise with spreadsheets (copying, formulas, formatting).	1.4	.6
The case study increased my knowledge of specific spreadsheet features (date feature, geomean, sorting, correlation).	1.3	.6
The case study increased my understanding of investment theory (creating optimal portfolios).	1.6	.7
Before this course, I had enrolled in _____ courses	1.8	1.0

that required spreadsheet and/or other software packages.		
Do you recommend more or less assistance with the spreadsheet case study in the course? In other words, should I have spent more time in class working on the case or less time? 1=more, 2=same, 3=less	1.9	1.1
Would you like to see more or less of similar case studies used in this course? 1=more, 2=same, 3=less	1.7	1.0

Learning outcomes were not measured directly nor compared to a section that did not use an integrated case approach. However, the results of a learning outcome assessment are probably dependent upon the type of instrument used and the objectives assessed. For instance, students in a lecture-based class may score higher on a multiple-choice test that measures student knowledge of definitions. Skill based assessment instruments, like writing a research report or screening companies for a portfolio, would probably favor the integrated case method. As institutions move towards standardized assessment instruments, the technology-based case approach will become less attractive to faculty whose performance is measured by test results that measure subject based knowledge and not skill acquisition.

The efficient frontier and the related concept of the capital market line are topics that prove difficult for students. The case approach seems to have made the concept clearer to students, although it may reflect the longer period of time spent on the topic since it was the subject of the case.

The technology enhanced case approach, like a science laboratory class, is more time-consuming for the instructor than a traditional lecture. For the class to be successful, the instructor should be aware of the following pitfalls:

1. Since students will stumble across various problems while solving the case, the instructor has to be very familiar with the case content and its solution.
2. Web sites change frequently and the case needs to be solved again each semester used to ensure that the links are still active.
3. Equipment is subject to failure and each class session should have a non-technology based contingency plan.
4. To assess students individually on their skill acquisition, consider using computer-based problems in a portion of the exams.
5. Since a greater amount of time is spent on skill-acquisition, less class time is spent on content. Students should be made aware of their responsibility to follow assigned readings for knowledge-based content.

Faculty may realize the benefits of a collaborative, technology based approach but they need to have the support of administrators to successfully implement the pedagogy. Some guidelines for administrators to assist faculty in using technology in the classroom include:

1. Keep class sizes appropriate for technology-enhanced classes. For example, if the classroom has 20 computers limit enrollment to 20 students.
2. Provide technology support to ensure that computers are operational. Even if the class has 20 computers, if five are inoperable, students without computers will be disengaged. Faculty should not be responsible for maintaining classroom technology.
3. Maintain faculty teaching modes. If an instructor teaches a technology-enhanced class, schedule the class in a room with the appropriate number of computers. When a class is taught in a different mode, it is equivalent to an additional preparation.

Technology-enhanced case studies can be an effective method to teach students skills that will be important in the workplace while also teaching knowledge-based concepts. The pedagogy required takes more effort by the faculty and requires administrative support.

References

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Appendix A. Case Study

Constructing an Efficient Investment Frontier

Case Description

The primary subject of this case concerns calculating portfolio returns and standard deviation of returns for a portfolio constructed of two funds. The case requires students to calculate holding period returns, average returns, standard deviation and the correlation of returns between different investments; demonstrate how assets that are not perfectly correlated can be combined to reduce portfolio risk; and construct an efficient frontier for two assets using historical returns. This case has a secondary objective of introducing students to data extraction and analysis techniques. Students must download investment fund values from the Internet, import data into a spreadsheet, and use spreadsheet functions to manipulate and analyze data. The case has a difficulty level appropriate for the senior or graduate level course. The case is designed to be taught in two class hours and is expected to require four class hours of outside preparation for students.

Case Synopsis

This case study uses daily fund values from TIAA-CREF to demonstrate the risk reduction resulting from portfolio diversification. Using over ten years of daily data, weekly holding period returns are calculated for the stock and bond funds. Students calculate for each fund, the average weekly return and its corresponding standard deviation. The correlation of returns for the funds is calculated and used to construct an efficient investment frontier.

