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BINOMIAL OPTION PRICING MODEL IN
INVESTMENTS COURSES**

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MANAGERIAL FINANCE COURSE**

**A PRIMER ON
FINANCIAL CALCULATORS**

**Using Crystal Ball® Software to
Simplify Simulation Analysis in Excel**

A Publication of the
INSTITUTE OF FINANCE CASE RESEARCH

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Capital Structure and Dividend Policy in an Intro to Business Course?

Sean Reid, Len LaBonia, Ben Shaw-Ching Liu, Patrice Luoma, and Anthony Asare

At the undergraduate level, capital structure and dividend policy are generally introduced in a basic finance class and further developed in advanced courses in corporate finance. Exposure to the concept of shareholder wealth maximization earlier in the curriculum would be beneficial for student understanding of business decision-making. It is difficult to grasp the complexities of the process without some basic appreciation of the financing aspect of those business decisions. This paper outlines a pedagogical method for incorporating capital structure and dividend policy decisions into an Introduction to Business course through the use of a business simulation.

FINANCE IN BUSINESS SIMULATIONS

Educators are being challenged with applying new pedagogical approaches that satisfy the needs of the next generation of students who have grown up with immersive, computer mediated experiences (Lynch and Tunstall 2008; Nadolski et al. 2008). A growing body of evidence suggests that well-designed and relevant simulations can help students learn complex materials relatively easier (Lynch and Tunstall 2008). Recognizing the ability of computer simulations to serve as effective learning tools for complex material and also the fact that students in this generation feel comfortable utilizing immersive computer related tools, this paper examines the use of a business simulation tool to teach complex materials in an undergraduate curriculum.

This paper explores how the complex topics of capital structure and dividend policy can be effectively introduced early in the typical undergraduate curriculum in an Introduction to Business course using a business simulation. It also explores some of the challenges and opportunities facing schools that might decide to adopt the use of business simulations in their undergraduate finance curricula. The paper is organized as follows: we describe the introductory course; we then describe the simulation; we next describe the capital structure and dividend policy decision-making strategies required; finally, we conclude with a summary and discussion of challenges and opportunities.

THE INTRODUCTION TO BUSINESS COURSE

At Quinnipiac University all incoming freshmen and new business majors are required to take a sequence of courses in their first semester that includes Introduction to Business. The Introduction to Business (SB101) course along with Introduction to Information Technology (ISM101) and Personal Effectiveness (SB111) make up the first semester core business sequence. The students take this sequence of three courses as a cohort with projects and assignments that are interrelated across courses. SB101 is taught by a cadre of four to five tenure-track

professors with representation from the management, marketing, accounting, and finance departments. The course objectives include exposing the students to the four primary functional areas of business (operations management, marketing, accounting, and finance), emphasizing the interdependency of the functional areas, and developing basic skills required by business students (team-building, leadership, decision-making, business writing, and presentation delivery). While each professor teaches the entire course to their assigned sections, weekly team meetings among the cadre ensure that the respective subject matter expert emphasizes the key goals and objectives for the upcoming topics.

The interdisciplinary course is structured around a computer business simulation called MikesBikes Intro® created by SmartSims Inc. The integrated business simulation ensures that students are forced to apply textbook concepts in an experiential learning exercise shortly after those topics are discussed in class. The sequence of topics is presented in Table 1 with the topic followed by the functional area designated as the subject matter expert responsible for the content of each.

Table 1. Topics and Responsibility.

Topic	Responsibility
Teamwork and Team-Building	Management
Planning, Organizing, Leading and Controlling	Management
Financial Statements	Accounting
Market Segmentation	Marketing
Branding	Marketing
Demand Forecasting	Marketing
Production and Inventory Management	Management
Promotion Strategies	Marketing
Pricing	Marketing
Ratio Analysis	Accounting/Finance
Capacity Planning	Management
Debt Capital	Finance
Equity Capital	Finance
Dividend Policy	Finance

A comprehensive survey of literature related to the use of business simulations in courses is Faria (2001). As Faria notes, research has shown that team member personality traits are a major factor in performance in business simulations (Armenakis, Field, & Holley, 1974; Johnson & Landon, 1974; Napier, 1974). Early in the course as part of the teamwork and team-building topic, the students complete a modified version of the Herrmann Brain Dominance exercise (Herrmann, 1981) and are divided into seven teams of four to six students. The size of the teams is determined by the size of the section with the constraint that the simulation allows a maximum of seven teams per class. The goal is that each team has at least one student from each of the personality trait groups. For many students, this is their first experience in a team-related educational project.

As a result, the freshman business program emphasizes interpersonal behavior and group dynamics through workshops and course material. These teams work together throughout the SB101 course and the other two courses in the freshman business sequence. Competition within the business simulation is the primary activity for these student teams throughout the semester.

THE SIMULATION

The course is structured so that the topics covered are immediately followed by an application of the concept through a decision-making challenge in the business simulation. The course relies on a custom textbook where the topics are arranged in the order of the required decisions within the simulation. This approach allows the students to immediately relate the concepts covered in the course to actions required to run the company within the simulation.

The MikesBikes Intro® business simulation package allows the student teams to compete among the seven teams within each section. The number of sections (known as “worlds” within the simulation) ranges from twelve to fifteen depending on enrollment levels in the course. Each world contains seven bicycle manufacturing companies in a multi-period simulation. The simulation begins with all seven teams having identical companies and an identical mountain bike product to “sell.” The teams must initially make very basic decisions such as naming their company and devising a promotion strategy for their existing product. With each subsequent period the decisions become increasingly complex and numerous. The exercise culminates with the launch of a new product (either a high-priced road bike, a redesigned mountain bike, or a low-priced youth bike). By the fourth fiscal year in the simulation each team must make a full set of corporate decisions that include promotion expenditures, product selection, product specifications, production quantity, production capacity, plant efficiency and quality, capital structure, and dividend policy. The number of periods can vary but we elect to end after the seventh “rollover” (eight fiscal years).

The winner of the simulation contest is that team with the highest shareholder value. Shareholder value is calculated through a proprietary algorithm developed by SmartSims Inc. described in Equation 1:

$$SHV = f(EPS, D/E, DIV) \quad \text{Equation 1}$$

The variables in Equation 1 are defined as follows:

SHV is shareholder value defined as market share price plus cumulative dividend payments

EPS is earnings per share defined as net income divided by shares outstanding

D/E is the debt to equity ratio defined as book value of debt divided by book value of equity

DIV is the dividend payment history of the company.

CAPITAL STRUCTURE AND DIVIDEND POLICY DECISIONS

In the MikesBikes Intro® simulation, the student teams launch a new product in the fourth period. During the third period, students must determine whether the company has adequate plant capacity to produce the new product. In addition to the capacity decision, there are significant product development, quality improvement, and promotion strategy costs that are also associated with the new product launch.

At this stage of the course and at this point in the simulation, we introduce the concepts of capital structure. In accordance with the Pecking Order Hypothesis (Myers 1984), the simulation algorithm rewards those student teams that are able to finance their new product launch with internally generated funds. Very few teams are capable of financing the new product launch without raising external capital. The basic trade-off the teams must make is a comparison of the cost of expanding capacity to launch a new product versus the opportunity cost of lost sales and unsatisfied demand. The nature of the shareholder value algorithm forces the students to thoroughly consider the pros and cons of debt and equity financing and assess the impact of each on the resulting share price.

The first option available to the students is debt. Debt financing is available in the short-term (through an overdraft facility that must be paid back in one year at approximately 20% interest) or in the longer-term (through a three-year maturity bond with an 8% annual coupon rate). The student teams are limited in the amount of debt capital they are able to raise based on the financial condition of the company and a maximum amount available on the decision screen. The bond decision screen can be seen in Exhibit 1:

Exhibit 1. The Debt Capital Decision Screen

As the company takes on additional debt and the debt-to-equity level increases, the students will see an immediate negative impact on the share price within the simulation. Also, as the company’s financial condition changes, the required rate of return on debt changes as well and bonds will sell at a premium or discount. For example, the bonds in Exhibit 1 are selling at a discount indicating that the firm’s cost of debt has increased from 8% since the bonds were issued. This is likely due to the increased riskiness the simulation applies to a firm with the relatively high debt level illustrated in the example.

In the period after debt financing becomes available, the students are given the option of raising equity capital within the simulation. The student teams are also limited in the amount of equity capital they are able to raise based on the financial condition of the company. The decision screen for equity allows for equity issuance, share repurchase, and dividend payments and can be seen in Exhibit 2:

Exhibit 2. The Equity Capital Decision Screen

Bonds	Maturity	Face Value	Coupon Rate	Market Value	Interest	Repayment
	Jan 2014	1,000,000	8	997,266	80,000	1,000,000
	Jan 2015	1,500,000	8	1,492,111	120,000	1,500,000
	Jan 2016	0	8	0	0	0
	Jan 2017	0	8	0	0	0
Max		4,850,000		Total Interest	200,000	

Companies may issue up to 50% of the market value of existing equity during any period but may repurchase only 10% in each decision period (called a “rollover” in the simulation). Further, stock is issued at a 5% discount to current share price (representing flotation costs and market reactions to equity issuance) and equity is repurchased at a 5% premium to current share price. Raising capital through an equity sale has a positive effect on the shareholder value through lowering firm’s debt-to-equity ratio, but a negative effect on the shareholder value through lowering earnings per share (as the number of shares outstanding increases). These effects partially offset each other, but the overall impact on share price to an equity issue is generally negative. The other option available on the equity decision screen seen in Exhibit 2 is the ability to pay a dividend. The simulation limits the amount of dividends that can be paid to 50% of the firm’s retained earnings. The fact that dividends have a positive effect on share value tends to support the Gordon (1963) or Lintner (1962) proposition that dividend payments increase firm value as opposed to the dividend irrelevance theory of Modigliani and Miller (1961). Generally, teams only issue a dividend when there is no other more productive use of the cash.

The choice between debt and equity for external financing affords the opportunity to explore several additional capital structure considerations. Perhaps the most important distinction between the two sources of capital that is made obvious to the student is the discretionary nature of dividend payments on stock compared to interest payment obligations incurred with a bond issue. Next, interest payments are a tax-deductible expense in the simulation while dividends are paid from after-tax profits. Finally, students observe the impact of leverage and cost of capital through analysis of the financing decisions within the simulation.

Once the new product is launched, students will have three additional periods to refine their strategy and compete for the highest shareholder value. Teams can (and do) go bankrupt if they have an unsuccessful product launch or make serious

errors, but the instructor has the option of providing an “emergency equity injection” to allow every team the opportunity to complete the game. For the successful teams, financial strategies become as critical as product marketing and capacity/inventory management strategies to winning the game. Indeed professors teaching the course observe that teams often overemphasize the importance financial strategies designed to improve shareholder value at the expense of other value-creating operational decisions.

