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Updating the 100-Year-Old DuPont Analysis: Using ROME vs. ROE

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The traditional DuPont Analysis, first used almost 100 years back, decomposes Return on Equity (ROE) as a means to explain changes in investor returns. We propose using instead Return on Market Equity (ROME), to incorporate an additional component into the traditional DuPont Analysis—the book-to-market ratio, a proxy for a firm's level of intangible assets which while valued by the market may not appear on corporate balance sheets. We demonstrate that firms' assets are becoming increasing more intangible, and the traditional DuPont Analysis omits this crucial piece of a firm's ability to generate profit. We illustrate how the ROME is a more effective measure of investor returns for a number of firms and industry sectors. This updated DuPont Analysis makes understanding investor returns more meaningful for students in finance and accounting courses, and is more relevant to analysts and investors.
Keywords: *Return on Equity, Book to Market, intangible assets, profitability, accounting*
JEL classification: *G11, G30, G32, M41*

Introduction

Since the 1920s, firms and analysts have been using the DuPont Analysis which decomposes a firm's Return on Equity (ROE) into key components: profit margin measuring profitability, asset turnover assessing operational efficiency, and the equity multiplier indicating financial leverage. However, the U.S. economy has changed tremendously since the industrial 1920s. In the current technological business environment, many firms have more intangible assets which are crucial

to generating sales and profits. The ROE we currently teach in finance classes fails to incorporate these assets which are typically valued in the market, but not on corporate balance sheets. This traditional DuPont Analysis also does not reflect other classroom teaching that finance students should focus on market values versus book values. To correct these issues, we propose using Return on Market Equity (ROME), the ratio of net income to market equity rather than book equity.

ROME explicitly accounts for the valuable intangible assets that add to a firm's bottom line. The traditional DuPont Analysis can easily be extended to the ROME measure by adding a fourth component, a firm's book-to-market ratio. The intuition behind the use of market value of equity in the denominator of the book-to-market ratio is that the market more efficiently incorporates information about a firm's future earnings potential arising due to intangibles that do not necessarily appear on accounting books, such as new patents or approvals for drug firms, the hiring of a top CEO, or a technological advancement. Consequently, the book-to-market ratio is often used in financial literature as a proxy for the growth opportunities of a firm, since it reflects valuable information that may not be incorporated in financial statements.

Our simple, but elegant solution, adds this familiar valuation measure, book-to-market ratio, which we teach in finance and accounting classes and use extensively in research through the Fama-French multifactor models. And, in classroom discussions and conversations with finance and accounting faculty, students and academics overwhelmingly agree that the updated DuPont analysis provides a lot more clarity about actual returns to shareholders.

To fully examine the merits of our new measure, remainder of this paper is set out as follows. First, we discuss the classroom motivation for this paper through a review of the current literature and examples of the limitations of ROE. We then provide a detailed description of the proposed measure decomposed via an updated DuPont Analysis and discuss the importance of the addition of the book-to-market ratio. We also illustrate the differences between ROE and ROME and the importance of this model through illustrations of traditional ROE and the updated ROME measure for a few select firms. Finally we evaluate the differences between ROE and ROME for a variety of industries and over time.

Motivation

ROE and the DuPont analysis has long be taught as a method for analyzing the financial health of a firm and predicting future profitability. The literature acknowledges the limitations of the existing measure of ROE and the current DuPont Analysis in assessing the financial health of a firm and predicting future profitability. Soliman (2004) proposes that, because the DuPont analysis is highly industry dependent, the use of industry-adjusted DuPont analysis is a better

predictor of future firm profitability. Chang, Chichernea, and HassabElnaby (2014) find that the informativeness of the DuPont components about future profitability is reduced in the healthcare setting. One common factor between the Apple example and the healthcare industry is the presence of a large amount of intangible assets which are an important but often undervalued component of the firm in traditional performance measures. Hence Chang, Chichernea, and HassabElnaby (2014) findings provide additional evidence of the need to incorporate intangible assets into performance measures and the DuPont methodology.

Nissim and Penman (2001) examine an alternative return on equity measurement, return on common equity (ROCE) which focuses on a division of line items that distinguishes operating from financial activities. Maji, Mitra, and Sur (2014) propose adding two additional components to the existing DuPont formula to capture the impact of additional firm characteristic important to accountant, namely the interest burden ratio and the tax burden ratio. Zhang (2016) discusses the inability of the DuPont formula to account for firms with negative net financial debt because of the traditional equity multiplier and how a modified DuPont analysis should be used for firms with negative net financial debt.