Introduction

Financial markets behave as if investors are risk averse; investments with greater risk must compensate investors with higher expected return. Development of portfolio theory has been one of the most important advances in the investment field over the past 40 years. Combining assets into a portfolio is superior to holding individual assets because the portfolio has a lower variation in returns than its underlying assets. The expected return on a portfolio is equal to the weighted average of the expected returns of the component securities. However, the portfolio's variation in returns, as measured by standard deviation, is less than or equal to the weighted average of its component asset variations. For a portfolio, P, the expected return is:

$$E[R_p] = \Sigma\, w_i E[R_i]. \qquad (1)$$

Where,
w_i = Market value weight of security i.
R_i = Expected return of security i.

The standard deviation of returns for portfolio P is:

$$\sigma_p^2 = \Sigma (w_i\sigma_i)^2 + \Sigma (\Sigma(\rho_{ij} w_i\sigma_i w_j\sigma_j))$$ (

Where,
σ_i= Standard deviation of expected returns for security i.
ρ_{ij}=Correlation of expected returns between security i and j.

The expected return on a portfolio is equal to the weighted average of the expected returns of its components. The standard deviation of the portfolio is less than or equal to the weighted average of the standard deviations of its components. This means that an investor with a low appetite for risk may wish to include a risky asset as part of the portfolio in order to reduce total variation. Fixed income securities historically exhibit less return variation than equities. However, an investor attracted by the constancy of bonds may want to include equities in the portfolio in order to reduce return variation.

Investment Data

This case study uses daily fund values from TIAA-CREF. For over 80 years TIAA-CREF has provided retirement benefits for the education and nonprofit research communities. In 2001, TIAA-CREF had over $290 billion in assets under management, making it a leading financial services organization, a major institutional investor, and the world's largest retirement system.

TIAA-CREF has a number of investment funds under its umbrella. Some of the funds are variable annuities available only to participants in its retirement plan. Recently, TIAA-CREF has begun offering mutual funds to the general public. This case study utilizes the variable annuity CREF bond and stock funds. TIAA-CREF describes these funds as follows:

The CREF Bond Market Account seeks favorable long-term returns, mainly through high current income consistent with capital appreciation. It holds bonds of many different companies and government agencies, all with varying maturities. Its returns will depend on interest income and price changes in the bond market, themselves ordinarily dependent on interest rate changes--increasing rates usually reducing prices, and decreasing rates usually increasing prices. The Bond Market Account is a variable annuity, and past performance doesn't guarantee comparable returns in the future. Both your returns and the value of your invested principal will vary throughout your participation.

The CREF Stock Account seeks favorable long-term returns through capital appreciation and current income. Because its primary purpose is to provide retirement benefits, the account avoids the extremes of conservatism and high risk. In general, we expect the account's performance closely to follow that of the overall stock market. Over the long periods typical of pension-plan participation, the account's gains have significantly outweighed setbacks, but past performance doesn't guarantee comparable returns in the future. Your returns and the value of your invested principal will vary throughout your participation.

Unit value data for these funds and other variable annuities can be downloaded from the TIAA-CREF website,

http://www.tiaa-cref.org/financials/selection/ann-select.html.

- Request unit value data for the CREF stock, CREF money market and the CREF bond market fund from March 1, 1990 through February 1, 2001.

The website will return data with the fund, the fund unit value and the date separated by commas. An entry for the CREF stock fund is given below:

CREFstok,188.7248,01/01/2001

All of the observations are returned for one fund, followed sequentially by observations for the second and third funds.

Save the data into a file and import the file into a spreadsheet program. Combine the data so that each observation includes four columns: a date and the unit value for each of the funds.