Within each world, the teams with adequate cash spend the last three periods making decisions that are intended to drive the share price as high as possible. For many teams, this will involve launching additional new products, improving existing products, potentially selling off excess capacity (at a 50% discount), and implementation of cost control measures. Further, many teams will use available cash to repurchase shares, pay off outstanding debt, and pay dividends in an effort to increase earnings per share, reduce the debt-to-equity ratio, and increase cumulative dividends paid. MikesBikes Intro® has restrictions on the capital structure and dividend decisions to avoid teams being able to “game the system” at the end of the simulation. Recall the 5% premium on repurchased shares, and restriction that teams may not buy more than 10% of the outstanding shares in any one period. Once the maximum number of shares has been repurchased (and earnings concentrated as much as possible), the amount of excess cash that can be paid out as dividends is limited to 50% of the value of retained earnings account from the balance sheet. The winning team is typically a team that had a successful product launch, excellent demand forecasting ability, and a thorough understanding of capacity planning and inventory management. Further, the winning teams always employ at least one, if not all, of the capital structure and dividend policy strategies described above.

CONCLUSION

In the seven years that Quinnipiac University has used the MikesBikes Intro® simulation package as part of the Introduction to Business course, we have found it to be an effective way to introduce many complex business topics that are often not fully understood by the students until much later in their undergraduate curriculum. In this paper we have focused on the key financial considerations of capital structure and dividend policy. The students are introduced to the concepts as a topic in Introduction to Business and the concepts are reinforced during the later Corporate Financial Management course. For finance majors, the topic is explored yet again in the required Intermediate Corporate Finance course. At the end of the course, the professors in the course conduct a survey of the students. One of the questions seeks to gauge the student perception of understanding in each of the functional areas of business. The survey asks the following question: “Indicate how much you feel you learned about each of the functional areas of business through the simulation.” The responses are on a 5-point scale with 5 being the highest (“A Great Deal”) and 1 being the lowest (“Nothing”). The results of this survey question are presented in Table 2.

The survey indicates that almost 90% of the students in the course feel that they learned some or a great deal about finance through the use of the simulation. A similar question asks them to rate their perceptions on learning with respect to specific learning goals. The survey asks the following question:

“Using the rating scale below, indicate how well you feel you learned the concepts through the simulation.” Again, the responses are on a 5-point scale with 5 being the highest (“Learned Very Well”) and 1 being the lowest (“Didn’t Learn at All”). The results of this survey question are presented in Table 3.

For purposes of this study, we focus primarily on the dividend policy and debt/equity financing concepts where the vast majority of students (approximately 85% of respondents) feel they learned the concepts in either the “learned a great deal” or “learned somewhat” categories. While student perceptions of learning are often biased, we interpret these results to mean that the students generally view the simulation as a valuable part of the course and useful learning experience.

The use of the simulation to introduce the capital structure and dividend policy concepts does present challenges. First, a student could possibly learn to correctly change the numbers in the decision screen within the simulation with little to no understanding of the underlying concept behind the impact on shareholder value. Indeed, many of the students that perform best in the simulation are not the same students that perform best in the course. Student grades are determined by exam scores, assignment grades, and a course project that requires synthesis of the course content with simulation outcomes. Another major concern is that students equate success in the simulation with earnings manipulation and accounting “shell games.” In this era of rampant accounting fraud, an academic exercise that rewards potentially questionable financial decision-making is a serious concern. Finally, the nature of the team decision-making does little to ensure that every student on each team fully understands the application of the concept. Often, one or two students on a team make a majority of the decisions and “free riders” are allowed to coast along. We attempt to mitigate this situation by weighting the course project grade by a peer evaluation grade, but invariably some team members “slip through the cracks.” Unfortunately, it is impractical to run the simulation with companies run by individual students. However, every student in the course takes a common final exam specifically designed around the MikesBikes Intro® simulation. This evaluation helps ensure that all students are knowledgeable in the concepts developed during the exercise.

Overall, the MikesBikes Intro® simulation is perceived by students and faculty alike as a positive experience for the new business students. First and foremost, it exposes the students to the different functional areas of business within a company, shows how decisions within those functional areas are interrelated, and demonstrates the importance of each for a successfully managed company. For finance in particular, the positives far outweigh the negatives. Even for students that may not fully grasp the concept during the Introduction to Business course, instructors in upper-level finance courses are frequently able to refer back to the shared MikesBikes Intro® experiences when these topics are revisited later in the curriculum. Instilling the concept that maximizing shareholder value leads to success in business at an early stage of the curriculum establishes a solid foundation for students in the finance major. Understanding by beginning business students of the impact of capital structure and dividend policy on shareholder value, even at a very basic level, makes the simulation worth consideration for inclusion in an undergraduate business curriculum.

Be sure to look at the *MikesBikes* advertisement following this article

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Table 2. Survey Results – Functional Areas of Business

	A Great Deal	Some	A Little	Very Little	Nothing	Rating Average	Response Count
Management	152	210	30	9	1	4.25	402
Accounting	110	203	64	22	4	3.98	403
Marketing	209	164	22	7	1	4.42	403
Finance	180	181	31	8	2	4.32	402
<i>answered question</i>						403	403
<i>skipped question</i>						15	15

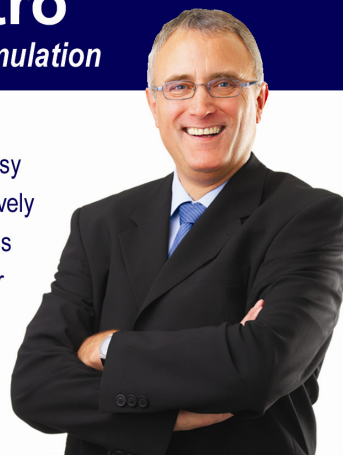
Table 3. Survey Results – Specific Business Concepts

	Learned Very Well	Learned Somewhat	Neutral	Didn't Learn Much	Didn't Learn At All	Rating Average	Response Count
Integration of functional areas	133	207	55	6	1	4.16	402
Industry analysis	154	203	42	2	1	4.26	402
Competitive advantage	204	164	30	2	1	4.42	401
Competitor analysis	189	169	40	4	1	4.34	403
Creating an effective mission statement	147	179	62	8	5	4.13	401
Analyzing and using financial data	186	173	38	2	1	4.35	400
Forecasting demand	194	163	34	9	2	4.34	402
Capacity planning	187	165	40	7	2	4.32	401
Debt versus equity for financing	197	141	52	8	4	4.29	402
Dividend policy	174	161	53	11	3	4.22	402
Effective decision making	225	142	33	1	1	4.47	402
Impact of decisions made on firm outcomes	221	143	36	1	1	4.45	402
<i>answered question</i>						403	403
<i>skipped question</i>						15	15

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A Method for Teaching the Binomial Option Pricing Model in Investments Courses

Steve Johnson and Robert Stretcher

One of the most important concepts in modern finance in general, and in teaching an investments course in particular, is option pricing. While the Black-Scholes model is the most well-known option pricing method, we have found that the binomial option pricing model is sometimes better for illustrating how different inputs affect the value of the option. The binomial option pricing model provides students with an intuitive understanding of the mechanics of option pricing. The binomial option pricing model is also widely used in practice. This paper presents an implementation of the one-period binomial model in Excel. By using spin buttons, students can directly observe the effects of changes in volatility, the underlying asset price, and the risk free rate, on the price of a call option. The model also allows students to compare prices of options with different strike prices. In addition to calculating binomial option prices and providing students with improved intuition, this spreadsheet provides a graphical representation of option value relative to the value of the underlying asset.

The spreadsheet is formed by first listing, on the left hand side, the input variables:

- S₀, current asset price
- S_{mid}, the midpoint (simple avg) of the expected stock prices
- S_{spread}, the spread (difference) between the expected stock prices
- Strike, the strike price
- R_f, the risk-free rate

The five input variables, S₀, S_{mid}, S_{spread}, Strike, and R_f, will all be derived from spin button outputs. We will demonstrate how to add a spin button in Excel 2007, using the first input variable, S₀, as an example. First, enter the items in figure 1 into a blank spreadsheet. In order to add spin buttons to the spreadsheet, it is convenient to first add a spin button icon to the Quick Access Toolbar. Click on the "Customize Quick Access Toolbar" icon and scroll down to "More Commands." Select "More Commands," then choose "All Commands."

Figure 1: First Entries.

	A	B	C	D
1	Binomial Call Option Pricing			
2	Inputs			
3	s ₀			
4				
5				
6				

After choosing "All Commands," then scroll down to "Spin Button (Form Control)." Click "Add," then "OK." This will add the spin button to the toolbar.

Next, click on the spin button icon. This will give you a "+"-shape that you can use to draw your spin button. Go to the upper left-hand corner of cell C3, hold down the left mouse button, and drag to the lower right-hand corner of cell C4. Then, release the left mouse button. This creates the spin button.

Figure 2. Spin Button Inserted.

	A	B	C	D
1	Binomial Call Option Pricing			
2	Inputs			
3	s ₀	0.9		9
4				
5				
6				

Right-click on the spin button. This will give you a box with a list of choices. Select Format Control. If the Format Control box is covering your spin button key, left-click on the blue banner at the top of the box, then drag the box off to the side. The raw output from the spin button is a whole number. In order to put the raw output in cell D4, click on the "Cell link" box, then click on cell D4 in the spreadsheet. Now we have linked the raw output from the spin button to cell D3. Click on the spin button a few times to see how the output changes

The stock price will vary in steps of \$0.10. It is not possible to do this directly, because the smallest step size available is 1. In cell B3, reference the cell D3, and multiply the raw spin button output by the step size, in this case \$0.10. It will be important to refer to this cell. It is convenient to give this cell, B3, a name. This allows absolute referencing without the need to remember the exact location of the cell. Click on B3, then click on the address of the cell in the name box. Create a variable name by typing "S₀" into the box. Hit enter. The first spin button is finished. Again, note that the raw output from the spinner, in column D, is a whole number. In order to create different step sizes, we multiply that raw output by the step size that is needed, in this case, \$0.10. Create the next four spin buttons similarly. The step size for S_{mid} and Strike is \$0.10. The step size for S_{spread} is \$0.01. The step size for R_f is 0.001. These values are illustrated in figure 12. Each of the variables above, in the inputs list, is given the name to the left. For example, the stock price at time 0, 9.1, is given the name "S₀." Naming variables simplifies later references.

Figure 3. Completed Spin Buttons.