In addition to academic papers which find a weak link between ROE and current stock prices, the financial media has also noted that ROE is not a good predictor of future stock prices. A 2013 Forbes article identifies that ROE is only a good measure of future profitability for firms in the top and bottom quintiles when firms are sorted by ROE, meaning that for the majority of firms in the middle quintiles, there was no direct correlation between ROE and stock performance[1]. The article elaborates that one of the limitations of ROE is that it lacks comparability across industries, which is why we examine the differences in ROE and the new ROME across industries. A 2010 Harvard Business Review Case also points out the potential pitfalls of ROE noting that companies manipulate accounting values to artificially maintain a healthy ROE and hide performance issues in business fundamentals. The case also identifies a firm can employ leverage and stock buybacks funded through accumulated cash to help to maintain a company's ROE in spite of decreasing operational profitability.[2]

The literature finds intangible assets have been increasing in value and importance when evaluating companies over the last several decades. Lim, Macias, and Moeller (2014) outline the increase in firm's intangible assets and discuss the importance of including these assets in the evaluation of a firm's capital structure. Chan, Lakonsihok, and Sougiannis (2001) find companies with a large amount of intangible assets earn large excess returns. Barth, Kasznik, and McNichols (2001) find that firms with a large amount of intangible assets experience more analyst

[1] https://www.forbes.com/sites/investor/2013/01/18/beware-weak-link-between-return-on-equity-and-high-stock-price-returns/#5f4732496954

[2] https://hbr.org/2010/03/the-best-way-to-measure-compan.html

coverage than other firms. Daniel and Titman (2006) find that future performance of stock returns depends heavily on the "intangible" return component; furthermore they find that the book-to-market ratio forecasts future returns well because it is a good proxy for the intangible return. More recently, Elbannan (2013) highlights the importance of valuing intangible assets as we have seen the rise in their use by firms in recent years; he confirms that analysts continue to have incentive to follow firms with higher intangible assets.

These findings provide ample motivation as to why the book-to-market ratio should be included in the DuPont methodology, and is our proxy for intangible assets. A meaningful DuPont Analysis that hopes to provide analysts and investors with important information about a firm's future performance is thus missing a crucial component for firms with high levels of intangible assets. ROME will also improve classroom outcomes because it is more intuitive to students who have been taught to focus on market versus book values as financial managers and it also provides an outlet to introduce book-to-market and how it can impact the return to investors from a firm's future profit streams. The students will also benefit from a discussion of why book values and market values may be different depending on the industry of the firm.

A recent classroom discussion of the ROE analysis of Apple Inc. (Ticker: AAPL) using the DuPont decomposition methodology reveals some of these limitations. Apple's ROE was calculated at the time at around 45%, but students had to be reminded that ROE rarely represents the actual return to shareholders. ROME, the inverse of the price-to-equity (P/E) ratio at 7% was more in line with market norms for a similar company, indicating the DuPont methodology as currently presented in classes may be either confusing or misleading or has limited application.

Updating the DuPont Methodology: ROME

Analysts and investors look to financial ratios to evaluate the financial health and profitability of firms. Traditionally, ROE is a popular to measure of how well a firm can utilize its investments to generate earnings. The numerator of this ratio contains net income, and the denominator is the book value for stockholders' equity of the firm. However financial textbooks such as Ross, Westerfield, and Jordan (2016) and Brigham and Ehrhardt (2016) emphasize how market values can diverge substantially from book values and stress the importance of market values for financial managers. Specifically, as finance academics and practitioners, we know market value of equity, the product of current market share price and shares outstanding, matters more to investors than accounting book value. Given this knowledge we propose using Return on Market Equity (ROME), which has

the market value of equity in the denominator instead of book value of equity. This ROME measure ties more closely to what we teach in finance classes: that market value matters more than book value.