Calculating Holding Period Returns

The downloaded data contains daily unit values for each fund. Holding period returns can be calculated by taking the difference between the ending value and beginning value and dividing by the initial value. Daily returns will give a biased estimate of return variation because asset values remain unchanged on weekends. For example, the money market fund will show no return on Saturday or Sunday, because the asset value does not change until Monday. The typical Monday return will be three times the return of other weekdays. Choice of the holding period will affect the correlation of returns. For this case, we use weekly holding period returns from Friday to Friday.

There are numerous methods to organize the data in order to calculate weekly holding period returns. One method involves applying the Excel™ Weekday function to Date. Weekday returns the day of the week in a numeric format. Fridays have a value of 6. The data can then be sorted by weekday in order to organize consecutive Fridays. Observations for other days can either be deleted or ignored.

- Calculate the weekly holding period returns for each fund by creating columns titled Stock Return, Bond Return, MM return. Use Excel functions to calculate the average weekly return and standard deviation of the returns for each fund. Annualize the weekly return by multiplying by 52.

If the returns are linked over a period of time for a future value calculation, the geometric average must be used instead of the arithmetic average. Excel™ has GEOMEAN function, but the data must be modified by creating columns that contain 1 plus the weekly returns.

- Calculate the geometric return by applying GEOMEAN to the newly created columns. Calculate an annual geometric return by raising the answer to the 52^{nd} power and subtracting 1.

Excel™ has an Analysis ToolPak that contains a correlation procedure. The Analysis ToolPak can be activated by clicking on Add-Ins on the Tools tab and checking the Analysis Tool Pak. The correlation procedure can now be accessed by clicking Data Analysis on the Tools Tab.

- Calculate the correlation of returns for the stock, bond and money market funds by designating the three return columns as the input data range. Labels for the correlation can be created by checking the box that uses the first row as a data label.

Constructing the Efficient Frontier

The efficient frontier denotes the expected return and the standard deviation of returns for portfolios constructed of component securities. In this case, we use the stock and bond funds as the component securities. This case uses historical returns rather than expected returns. Although investors need to be forward looking, historical returns provide a method for estimating future returns. Since only two securities, the stock and bond fund, are used in this example, equation 2 simplifies to:

$$\sigma_p^2 = (w_1\sigma_1)^2 + (w_2\sigma_2)^2 + 2\rho_{12}w_1\sigma_1w_2\sigma_2 \qquad (3)$$

The efficient frontier denotes the expected return and standard deviation of a portfolio containing various weights of the underlying assets.

- Use equations 1 and 2, with the stock and bond fund returns, standard deviations, and correlation of returns to calculate the return, standard deviation of returns, and coefficient of variations for portfolios containing 0 to 100% of the stock fund, in 10% increments.

Table 1

Stock Weight	Bond Weight	Portfolio Return	Sigma of Portfolio	Coefficient of Variation
0.0	1.0			
0.1	0.9			
0.2	0.8			
0.3	0.7			
0.4	0.6			
0.5	0.5			
0.6	0.4			
0.7	0.3			
0.8	0.2			
0.9	0.1			
1.0	0.0			

Portfolios have less variation in returns than the weighted average of their component securities. Diversification benefits the investor due to a reduction in variation for a given level of expected returns. This can be demonstrated by comparing the standard deviation of the portfolios in the efficient frontier to a weighted average of the standard deviations of the stock and bond funds.

Table 2

Stock Weight	Bond Weight	Sigma of Portfolio	Weighted Average Sigma
0.0	1.0		
0.1	0.9		
0.2	0.8		
0.3	0.7		
0.4	0.6		
0.5	0.5		
0.6	0.4		
0.7	0.3		
0.8	0.2		
0.9	0.1		
1.0	0.0		

Application Questions

1. Which portfolio resulted in the lowest level of return variation?
2. Which portfolio would a risk-neutral investor choose?
3. Which portfolio has the lowest coefficient of variation?
4. This case uses historical returns, rather than expected returns to construct the efficient frontier. Please discuss the advantages and disadvantages using historical returns.