Binomial Call Option Pricing			
Inputs			
S_0	9.1		91
S_mid	9		90
S_spread	1.5		150
Strike	8.8		88
Rf	0.065		65
S_up	9.75		
S_down	8.25		

The one-period binomial option model is a two-state model. The stock price can take on one of two possible prices. The possible stock prices at time 1 are calculated from this data, the midpoint (S_mid) and the spread (S_spread). The resulting output is reported as S_up and S_down. S_up and S_down are calculated from the midpoint and spread as follows:

$$S_{up} = S_0 + S_{spread}/2$$

$$S_{down} = S_0 - S_{spread}/2$$

Figure 4. Spreadsheet inputs, including the possible values of the underlying asset at time 1.

The inputs can all be varied dynamically by adjusting the Excel

Binomial Call Option Pricing			
Inputs			
S_0	9.1		91
S_mid	9		90
S_spread	1.5		150
Strike	8.8		88
Rf	0.065		65
S_up	9.75		
S_down	8.25		

spin buttons. The intermediate steps and final solution (call option value) are all reported under the heading "Outputs." The outputs include:

- * C_up, the payoff of the call option in the high stock price state
- * C_down, the low stock price state
- * Delta, the value of delta
- * Risk-free payoff, the payoff of the risk-free Portfolio at maturity
- * PV(Risk-free payoff), the value of the risk-free portfolio at time 0.

Figure 5. Inputs and Outputs.

Binomial Call Option Pricing			
Inputs			
S_0	9.1		91
S_mid	9		90
S_spread	1.5		150
Strike	8.8		88
Rf	0.065		65
S_up	9.75		
S_down	8.25		
Outputs			
C_up			\$0.95
C_down			\$0.00
Delta			0.633333
Risk-free payoff			\$5.2250
PV(Risk-free payoff)			\$4.9061
Call option value			\$0.8572

These variables are also named in Excel. The variable definitions are as follows and discussed in more detail in the following paragraphs:

$$C_{up} = \max(S_{up} - \text{Strike}, 0)$$

$$C_{down} = \max(S_{down} - \text{Strike}, 0)$$

$$\text{Delta} = (C_{up} - C_{down}) / (S_{up} - S_{down})$$

$$\text{Payoff} = \text{Delta} * S_{up} - C_{up}$$

$$\text{PV_Payoff} = \text{Payoff} * (1 + Rf)^{-1}$$

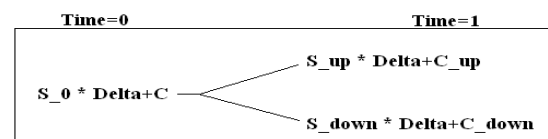
The binomial option pricing model allows the modeler to price a risky call option on an underlying asset without knowing either the probabilities of the up and down states, the required return on the risky underlying asset, or the required return on the call option. The key to solving for the option price is the creation of the risk-free portfolio.

This case specifically investigates the pricing of a call. Because a call option provides the option holder with the right to buy, the option is in the money when the value of the underlying asset is greater than the strike price. The option is out of the money, or worth \$0, when the value of the underlying asset is less than the strike price. This can be implemented with the Excel =max(.) function:

$$C_{up} = \max(S_{up} - \text{Strike}, 0)$$

$$C_{down} = \max(S_{down} - \text{Strike}, 0)$$

The modeler can create a risk-free portfolio by combining a short position in the call option with some amount of shares. This quantity of shares is called "Delta." The resulting portfolio value at time 0 and possible payoffs at time=1 look like this:



If the portfolio is a risk-free portfolio, then the two possible payoffs at time 1 should be equal. By setting the two payoffs equal to each other and solving for Delta, we obtain the value of Delta:

$$\text{Delta} = (C_{up} - C_{down}) / (S_{up} - S_{down})$$

Because the two payoffs at time 1 are equal, we can use either one to find the dollar value of the payoff at time 1. To be spe-

cific, we will choose the first one, the payoff in the “up” state:

$$\text{Payoff} = S_{\text{up}} * \text{Delta} + C_{\text{up}}$$

Next, the value of the portfolio at time 0 should be equal to the present value of the payoff at time 1:

$$\text{PV_Payoff} = \text{Payoff} * (1 + R_f)^{-1}$$

Set this equal to the value of the portfolio at time 0 and solve for C, the call option value:

$$S_0 * \text{Delta} - C = \text{PV_Payoff}$$

$$C = S_0 * \text{Delta} - \text{PV_Payoff}$$

This arrangement of inputs and outputs, and in particular, the inputting of the expected future stock prices by using the midpoint and spread, allows students to “see” the effects of volatility on the option price. Volatility is often a difficult concept to visualize. With this example, students have one specific type of volatility that is relatively straightforward to conceptualize--the spread between the two possible outcomes of the stock price at time one. By changing the value of the spread, the midpoint of the expected stock price remains the same, but the value of the call option increases.

The third part of the spreadsheet consists of the graph of the call option value, call option payoff, and call option time value. The graph provides students with additional insight. For example, when the underlying stock price changes, the value of the call option changes, but the option contract has not changed--only the *value* of the contract changes. However, different values of the strike price illustrate different call option contracts. The graph allows students to distinguish between changes in the value of an option contract and different option contracts. All recalculations of the option value are virtually instantaneous. The graph responds almost instantaneously as well.

Next, fill column J with stock prices that vary from \$8.00 to \$11.00, inclusive, in steps of \$0.01. Column L contains the payoff for a call option when the underlying asset price is equal to the corresponding stock price from column L. The formula entered into cell L3 is:

$$=\text{MAX}(J3 - \text{Strike}, 0)$$

This formula can be copied to fill column L. The variable that contains the strike price is named “Strike.” This is an absolute reference to cell B9, which contains the strike price, the output from one of the spin buttons. The absolute references all have variable names, making referencing easier. In this case, the relative cell reference refers to the stock price in column J.

Column K contains the values of the call for each value of the underlying stock price from column J. The formula for the call value for \$8.00, entered in cell K3, is:

$$=\text{MAX}(J3 * \text{Delta} - (1 / (1 + R_f)) * (S_{\text{up}} * \text{Delta} - C_{\text{up}}), L3)$$

This formula can also be copied to fill column K. Again, the absolute references all have variable names, while the relative cell references refer to the stock price in column J and the option payoff in column L. The absolute reference Rf refers to the risk-free rate, one of the inputs to the problem, determined by

the spin button setting. The value of S_{up} is determined by the value of the stock in the up state. This is an absolute reference to cell B14. The value of C_{up} is determined by the value of the stock in the up state and the strike price of the option. This is an absolute reference to cell G3. Delta refers to the number of shares needed to create a risk-free portfolio when taking a short position in one call option. This is an absolute reference to cell G7.

The time value of the option is calculated in column M. The formula for the time value found in cell M3 is:

$$=K3 - L3$$

This formula uses relative addressing and so can be copied to fill column M.

The graph consists of 4 separate diagrams. The Call Value (column K), Payoff (Column L), and Time Value (Column M), are all plotted versus the stock price from column J. These are represented by the blue, red, and green lines, respectively. This aids the student in visualizing how different contracts with different strike prices are priced differently and how volatility affects the payoff structure of a given option.

In addition to being able to visualize how payoff structures and the graphs of option values change for different strike prices, it is also possible for the student to see how movements in the underlying asset price affect the value of a given option contract. By adjusting S_0 , the stock price at time 0, it is possible to see how the value of the option changes, even though the option contract itself remains the same.

Figure 6. Screen view of the spin buttons, outputs, graph, and data for the graph.

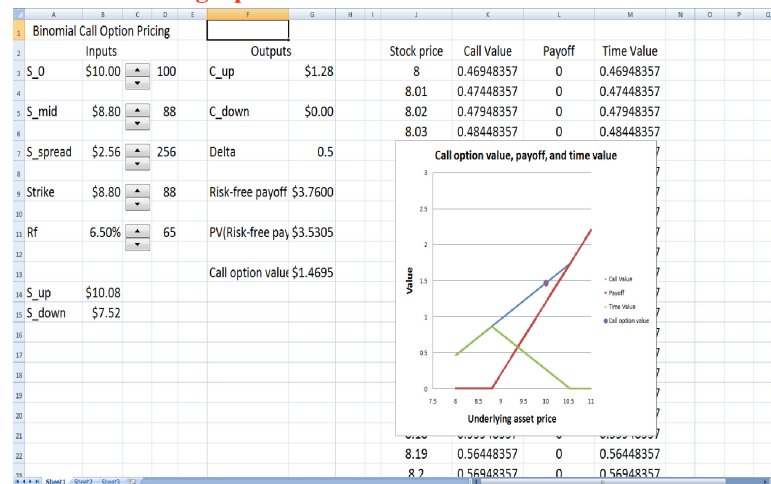


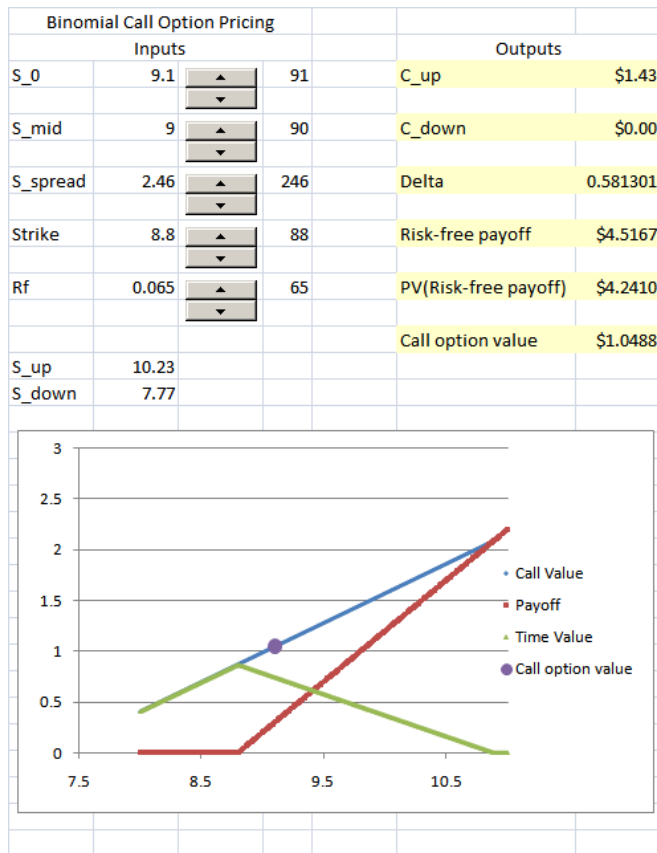
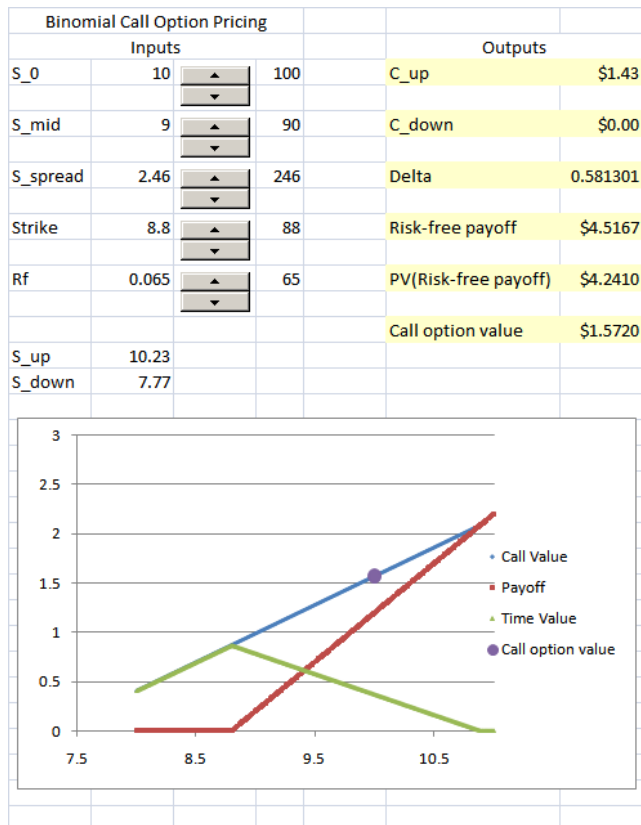
Figure 7. Inputs, outputs, and graph, underlying stock price = \$9.10**Figure 8. Inputs, outputs, and graph, underlying stock price = \$10.00**