The traditional DuPont Analysis decomposes ROE into Profit Margin, Asset Turnover and Financial Leverage:

$$\text{ROE} = \frac{\text{Net Income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times \frac{\text{Assets}}{\text{Book equity}} \quad (1)$$

Most past studies by researchers and analysts extend the traditional DuPont Analysis by adding additional ratios to focus on specific areas of company or industry performance. For example, the following five-step extended DuPont version further decomposes Profit Margin into Tax Burden (the ratio of Net Income to Earnings before Taxes), Interest Burden (defined as the ratio of Earning Before Taxes to Earnings before Interest and Taxes), and Operating Income Margin (the ratio of EBIT to Sales):

$$\text{ROE} = \frac{\text{Net Income}}{\text{EBT}} \times \frac{\text{EBT}}{\text{EBIT}} \times \frac{\text{EBIT}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times \frac{\text{Assets}}{\text{Book Equity}} \quad (2)$$

We instead propose extending the ROE definition itself to better reflect the dramatic shifts in the U.S. and global economy from tangible to intangible assets, and instead propose using ROME which indicates actual return to stockholders. The DuPont Analysis can be applied to this new measure by adding the component of the firm's book-to-market ratio.

$$\text{ROME} = \text{ROE} \times \frac{\text{Book Equity}}{\text{Marketing Equity}} = \frac{\text{Net Income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times \frac{\text{Assets}}{\text{Book Equity}} \times \frac{\text{Book Equity}}{\text{Market Equity}} \quad (3)$$

As the decomposition of ROME above shows, this measure highlights that significant differences in returns to stockholders may arise when using the accounting calculation of equity instead of actual market values. For use in classroom teaching, we also provide a graphical representation of our updated DuPont Analysis in Appendix A1.

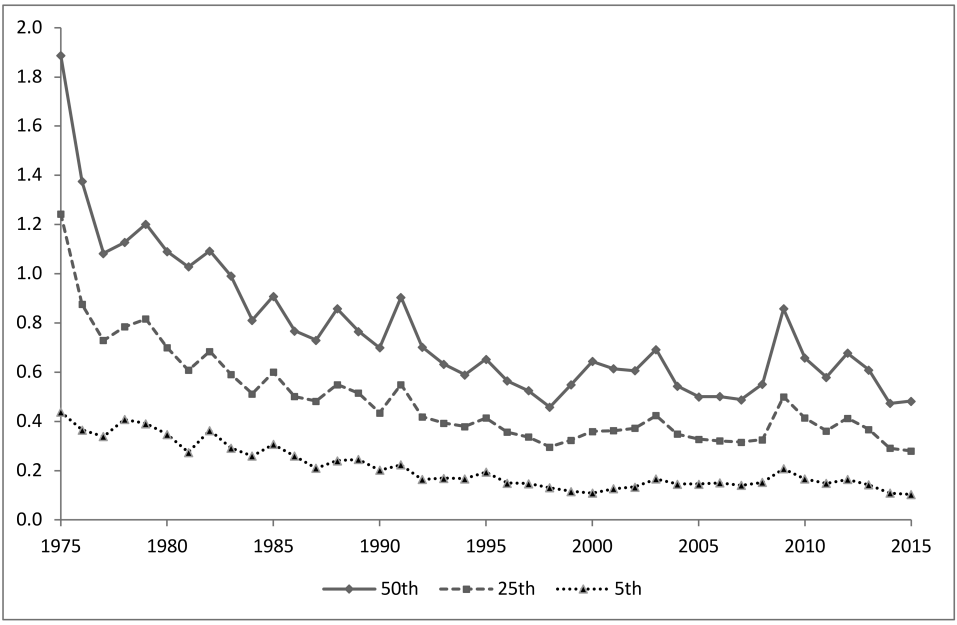
The Book-to-Market Ratio

The book-to-market ratio is often used to proxy for intangible assets and growth opportunities: two things that the market may value differently from accounting statements which can lead to material differences between market values and book values and hence the ratio. A low book-to-market ratio implies a high number of intangible assets and/or growth opportunities. Figure 1 shows that book-to-market ratios for U.S. firms have reduced dramatically over time.

Falato, Kadyrzhanova, and Sim (2014) find that this decrease in book-to-market ratios corresponds with the documented rise in intangible assets. Consequently, we argue that the current DuPont analysis is omitting a very important component of a firm's ability to generate revenues, intangible assets. Even though balance sheets

Figure 1. Book-to-Market Ratio.