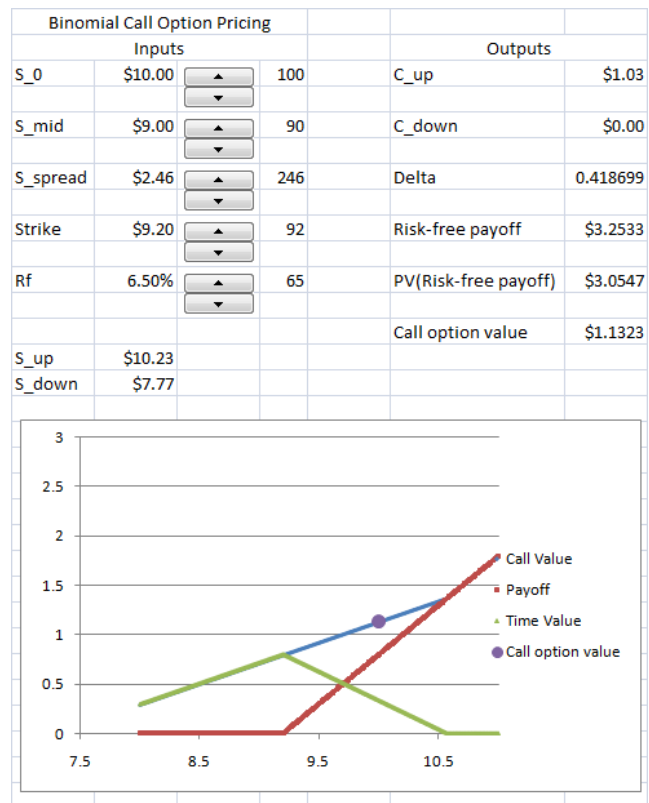
Figure 7 provides the following option diagrams:

- * call option value
- * option payoff at maturity
- * time value

Figure 7 also illustrates the value of the call option for a particular underlying stock price, in this case, \$9.10. Students can vary the values of the inputs. In particular, it is possible to see what happens to the value of the call option if the underlying stock increases to \$10 in price.

The graphs of the call value, payoff, and time value remain unchanged. Only the value of the call option itself has changed.

Students can see what would happen to the payoff, time value, and call value if the exercise price were different. Figure 9 shows the results for a strike price of \$9.20, leaving the other inputs from Figure 16 unchanged:

Figure 9. Strike price of \$9.20, other inputs unchanged from Figure 4.

The “corner” in the payoff graph is further to the right, signifying the higher strike price, and the graphs of the call value and the time value are “lower” (have lower values). This allows the students to visualize the effects of different strike prices more easily.

It is also possible to study the effects of different expected future stock prices on the value of the call option today. In this spreadsheet, the future stock price information is input in two variables—the midpoint of the two expected future stock prices and the spread between the future stock prices. If the midpoint of the two expected future stock price increases, the call option should move deeper into the money. This is illustrated in Figure 10:

Figure 10. Midpoint of expected stock price = \$9.50, otherwise unchanged from Figure 16.

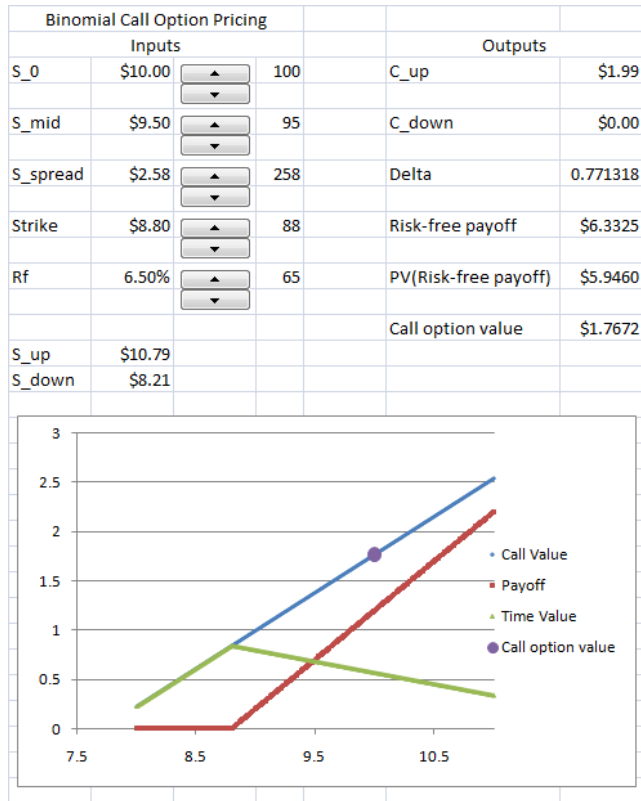
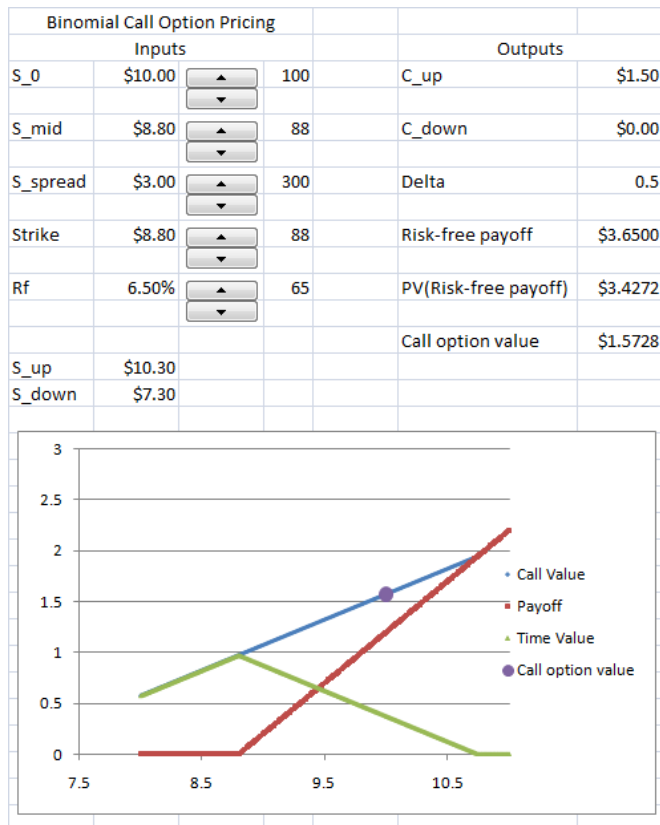


Figure 11. Spread of expected stock prices = \$3.00, other inputs unchanged from Figure 16.



By comparing this with figure 5 (or adjusting the input value in the spreadsheet), it is possible to see that the call value and time value have increased. The graph of the payoff is unchanged, because the graph of the payoff is determined uniquely by the strike price.

The effect of volatility of the underlying asset on option prices can be illustrated in a straightforward manner by the use of this spreadsheet. One of the input values is the spread between the two possible future stock prices. This spread is a rough measure of volatility. As the spread between the two possible future stock prices widens, the expected value of the option increases. This is illustrated in Figure 11.

If you try this method for enhancing options coverage, we would be grateful to receive feedback from you. Please contact us. The complete spreadsheet is available at www.jfcr.org in the downloads section for this issue of JITF.

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Using Crystal Ball[®] Software To Simplify Simulation Analysis in Excel

Speros Margetis

Using Monte Carlo simulation in the classroom allows students to better model risk inherent in forecasted models. Understanding the usefulness and limitations of Monte Carlo simulation provides students a framework in which to model a variety of uncertainties in the assumptions and the interrelationships between the assumptions placed in the model. This paper first describes how spreadsheet analysis traditionally has been used to quantify risk. Next the use of Crystal Ball[®] software to conduct Monte Carlo simulation is described along with a brief introduction of some of the capabilities and features of the software.

INTRODUCTION

The use of appropriate technology enhances the ability of individuals to make decisions under uncertainty. Conducting simulations to determine the distribution of possible outcomes from a forecast can improve the efficiency and accuracy of the information used in making these decisions. Crystal Ball[®] is a graphically oriented program that allows uncertainty in the assumptions and the correlations between those variables to be modeled. It can also be used to provide a visualization of benefits and consequences of choosing between various alternative actions which can aid in decision making. When many of the variables in a model have uncertainty it is difficult for students to visualize the impact of all the random factors at the same time on the forecasts being made by the model. Crystal Ball[®] is simple to use and piggybacks on an Excel spreadsheet. Any forecast that can be modeled in a spreadsheet can be analyzed by using Crystal Ball[®] to conduct a Monte Carlo simulation. The simulation allows us to examine the entire distribution of results possible for the forecast along with appropriate statistics associated with the various outcomes. The key drivers of risk are identified and quantified through the simulation as well. Understanding the distribution of possible outcomes and the drivers of risk provide individuals better information to make decisions under uncertainty.

The limitation of traditional spreadsheet analysis is due to the fact that the values in cells have to be changed one at a time to conduct a "what-if" analysis. The results provide point estimates of outcomes resulting from various combinations of point estimates of the underlying assumption. As the number of assumptions and possible values of each assumption increase, the quantity of possible outcomes grows exponentially. The probability of the occurrence of an individual forecasted point estimate approaches zero as the number of possible outcomes grow. One common approach to modeling uncertainty is to conduct scenario analysis. Scenario analysis involves changing the values of the variables to get a point estimate of the outcome if that scenario occurs. To examine the risk inherent in a forecast point estimates of the best case, most-likely case, and

worst case scenario are frequently forecasted. This allows students to compute the range of possible values between the best and worst case scenario as measure of risk. Intuitively the larger the range, or the difference between the best case scenario forecast and worst case scenario forecast, the greater the risk inherent in the forecasted values. Unfortunately this method of risk analysis does not provide any information about the probability of any of these extreme scenarios occurring or the probability of the forecasted value being above or below any of the values between the two extreme scenarios. It is very unlikely that best case scenario or worst case scenario will actually occur. Additional information can be provided by constructing more scenarios. This can lead to a paralysis of analysis as the additional information from alternative scenarios is being processed. Imagine being given the results of fifty different scenarios and then asked to make a decision based off of those results. It would be difficult to remember the numerous different results provided by the fifty scenarios presented. It would also be very time consuming to generate the various scenarios. Ignoring the time it would take to generate the scenarios and the difficulty in retaining all the information provided by those scenarios, you still would not be certain that the fifty scenarios are representative of the true distribution of possible outcomes. Many biases in the information generated could easily result from the selection of scenarios used to generate the results.

Understanding the drivers of risk in forecasted models allows the decision maker to focus efforts on the most relevant variables generating uncertainty in the forecast. Sensitivity analysis is a common technique used to determine the impact of the uncertainty in an assumption on the uncertainty in the forecast. Traditional spreadsheet analysis allows for individuals to conduct sensitivity analysis by the changing the value of one variable at a time to determine its impact on your forecasted variable. If the forecast alters dramatically as a result of the change in the variable then the forecasted variable is said to be very sensitive to the underlying variable. Procedures for conducting sensitivity analysis require changing the variable up and down from its expected value. The individual must decide if he is going to change the variable by a certain percentage of the expected value and what that percentage should be, change the variable by an absolute amount and what that amount should be, change the variable to its maximum and minimum amounts, or some combination of the three. The choice of how much the variable is allowed to vary in the sensitivity analysis will impact the results of the sensitivity analysis. Of course as the number of variables in the model increase, sensitivity analysis becomes very labor intensive. The results of this primitive sensitivity analysis do not allow you examine the impact of one variable as all the other variables are changing. Once all of the sensitivity analysis is conducted the information will still need to be aggregated into a convenient format to assist in determin-

ing the drivers of risk in the forecasted model.

When analyzing the benefits and costs associated with various choices under control of the decision maker (for example whether to pay a dividend, what price to charge, or how to incentivize employees, etc.), the goal is to make the optimal decision given the uncertainty in the forecast. To measure the impact of different decisions made in the model requires the model to be forecasted under each different decision. Then a scenario analysis and sensitivity analysis is conducted for each decision with the results being compared against each other. All of this information then needs to be aggregated into a decipherable format to assist in making informed decisions.

The difficulty and time involved in fully analyzing all possible outcomes due to variations in the assumptions and the impact of each variable on the overall risk of the forecast often leads decision makers to use a small sample of the possibilities to make their decisions. For example, the decision maker might just look at three scenarios (best case, most-likely case, and worst case), conduct a sensitivity analysis on a few variables using only the most-likely case scenario as a base and then look at the impact of a few decisions on the most-likely case scenario. The information set for making a decision could be improved by expanding the number of scenarios to include all possible combinations of events, conducting sensitivity analysis for each variable under each of these scenarios, examining the impact of each decision variable under each of the scenarios, and then aggregating the information into a graphical format to display the entire distribution of forecasts. Using Crystal Ball ® to conduct a Monte Carlo simulation allows this to be done quickly in a very user friendly format. Crystal Ball ® assists in decision making by performing simulations on spreadsheet models which results in forecasts that quantify the risks in these models and provide a more complete information set on which to base the decision being made under uncertainty.

CRYSTAL BALL ® FEATURES AND TERMS

Before using Crystal Ball ® students need to become familiar with the features of the software and some common terms used to describe those features. Once Crystal Ball ® is loaded onto Excel a new tab will appear with a ribbon that provides access to the features provided by Crystal Ball ®. A few key terms need to be defined to facilitate the explanation of how to use Crystal Ball ® in the classroom. First we must explain what Monte Carlo simulation does and why it is beneficial in modeling uncertainty in forecasts. Monte Carlo simulation is a process in which random numbers are used to measure the effects of uncertainty on forecasts. By generating random values from a distribution of values for each assumption and estimating the forecasted value for the model under those assumptions we are generating information about possible outcomes in the forecast. Each different combination of the assumption values is called a trial. The simulation can be set to run as many trials as necessary to describe the variety of possible outcomes for the forecast. The number of trials to be run on a simulation is directly related to the number of assumptions and possible values for each assumption. As the result from each trial is aggregated into a graphical format, the information about the distribution of forecasted values is provided visually along with key statistics on the distribution.

Simulation is useful when other forms of analysis are too difficult to perform by other means. Imagine having a forecast

that has twenty assumptions with each assumption having its own unique distribution and some of those variables are correlated. Generating the appropriate amount of trials manually to adequately describe the distribution of possible outcomes becomes a daunting task. This task can be made simple by using Crystal Ball ® to run a simulation and aggregate the results into a forecast chart. On each trial Crystal Ball ® generates random numbers from the distribution for the assumption cells, recalculates the spreadsheet model, and then displays the results in a forecast chart. The forecast chart provides the range of values for the forecasted variable, the probability of that event occurring, and the frequency of that occurrence in the simulation. It also provides a graphical representation of the distribution of forecasted variables. Outliers or extreme values are included in calculations but are excluded from the display range on the forecast chart. The certainty of the forecast variable being above, below, or between certain values can be determined by changing the certainty range field values. For instance, if the forecasted variable is the net present value of free cash flows it might be of interest to determine the probability of the net present value being greater than zero.

Once a basic spreadsheet model is developed the assumptions need to be defined for each assumption cell. Instead of placing a single point estimate for an assumption cell, Crystal Ball ® allows a probability distribution to be defined for the cell. The probability distribution provides the set of all possible values for the cell along the associated probabilities of those values. Several distributions are available for use, and each is described in a distribution gallery that appears once you begin to define the assumption cell. Along with the description of each distribution, the distribution gallery provides the parameters to be used for each distribution. Once a distribution has been selected the distribution dialog box appears. The assumption name and parameter values can now be entered for the variable. Crystal Ball ® will select a value from the distribution on each trial of the simulation being performed for each defined assumption. Once all of the assumptions are defined then forecast cells should be defined. The forecasts cells contain formulas that refer back to the assumption cells. Now students are ready to run the simulation. The simulation can be ran, stopped, and continued at their discretion. The run preferences of the simulation can be set to the desired number of trials for the simulation and seed value if desired. The seed value is the first number in a sequence of random numbers, and if used the same sequence of random numbers appear every time the simulation is ran. If no seed value is given the sequence of random numbers will be different every time you run the simulation.

DISTRIBUTION GALLERY

Crystal Ball ® includes twenty-two different distributions in the distribution gallery. For each distribution, a description along with the parameters for each distribution is provided. I will provide a brief description of some of the more common distributions used in finance and economics. A normal distribution is a continuous probability distribution useful in describing many natural phenomena such as inflation or profit margin. The normal distribution is described by its mean and standard deviation. The mean is the most likely value for the distribution with occurrences being symmetrical about mean. More occurrences are likely to appear closer to the mean. Normal distributions follow the 68-95-99 rule which states that 68 percent of the

observations fall within plus or minus one standard deviation of the mean, 95 percent of the observations fall within plus or minus two standard deviations of the mean, and 99 percent of the observations fall within plus or minus three standard deviations of the mean. A triangular distribution is a continuous probability distribution useful when you know the maximum, minimum and most likely value for a distribution and the values near the maximum and minimum value are less likely to occur than values near the most likely value. A triangular distribution is often used to describe a sales projection where the minimum, maximum and most likely values are known. A uniform distribution is a continuous probability distribution in which all values between the maximum and minimum are equally likely. The lognormal distribution is a continuous probability distribution used in situations where values are positively skewed. Stock and real estate prices are usually positively skewed because their price cannot fall below zero but can increase to any value. Three conditions underlying the lognormal distribution is that the unknown variable can increase without bound, but is confined to a finite value at the lower limit, exhibits a positively skewed distribution and the natural logarithm of the unknown variable will yield a normal curve. The logistic distribution is a continuous probability distribution commonly used to describe growth and the parameters for the logistic distribution are mean and scale. It is useful when describing the growth of a population over time. The Student's t distribution is similar to a normal curve, but with more outliers and high kurtosis in the central region. The Student's t distribution has a degrees of freedom parameter that controls the shape of the distribution which is sometimes preferred over the normal distribution for more precise modeling of nearly normal quantities found in many econometric and financial applications. The Pareto distribution is a continuous probability distribution commonly used for city population sizes, the size of companies, personal incomes, and stock price fluctuations. The parameters for the Pareto distribution are location and shape. The discrete uniform distribution has all integer values between the minimum and maximum equally likely to occur. A classic example of a discrete uniform distribution is the modeling the rolling of a dice. The parameters for the distribution are the minimum and maximum value. There are three conditions underlying the uniform discrete distribution is that the minimum is fixed, the maximum is fixed and all integer values between the maximum and minimum are equally likely. A custom distribution allows you to describe a series of unweighted values, weighted values, continuous ranges, or discrete ranges for unique situations that cannot be described by the other distribution types. This is a very flexible distribution that can be customized to meet the needs of the particular assumption being modeled.

CORRELATIONS

The values of assumptions cells can be correlated with each other meaning that a dependency exists among the assumption cells. The price of a good and the quantity demanded or supplied of that good are often dependent on each other. As the price of a good increase, the quantity of that good demanded declines and the quantity of that good supplied increases. When choosing values for the assumption cell in each trial of the simulation these relationships need to be accounted for when selecting the random values for the assumption cells. The dependency between the assumption cell can be described the

correlation coefficient between those assumption cells. The correlation coefficient is a standardized number whose value is between negative one and positive one. If the correlation coefficient is positive one then the cells are said to be perfectly positively correlated. If the cells are positively correlated then they move in the same direction. In other words if one variable increases then so does the other. In our example the price and quantity supplied are positively correlated with each other. When the correlation coefficient is negative one the cells are said to be perfectly negatively correlated. If the cells are negatively correlated then the values of the cells move in the opposite directions. The price of the good and the quantity demanded are negatively correlated. It is rare to find variables that are perfectly positively or perfectly negatively correlated but correlation coefficients can be near one extreme or the other. The greater the absolute value of the correlations shows higher degrees of correlation. To set the correlations between the assumptions select the tools button. A drop down menu will provide the option to select a correlation matrix. The correlation matrix allows you to select variables and assign their corresponding correlations. Using the correlations between the variables improves the accuracy of the simulations when the variables are truly correlated. Note that correlation between a variable and itself will always be positive one. The correlation coefficient between two variables can be entered into the correlation matrix so that dependencies between those variables are properly accounted for when assigning the random values to the assumption cells in each trial of the simulation.