Ratios of Book Value of Common Equity (BE) to Market Value of Market Equity (ME) breakpoints are computed at the end of each June. The BE used in June of year t is the book equity for the last fiscal year end in t-1. ME is price times shares outstanding at the end of December of t-1. The breakpoints for year t use all NYSE stocks for which we have ME for December of t-1 and (positive) BE for the last fiscal year end in t-1 Data for the 50th, 25th, and 5th percentile breakpoints presented. All data is obtained from Kenneth French's website.



may not reflect the value, the market recognizes the importance of intangible assets like patents, trademarks, internet domain names, customer lists, software and trade secrets, and incorporates news and information about these intangible assets into the stock's market price in the current increasingly service-oriented economy.

Consider for example a biotech company that decides to increase investments on research and development (R&D) to cultivate new patented drugs, and on advertising and marketing (A&M) to build the brand value of its drugs portfolio. Under US GAAP, net income would be reduced correspondingly, but the company's assets would not reflect the increased value in its drugs portfolio of assets. However, when we use the market value of equity in the denominator to calculate ROME, we reflect more accurately the return to investors on a firm's investments in all assets.

Another reason for the disparity between ROE and actual return to shareholders is the growing use of stock buybacks; stock buybacks reduce book value of common equity which in turn raises ROE for most firms. But, given the accounting treatment of treasury stock, this may dramatically lower the book value

of common equity. For some firms, it may even force the book value of common equity to a negative value.

These issues with calculating a more meaningful return to stockholders are mitigated when using ROME. As Golec and Gupta (2014) show, the market value of common equity should reflect the impact of increased investments in R&D or A&M through an implicit increase in the value of the company's drug portfolio or increased brand value creation efforts. Also, the market value of common equity immediately accounts for the common shares outstanding after a stock buyback, providing a more meaningful number for stockholder investment.

Illustration of the New ROME

The issues with a traditional DuPont Analysis, and using ROE to screen for stocks, are apparent when looking at even large companies such as Wal-Mart, Apple, Pfizer, Citigroup, and Chevron. In Table 1, we present a comparison of ROME and ROE for these firms.

Table 1. ROME versus ROE for some select firms.

Return on Market Equity (ROME) is defined as the ratio of Net Income from Continuing Operations to Market Value of Common Equity, Return on Equity (ROE) is defined as the ratio of Net Income from Continuing Operations to Average Total Common Equity, and Book-to-Market (B/M) is the ratio of Average Total Common Equity and Market Value of Common Equity. Data is obtained from FactSet. All data are for the fiscal year ended December 2015.

	ROME =	ROE x	B/M
Apple (Ticker: AAPL)	**7.96%**	46.25%	0.172
Chevron (Ticker: CVX)	**2.69%**	2.98%	0.901
Citigroup (Ticker: C)	**10.53%**	7.90%	1.333
Pfizer (Ticker: PFE)	**3.32%**	10.22%	0.325
Wal-Mart (Ticker: WMT)	**6.95%**	18.15%	0.383

For firms with low book-to-market ratios such as Wal-Mart, Apple, and Pfizer, though ROE is high, the actual return to stockholders is dramatically lower. These firms each have at least one prominent source of intangible assets. Walmart has a large amount of A&M which has created and maintained brand loyalty; Apple has a vast portfolio of intangible assets spanning patents, software, intellectual capital, among others; and Pfizer is a classic example from the healthcare industry that has high intangibles throughout the R&D pipeline. For Citigroup on the other hand, actual return to shareholders is higher than ROE indicates. Citigroup is one of an increasingly small number of firms in the US stock market which has a high book-to-market ratio. This high book-to-market is not just evidence of a low amount of intangibles, but also reflects the delayed accounting recognition of bad assets,

the negative investor sentiment for banking stocks following the financial crisis, and various other accounting differences for financial firms. Chevron shareholder actual returns, measured by ROME, are about the same as indicated by ROE, which would be the case for all firms whose book-to-market ratios hovers around one.

We also examine the impact of the use of ROME versus ROE for all industry sectors. First in Table 2, we compute the average ROE and DuPont components for each industry sector and rank them by ROE for year-end 2015 with data obtained from FactSet. This initial screen of sectors reveals that Transportation, Consumer Non-Durables, Electronic Technology, and Retail Trade would be the highest ranked sectors and most desirable for investment.

Table 2. DuPont Analysis of The Traditional ROE.

Return on Equity (ROE) is defined as the ratio of Net Income from Continuing Operations to Average Total Common Equity, Profit Margin (PM) is the ratio of Net Income from Continuing Operations to Sales, Asset Turnover (TATO) is the ratio of Sales to Average Total Assets, and Equity Multiplier (EM) is the ratio of Average Total Assets to Average Total Common Equity. Data is obtained for all industry sectors listed in FactSet. All ratios are for North America for the year ended December 2015.