DECISION VARIABLES

Decision variables are not required to run simulations but can be extremely useful when comparing alternate scenarios. Decision variables are variable that you control. Examples include setting a dividend payout ratio, the price of products sold or the weights applied to assets in your portfolio. To define a decision variable select the cell or cells on which you will define as decision variables. The cells selected cannot include a formula or non-numeric value. Next select the define decision button under the Crystal Ball ® menu. This will open the define decision variable dialog box. Here you have the option to name the decision variable, provide upper and lower bounds for the decision variable, define whether the variable is continuous or discrete and define the interval between values for discrete variables. It can be difficult to see the impact of various choices made under uncertainty. To better understand the impact of decisions we need to compare the forecast results based on various values for the decision variables. The Decision Table tool in Crystal Ball ® can be used to perform several simulations to test decision values for one or two decision variables. To create a Decision Table select the tools button and then select the Decision Table option from the drop down menu. You will be prompted to enter a forecast or cell to be the target of the analysis and one or two decision variables to analyze. The tool tests values across the range for each of the decision variables and then puts the results in a table that can be analyzed using Crystal Ball ® trend, forecast, or overlay charts.

FORECAST CELLS

Spreadsheet models are frequently used to compute key variables of interest such as the net present value of projected cash

flows from a capital budgeting project. The uncertainty in the net present value results from the uncertainty in the assumptions used to project the cash flows. To analyze the uncertainty in net present value it can be defined as a forecast cell for the simulation. Forecast cells usually contain formulas that refer back to the assumption cells and decision variables in the model. To create a forecast cell go to cell that contains the variable and click on the define forecast button. Be sure to name the forecast and specify the units for the forecast when defining the forecast cells. By default crystal ball selects either the value in the cell to left of the forecast or the location of the cell as the name. Naming the forecast cell appropriately lets identify which forecast value the simulation is analyzing which is especially useful if you have selected more than one forecast variable. You also have the option to set additional forecast preferences at this stage by clicking the more button in the define forecast dialog box. The forecast preferences can be set to choose the type of display, to select whether to display the forecast window while the simulation is running or when it stops and whether to fit a continuous probability distribution to the forecast.

RUNNING THE SIMULATION

Once all the cells and variables have been properly defined it is time to run the simulation. It is often useful to run the simulation a single step at a time to demonstrate what is occurring during the simulation. By clicking the single step button the simulation will run a single trial. Students can observe the assumptions changing in each trial of the simulation. Once students understand what is going on in the trials the simulation can be ran by selecting the start simulation button. Once the simulation is completed Crystal Ball ® can generate a variety of reports to aggregate the data in a convenient format. To generate a report select the create button. A variety of predefined reports are available through Crystal Ball ® or a custom report can be created to provide the specific information desired. I recommend creating the full report to provide all the data generated from running the simulation.

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Corporate Mole: A Grouping Strategy for Minimizing the Free-Rider Problem in a Managerial Finance Course

Group projects in upper level finance courses are becoming common, both for the reflection of real-world group tasks in business firms and for their appropriateness in dealing with certain types of assignments in the classroom and beyond. Professors often lament over effective formation of groups and the task of managing group dynamics, including the problem of free-riders: those students who, knowing that the group gets the grade, will shirk their respective responsibilities in accomplishing group tasks. The following article represents one evolution of grouping methods over two decades and the observations surrounding each. The most successful, in this author's experience, is a recent marriage of a so-called "reality TV" recipe with structured groupings.

This study was carried out in a typical finance capstone course. The first part of the course involves a comprehensive review of the breadth of managerial finance in the first six weeks of the course, incorporating two exams on the selected topics. This portion of the course is very rigorous, and involves traditional lectures, website instruction, exercises and assignments on the review material, and several case studies that di-

rectly enhance the topical coverage. All of the solutions are presented during class time, with the objective of preparing students for the examination. It also establishes an approach to problem solving that is direct and quick, and one that weeds out information that may not be pertinent to the issue at hand.

The remainder of the course is dedicated to groupwork with the objective of developing solutions to business problems and issues. The material for the course is provided using a variety of cases in finance. The capstone course is typically taken in the senior year of the undergraduate experience for finance majors.

The grouping methods presented here were developed at two universities. One university (University A) is somewhat unique in terms of the student population. Most are of traditional college age, and camaraderie is easily established in the typical finance graduating class of twenty-five to thirty students. In much of the required coursework, a practical and real-world approach is stressed. Through substantial interaction with corporate and workplace representatives during their business education experience, students tend to realize the importance of working in groups, communicating effectively, and being ana-

lytically savvy. The environment was also fairly consistent from year to year. The most significant change in grouping methods at University A was a change from unstructured groups to structured groups, described *infra*.

The university where the second major re-structuring occurred (University B) contains a very different student population. While most students are traditional college age, smaller portions of classes are represented by non-traditional students. Camaraderie is much more challenging to establish among students, and few students are acquainted with much of the rest of the class. Students are not generally interactive with one another, preferring to open cell phones and communicate with others who are not present than communicating with one another. It is also a larger university, adding to the impersonal environment. Classes are larger, making group projects less manageable. Interaction with corporate representatives is essentially absent, and students do not generally seem to grasp the importance of working with others, communicating effectively, and being analytically savvy prior to taking the class. The most significant change in teaching methodology at University B was the development of the current teaching strategy, "Corporate Mole."

TWO GROUPING STRATEGIES AT "UNIVERSITY A"

Non- Structured Groups

For three years running, groups were established with four to five members per group, depending on class enrollment. The group assignments did not involve any specific reasons for the combining of students. In fact, they were determined randomly, using a random number generator in Excel. The groups were formed using quintiles (or sextiles, depending on enrollment) using the random numbers. Group members, through interacting with one another, came to some decision about how the group would work together. No direction concerning how this would be accomplished was given by the professor. For every case analyzed, some form of presentation of the analysis was required, either in written communication, or by oral presentation (in front of the class and professor), or both.

No direction concerning responsibility for the presentation of the group's work was given. The group decided who would present. Students were given instruction about length requirements for the reports, and about the structure of the report and presentation. Groups were evaluated based on the report, the presentation, or both. All group members received the same grade. Students had at their disposal the same resources described for structured groups (see item 6, below).

Structured Groups

For the next two years running, groups were established with six to seven members per group. Groupings were again determined by random numbers, but using quartiles, since classes were kept smaller. Students were given the following guidance as to how the group members would interact with one another and with the professor.

1. A "Leader" was assigned randomly as the group member with the highest random number in the quartile. The class was informed in writing that the leader's task was to be the communicator for the group. The leader was responsible for asking all questions directed to the "expert" (the professor). The leader was responsible for delegating ALL responsibility for analysis

of the case and reporting of findings to other group members. The leader was prohibited from taking part in the work tasks of the group, either in analyzing or reporting. The leader's responsibility was to lead, to organize the group meetings and work schedules, and to inspire the group's motivation to complete the tasks in a correct, concise, and professional manner. The single production responsibility for the leader was to create a progress report in professional memo form, due at the beginning of each of four class periods during the time the group analysis was to be carried out. The leader would be evaluated by the six group members as to the effectiveness of the leadership. The leader would also be evaluated by the instructor for leadership effectiveness. Half of the leader's grade was group-determined and half was professor determined.

2. An "Auditor" was assigned randomly as the group member with the lowest random number in the quartile. The class was informed in writing that the auditor's task was to be the recorder for the group. The auditor was responsible for reporting the tasks assigned to each group member, the time allotted for the task, and whether or not the task was completed by the group member on time. The auditor was prohibited from taking part in the work tasks for the group, either in analyzing or reporting. The single production responsibility for the auditor was to create two copies of a report of specific activities to be distributed to the leader and to the professor at the beginning of each of the four class sessions. This created a somewhat sensitive position for the auditor, since the report could essentially contain negative feedback about group members' participation. The auditor's position was therefore made autonomous of evaluation by the group members. Instead, the auditor was evaluated strictly by the professor, and strictly on the basis of the clarity, honesty, and accuracy of the report.

3. "Analysts" were assigned randomly as the group members without the lowest or highest random numbers in the quartile. The class was informed in writing that the analyst's task was to carry out the work required for analysis of the case, preparation of a report of findings and presentation of the findings. Analysts were prohibited from involving the leader or the auditor in the working tasks. It was reiterated (for emphasis) that "the analysts do all the work," except for the leader's and auditor's reports.

4. Evaluation of students was done according to the role each one played in the assignment. Students were informed in writing that the leader would be evaluated by the other group members, and by the professor, based on their effectiveness as the leader. The auditor would be evaluated strictly by the professor, based on the accuracy, honesty, and clarity of the auditor's reports. The group members would be evaluated by the professor based on the quality of their work, and on the quality of the output produced by the group, whether in the form of a report, presentation, or both.

5. Miscellaneous information: for the structured groups, the expected output was specified for each assignment (report, presentation, or both). Instructions regarding reports and presentations included: no fancy bindings or covers - just stapled in the upper left corner, the report or presentation should be neat and well-organized, reports should be typed in laser or sharp inkjet output, the report or presentation should appear profes-

sional, the report or presentation should contain no irrelevant content (no 'bull' or 'fluff'), there was no length requirement - it was the leader's responsibility to determine what due diligence was required and what 'adequate' was, no visual aids in either a report or a presentation unless they contributed significantly to the analysis, and the report had to be segmented and organized.

6. Resources: All students had a detailed guide to analysis, reporting, and presentation of case reports. The sections of the guide included an introduction to the case method and the philosophy of cases, organization of thought concerning cases, strategic concerns for the enterprise and its environment, financial analysis (including analysis of leverage, capital budgeting and other quantitative methods), financial concepts (including business structure, agency, market characteristics, etc), analytical process, reporting guide, and a large guide to sources of outside information. Additionally, most of the students still had textbooks and other resources from prior business courses, or purchased a financial management textbook at the intermediate level.

Initial Reactions to Non-Structured and Structured Groups

It is interesting to observe students' reactions to each of the group regimes. The non-structured regime creates a flurry of questions regarding guidance as to how the system will work. Questions tend to lean toward how to proceed with the analysis, who leads the group, and how a leader is chosen. Students usually select a leader, and it is usually by suggestion by more than one person. Sometimes, the leader will simply take charge, collecting contact information and setting meeting times and places. Often, the person a group chooses as their leader is less than enthused about being the leader. Unless most of the group is in favor of the selected leader, problems usually crop up as a result of unwilling followers. Leadership within a group seems to be of tremendous importance to the effectiveness with which a group operates. In the unstructured approach, the authority of the leader is at the whim of the group.

Leadership in the structured approach is obviously very different. Students seem to appreciate the randomness of selection of the leader. The authority commanded by the leader comes from a higher authority, the professor. Also, in the structured approach, group members realize that the leader answers both to them and to the professor, both of whom are constantly assessing the effectiveness by which they lead. If the structure of the groups is explained prior to revealing the selections, there is usually a high degree of anticipation about who will be in what group, and who the leader and auditor will be. This generally presents a good opportunity to give students some insight about committee tasks and decisions that occur in the business world. The group leader is usually someone in higher authority within the firm, and tasks are usually delegated to the different committee members.

Reactions Over Time

Student suggestions for structure run rampant in the unstructured regime. Several times, suggestions that students be allowed to determine their own groups pop up. It is reminiscent of the 'buddy' system, where two or three persons will seek to be in the same group. Some have even suggested the equivalent of the 'playground' solution; select four people to choose sides. In the unstructured group, the personal preferences involved in the formation of groups has generally been despised, and it is

commonplace for the professor to come up with remedies for problems that crop up. Other times a group just seems to 'mesh', completing tasks seemingly without mishap. Still other observations indicate that only one or two group members actually did any work on the tasks. Unfortunately, in these situations, the group grade is recorded for all group members.

The structured approach seems to solve some of these issues. There still appears to be some initial wariness about the randomness of the groupings and selection of leader and auditor, but it has been short lived during the observed semesters.

A very interesting result is that the auditor position becomes a coveted prize. This is partially because of the autonomy, but an even more likely attraction is the evaluation of the auditor solely by the professor. The task for the auditor is also very clear-cut, and not dependent on the actions or attitudes of any other group member. In the three semesters observed, it has been a fairly easy task to detect auditor fraud. Auditors unwilling to report truthfully receive a severe markdown. In both semesters, this has been a good opportunity to cover the importance of an auditor's words. The auditor is in a unique position that requires recording of fact. It has been pointed out to us by other professors that the auditor's position may be coveted because students can easily earn full credit by being accurate and on-time.

The leader position is a different story. It becomes very apparent that leadership is a crucial element to the success of the group. In the observed semesters, students either personally dread the prospect of being selected as leader, or they personally covet the position. Their attitude toward the position is based on their experiences from the past in dealing with being in a leadership position. Perhaps surprisingly, though, the randomness of selection still appears to be appreciated by both selected leaders and by their group members. On several occasions, students who would never have volunteered for a leader position rose to the occasion and actually gained some leadership confidence.

Another element of the structured approach that seems to be prevalent is the enhanced rivalry between groups. After observing this result in the first semester of structured groups, an experiment on the final group project was attempted. The four groups would compete for letter grades, involving a simple ranking of the report and presentation of their last projects. The highest ranking group received an 'A', the second highest ranked a 'B', etc, down to a 'D'. The rivalry and effort that went into that week of groupwork was unprecedented. In fact, three of the four projects were truly excellent, in the 'A' range, and the other group handed in a 'B+' effort. The projects were so good that the grading was softened, with grades ranging from 'A' to 'B-'. Assigning a 'D' would not have been very appropriate.

Another noteworthy result is the development of leadership. Under the structured regime, the leader had a great incentive to promote cooperation (among the other group members), quality work, and team play. In most of the groups and during most of the projects, the leaders developed remedies for problems that cropped up. Toward the end of the course, absenteeism became virtually nonexistent, and very few assignments were bungled. There were few cases of observed lack of effort. In several cases, students who did not seek to become leaders found that they had a great ability to lead.

Feedback from the Corporate World

The communication received from former students who have chosen to contribute feedback has been exceptionally positive. Comments have indicated that the course prepared some students for what they would face in the real world. In many of the corporate environments that these students enter after graduation, teamwork is a vital element to the way the company operates. In most of the situations described, rarely does an individual get to pick their own team; rather they are thrown together with people they are unfamiliar with and must perform together in the common cause. Most of the feedback indicates that leadership within the corporate environment is based on responsibility and position, rather than on leadership capability. One of the most rewarding comments is that the methodology created memories of the one course that was most influential in their preparation for the business world.

THE DEVELOPMENT OF THE "CORPORATE MOLE" STRATEGY AT "UNIVERSITY B"

At University B, some refinement of the grouping strategy was necessary to overcome the lack of camaraderie among students, less interaction between students, a population that grew up in the information age, and less exposure to professional managers during their undergraduate experience. An astute former student came up with a great suggestion: "You ought to make the auditor a mole!"¹ The suggestion seemed to have merit, considering the enthusiasm with which our current students pursue the episodes of reality TV. A new grouping regime was launched in 2009, with the following changes to the former structured groupings.

The former "auditor" role was reworked as the "corporate mole." A quick survey of former students currently working in corporations, financial institutions, and financial regulators confirmed the existence of informal information channels reaching to top management that were indeed secretive and to a large extent shrouded from general knowledge. These channels kept upper managers informed beyond formal hierarchical communication, and maintained some level of paranoia among lower level task groups. Even though the trial might prove risky in a class setting, it was decided to implement the strategy in 2009. Some colorful graphics emulating the TV reality shows were accompanied with the following role descriptions.

Group Descriptions and Group Dynamics

For casework in the last half of the semester, we will determine groups using random number generation in excel. In each group, group members will have a designated role according to randomly generated numbers as follows:

1. A "Leader" is assigned randomly as the group member with the highest random number in the grouping. The leader's task is to be the communicator for the group. The leader is responsible for asking all questions directed to the "expert" (the professor). The leader is responsible for delegating ALL responsibility for analysis of the case and reporting of findings to other group members. The leader is discouraged from taking part in the actual work tasks of the group, either in analyzing or reporting. The leader's responsibility is to lead, to organize the group

meetings and work schedules, and to inspire the group's motivation to complete the tasks in a correct, concise, and professional manner. The single production responsibility for the leader is to create a progress report in professional memo form, due at the end of each day during the time the group analysis is to be carried out. The leader will be evaluated by 1) the group members as to effectiveness of leadership and 2) by the instructor for leadership effectiveness evidenced by observation and by the quality of the progress report memos (50% weight for each evaluation).

2. A corporate "mole" is assigned randomly as the group member with the lowest random number in the grouping. The mole's task is to be the secret informant, reporting daily to the professor concerning the group's activities, whether everyone in the group is participating, being cooperative, and contributing to the success of the case analysis, and whether the leader is leading effectively. This is a somewhat sensitive position for the mole, since the reports could essentially contain negative feedback about group members' participation. The mole's position is therefore not known to others in the group, and the mole is free from evaluation by the group members. Instead, the mole is evaluated strictly by the professor, and strictly on the basis of the clarity, honesty, and accuracy of their reports. The designation of mole, of course, implies that their identity is totally secret. If the group members figure out who the mole is, then the mole's grade on the project will be negatively affected. The mole should participate fully in the analysis of the case, so as not to raise suspicions. In the corporate world, moles are commonplace; informal relationships provide information flows directly to top management. All group members should assume that their actions are being monitored at all times and that the identity of the mole will be secret until the end of each project. If the mole still desires to remain anonymous at that time, the professor will honor the request, of course.

3. "Analysts" are assigned randomly as the group members without the lowest or highest random numbers in the grouping. The analyst's task is to carry out the work required for analysis of the case, preparation of a report of findings and presentation of the findings. Since the mole is among the analysts, and acting as such, the mole participates in the analysis of the case.

After the determination of groupings, an email was sent to each of the secret "moles" with a large image of a fat mole digging out of a burrow with the caption "YOU ARE THE MOLE!"

Initial Reactions to the Corporate Mole Strategy

Students responded very positively after receiving the 'reality' materials outlining the grouping strategy and the thought of a "mole" reporting their every move. Less motivated students were wary of being perceived as a free-rider, and generally participated to a larger degree than they may have in absence of a secret informant. Leaders in the first group assignments reported greater participation and interaction among group members than in the prior structured group regime. In the first iteration of group projects, the moles in every group chose

to reveal themselves publicly in class at the end of the project. The class response was enthusiastic, with a buzz about “I knew you were the mole” or “I want to be the mole.”

In the second iteration of assignments, only three of seven group moles revealed themselves in class at the end of the projects. In the second iteration, there were four obvious free riders identified within the groups with the unrevealed moles. The offending students were almost chastised in the mole reports, and by three of the four group leaders in the affected groups. The lack of moles coming forward publicly created an even more intense buzz about the identity of the moles, and why they were not revealing themselves.

In the two iterations of projects following, the free-ridership was virtually eliminated except in two cases (repeat offenders). Their identification was reinforced by their different groups and their evaluation reflected their lack of contribution in the groups. For most other free riders, a single warning was enough to motivate them to change their ways.

Moles, in general, were very good at reporting detailed activities of the group and identifying free rider problems. In only one case, the mole was likely friends with the free rider, but in the leader's reports and the group's evaluation of one another, the free rider was identified in an obvious way. The incident was discussed in class, without identifying the people involved, which seemed to take care of any future repetition of the problem. It also indicated to the mole in question that they had been found out, and no question was ever raised by them concerning their grade, which reflected the lack of reporting the free rider.

Overall, student enthusiasm for the course and for the group study and case content was much greater when the “mole” was introduced into the mix. The link to reality TV popularity probably helped as much as anything, and the heightened interest in the course resulted in generally higher quality work and possible alleviation of the free rider problem.

Conclusion

This particular study is, of course, anecdotal, with little likelihood of any scientific conclusions. The results observed and presented, however, reveal a pattern of behaviors under each of the group strategies. As educators, professors often seek new ways of approaching particular courses, and solutions to some of the problems associated with non-traditional teaching methods.

The feedback from both students taking the course and completing the course, and from professional managers with whom the strategy was shared, has been positive. It would be interesting to see how others might employ the technique, and even refine it further to fit their own students' learning rubric.

1. I would like to give credit to Jeremy Martin, who initially suggested the corporate mole strategy to me in January 2009.

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A Primer on Financial Calculators

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Like it or not, business calculators have become a necessity of every day life for our students. This paper is not meant to condone or condemn the practice of employing calculators to teach a subject (or topic area), but to aid both the teacher and the student in the function and use of financial calculators. The objective of this paper is to test the most popular financial calculators for basic problem solving, accuracy and ease of use. We also present elementary primers to the basic usage of each of the calculators discussed. The primers represent an easy to understand, step by step instruction which could make teaching easier for the instructor and learning easier for the student.

Many business classes use financial calculators as a teaching tool. As a result, faculty members are frequently required to spend classroom time instructing students on the use of their calculators as a prerequisite to employing the calculators for analysis and decision making. Instruction in the use of calculators may be a more formidable task than expected. The enormity of the task is better understood when the number of calculator manufacturers, the number of models and the complexity of operation is taken into consideration. One also has to keep in mind that most calculators require different key strokes to solve identical problems.

Covering calculator functions in class may take time away from other teaching objectives. In order to save time, some professors insist their students become self-taught in the usage of their instrument. Other instructors will state that their students only purchase a specific calculator if they expect to obtain aid in its use from that instructor. As business calculators have become more powerful and more complicated, the learning curve for their usage has increased. This paper compares the use of the most popular financial calculators and includes a one page primer for each calculator model tested. The one page primer can be duplicated and given to students to accelerate their learning curve and increase their understanding.

The authors recognize that most employers require students to have a rudimentary knowledge of calculator usage and that the use of tables to calculate items such as the time value of money may be a thing of the past. Many of the textbooks in finance no longer have financial tables (although all of the textbooks that the authors examined have simplified calculator instruction). The authors of this paper also hold no position on the use of financial calculators in the classroom. This paper is designed to help faculty move more quickly out of calculator functions into more meaningful discussions, and to help students solve basic financial problems using calculators. The one page primers in the appendices of this paper (available at www.jfcr.org) may be printed and distributed by the professor to assist students in understanding the use of their calculators.

The financial calculator has been on the academic scene since the mid-seventies when the early hand held calculators were developed. Since that time there have been many revisions and modifications to the instrument. The early hand held calculators had LED (light emitting diodes) and limited calculating power. They were energy inefficient and not known for long battery life. Today's hand held financial calculators are light years away from the earlier models. Even compared to the calculators of ten years ago, today's calculators are much more sophisticated. This paper compares the most popular financial calculators available today and also provides a one page primer on each to help guide students (and instructors) in the use of the various calculator models. Most of the calculators required different key strokes to solve identical problems. This paper will be of use to those individuals looking for a quick starter for the correct keystrokes needed to solve common financial problems.

THE DIFFERENT CALCULATORS

The calculators chosen for this study represent the most popular models used in finance classes, both undergraduate and graduate. The calculators had to be promoted by their name, or by the manufacturer, as suitable for solving "business and financial" problems. The calculators also had to be available at outlets that students would frequent and were purchased from (or available at) Wal-Mart, Office Depot, K-mart and student and university run book stores. Online sellers were not used.

The calculators used for this paper were all portable hand held models. Some of the calculators were very obvious updates of previous models, that are now more powerful and more energy efficient. There are also the "new" kids on the block (the calculators from new manufacturers that hope to make a dent in the market) and the most recent addition to the calculator families, the graphing calculators. The graphing calculators are easily identifiable by their oversized display screens.

Many of the calculators tested have "sister" models that perform the basic problem solving with the same applicable key stroke. The alternative models are bracketed in the following list. The eight calculators examined in this paper are the Hewlett Packard's HP 10bII Business Calculator, HP 12c Platinum 25th Anniversary Edition Financial Calculator (also the HP 12c Financial Programmable Calculator), HP 17bii+ Financial Business Calculator, the Texas Instrument's BA II Plus Professional (also the BA II Plus), the TI 84 Plus Silver Edition (also the TI 83 and 83 Plus) the Casio fx-9750G PLUS (also the Casio fx-9850G PLUS), the LeWorld Financial Calculator and the Ativa AT 10. The various models vary greatly in price. The most expensive models are the HP12c, the HP17b and the TI 84 Plus Silver editions. Their prices range from \$100 - \$120 depending on the store. In the \$40 - \$60 range, there are the HP 10bII, the Casio fx-9750g, and the TI BAII Plus Professional. The Ativa AT 10 costs around \$20, and the Le World calculator's price is in the \$15 range. The Casio is the least expensive choice for graphing calculators. The Le World business calculator is the least expensive in the financial calculator category. Current textbooks realize that the rapid change in calculator models prohibit them from focusing on a particular model. Most textbooks including Ross, Westerfield, and Jordan; Keown and Martin, Petty and Scott Jr; and Brig-

ham and Houston discuss the general principles of calculator use, but do not provide detailed instructions. These textbooks do have a reference to web sites designed to help students use their calculators better. Unfortunately, to access the materials, students must register with a password available only to new text book buyers. This system locks many students out of the web sites because they purchased a used textbook.

To compare models, similar time value of money problems were calculated using each model. The list of eight problems included a future value of a present amount, a present value of an annuity, finding interest rates, finding the number of periods, bond pricing, cash flow analysis, a yield to maturity, and a loan amortization. On a separate page, beta calculations employing these calculators are also formatted.

Computing the future value of a present amount is the simplest time value calculation. In this case, we examined the effect of investing \$5,000 at an 8% APR for 10 years. Typing 10 into the N button, 8 into the interest rate button, and -5,000 into the present value is similar for all of the calculators except the Ativa AT 10. The Ativa AT 10 does not use negative signs, so the 5,000 is entered as a positive number. Each of the calculators examined was able to compute \$10,794.62 as the future value. While the exact keystrokes differed, all of the models allowed quick data entry and calculation.

To test the present value of an annuity, the authors chose a car loan problem with \$22,000 present value paid over 5 years at an APR of 6% compounded monthly. While all of the calculators examined required data entry including 60 payments, and \$22,000 for the present value, the interest rate could be either 6, or .5 depending on the payment frequency chosen. Entering a payment per year of 12 would mandate that a 6% interest rate is entered. Alternatively, dividing the APR by 12 periods provides a monthly interest rate of .5%. For this article, the authors assumed that the payment per year is always set to 12, and that the annual interest rate is divided by the compounding periods (12). All models found the correct payment of \$425.32 per month, and were relatively simple to use.

A stock price moving from \$25 to \$75 in 10 years implies a compound interest rate of 11.61% per year. This calculation requires a -25 in the present value and 75 as the future value input. With N set to 10, computing the interest rate provides the correct answer for most models. A key step for all calculators except the Ativa AT 10 is to ensure that the signs for the present value and the future value are not identical (one has to be positive and the other negative). Since the Ativa AT 10 uses all positive numbers in its entry, it is incapable of computing the interest rate over an investment horizon, and could not be used to answer the problem.

The last basic time value annuity calculation involved finding how long it takes to grow, or spend, a certain amount of money. Using a retirement example, the calculators computed how long it takes to spend \$500,000 if we make withdrawals of \$65,000 per year, while earning a 7% APR. By entering 500,000 as the present value, -65000 as the payment, and 7 as the interest rate, the calculators computed an N of 11.43 years. The annuity runs out part of the way through the 11th year. The Ativa AT 10 computes 11 years because it rounds to the closest number. This answer is financially incorrect.

Finding the yield on a bond is similar to the interest rate problem. In the example, the authors used an 8 year bond with a 12% semi-annual coupon payment. The price of the bond is \$1,233.05 and the face value is assumed to be \$1,000.

Because payments are semi-annual, the N is set to 16 (8 years x 2 payments per year = 16 periods), and the payment is set to \$60.00 ($\$120/2 = \60.00 semi-annually). After the present and future values are entered, the interest rate is computed to be 4%. Since the payment per year was not used, this answer is a 6 month (semi-annual) interest rate. In order to obtain the annual interest rate the semi-annual interest rate must be multiplied by 2 ($4\% \times 2 = 8\%$ annually). All of the calculators except the Ativa AT 10 were able to compute this answer.

All of the basic time value functions can be easily computed on all of the models examined except the Ativa AT 10. They are comparable in function, ease of use, and accuracy. The only perceived differences are that the HP models use fewer keystrokes, but the Texas Instruments models remember past data so secondary calculations such as changing the interest rate can be more easily and quickly computed. The TI 83 and the Casio fx-9575G have large screens which allow users to see all data entries, and thus reduce the possibility of keying errors.

The uneven cash flow function works very differently in each of the models tested. In the test problem, \$200,000 was invested. A return of \$40,000 was received in the first period. This return then grew by \$10,000 per year, to \$80,000 over the subsequent 5 years. With an discount rate of 10% the calculators computed a payback period of 3.71 years, a net present value (NPV) of \$20,249.49, an internal rate of return (IRR) of 13.45%, and a modified internal rate of return (MIRR) of 12.14. The Ativa AT 10 is not capable of computing uneven cash flow calculations. The Casio fx-9750G enters the cash flows into a list, then uses a menu driven system to calculate all of the results (Note: An incorrect payback period was obtained). The TI 83, 84 and 84 silver models can use a command to calculate the NPV. The cash flows can also be entered into a list feature and referenced in the NPV function. While this method uses the fewest keystrokes to accomplish the result, remembering the order in which to enter the data can be daunting. All of the HP series calculators perform this function similarly. The C_{ff} button on the HP keypad allows the user to enter the cash flows. Typing each cash flow followed by the input button (C_{ff}) enters the data. This was the fastest data entry method for the calculators tested. The calculator does have the drawbacks of not having the ability of allowing the user review the data entered. The HP models do calculate NPR and IRR, but they do not compute the payback, or the MIRR with the push of a single button. The LeWorld and the BAII+ Professional have similar data entry systems. In an uneven cash flow section, cash flows, and the number of consecutive times they appear are entered. With visible cues, data entry is fairly intuitive. Once entered, they can be reviewed for correctness. While both compute the NPV and IRR, only the BAII+ Pro computes the payback and MIRR with the push of a single button.

In the loan amortization test problem, the goal was to find; 1) the interest paid on the loan for a certain period, 2) the principle paid on the loan for a certain period and, 3) the balance of the loan. For the test problem, the authors used a 1 year, \$2,000 loan with a 12% APR, compounded monthly. All of the calculators first required calculating the monthly payments using the standard functions discussed above. Inputting the monthly payment of \$177.70 as the payment, each calculator was able to prepare amortization schedules. All of the calculators except the Ativa AT 10 have functions that allow finding the interest and principal over a series of payments and the bal-

ance at any amortization point. While the ease and logic of the data entry vary by calculator, each model requires several keys to access the answers at each step.

In addition to calculating basic finance functions, the calculators were also examined for their ability to run regressions and compute beta. All of the finance calculators except the Ativa AT 10 can calculate beta. The BA II+, the TI83, 84, the Casio fx9750-G, the HP17b2 and the LeWorld have fairly easy to use menu systems that store the data, and calculate the results. The HP10Bii and the HP 12c manuals are both more complicated and offer little guidance on keystrokes or procedures for finding beta. Finding beta with any calculator is not intuitive and it is strongly recommended that the user have access to an instructional guide.

In summary, each of the calculators examined except the Ativa AT 10 is acceptable for finance classes. The overall lowest cost of any finance calculator is the LeWorld financial calculator. It works in a similarly keystroke fashion to the BAII+. While some offer larger screens and menu driven operation, the basic operation of all of the models the authors examined were similar despite the price differences.

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The one-page handouts for each calculator model are available at www.jfcr.org in the downloads section for JITF.



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