	Rank	ROE =	PM x	TATO x	EM
Transportation	1	**25.88%**	10.28%	0.74	3.415
Consumer Non-Durables	2	**23.32%**	11.68%	0.70	2.862
Electronic Technology	3	**20.96%**	11.77%	0.73	2.434
Retail Trade	4	**20.10%**	3.49%	1.89	3.055
Process Industries	5	**18.99%**	6.91%	0.89	3.082
Consumer Services	6	**18.98%**	10.23%	0.55	3.377
Consumer Durables	7	**17.81%**	5.58%	0.75	4.271
Technology & Health Services	8	**16.66%**	13.25%	0.56	2.242
Commercial & Distribution Services	9	**14.62%**	5.96%	0.79	3.105
Health Technology	10	**13.81%**	16.31%	0.37	2.290
Producer Manufacturing	11	**12.21%**	6.69%	0.57	3.180
Utilities	12	**9.10%**	9.27%	0.27	3.640
Finance	13	**9.05%**	13.51%	0.07	9.628
Communications	14	**8.76%**	4.33%	0.44	4.612
Industrial Services	15	**7.52%**	5.04%	0.55	2.724
Energy Minerals	16	**3.98%**	3.27%	0.57	2.149
Non-Energy Minerals	17	**1.47%**	1.44%	0.47	2.192

Table 3 ranks the sector industries based on the ROME factor. As with Table 2, components of the DuPont Analysis are included along with the addition of book-to-market. While Transportation and Electronic Technology remain in the

top quartile of sectors, Consumer Non-Durable and Retail Trade have dropped out to be replaced by Finance and Consumer Durables. It is important to highlight here that the ROME rankings in Table 3, are not merely a re-ranking of firms by book-to-market. The table also highlights that the book-to-market ratio does not solely drive these rankings; similar to a traditional DuPont analysis, it is the combination of the various components. For example, the Finance sector ranked #3 has one of the highest book-to-market ratios while the Electronic Technology sector at #4 has one of the lowest ratios; Non-Energy Minerals with the highest book-to-market ratio is at the bottom of the rankings, while Transportation with a very low book-to-market ratios is at the top. Also, the ROME measure narrows the return spread across industries; the range of the ROME measures is 7.03%, while the range of the ROE measures was 24.41%.

Table 3. DuPont Analysis of the New ROME.

Return on Market Equity (ROME) is defined as the ratio of Net Income from Continuing Operations to Market Value of Common Equity, Profit Margin (PM) is the ratio of Net Income from Continuing Operations to Sales, Asset Turnover (TATO) is the ratio of Sales to Average Total Assets, Equity Multiplier (EM) is the ratio of Average Total Assets to Average Total Common Equity, and Book to Market (B/M) is the ratio of Average Total Common Equity and Market Value of Common Equity. Data is obtained for all industry sectors listed in FactSet. All ratios are for North America for the year ended December 2015.

	Rank	ROME =	PM x	TATO x	EM x	B/M
Transportation	1	**8.46%**	10.28%	0.74	3.415	0.327
Consumer Durables	2	**6.82%**	5.58%	0.75	4.271	0.383
Finance	3	**6.65%**	13.51%	0.07	9.628	0.735
Electronic Technology	4	**6.59%**	11.77%	0.73	2.434	0.314
Process Industries	5	**6.27%**	6.91%	0.89	3.082	0.330
Utilities	6	**5.55%**	9.27%	0.27	3.640	0.610
Producer Manufacturing	7	**5.53%**	6.69%	0.57	3.180	0.452
Industrial Services	8	**4.91%**	5.04%	0.55	2.724	0.654
Consumer Non-Durables	9	**4.91%**	11.68%	0.70	2.862	0.211
Consumer Services	10	**4.85%**	10.23%	0.55	3.377	0.256
Retail Trade	11	**4.39%**	3.49%	1.89	3.055	0.218
Commercial & Distribution Services	12	**3.83%**	5.96%	0.79	3.105	0.262
Technology & Health Services	13	**3.47%**	13.25%	0.56	2.242	0.208
Communications	14	**3.38%**	4.33%	0.44	4.612	0.386
Health Technology	15	**3.36%**	16.31%	0.37	2.290	0.243
Energy Minerals	16	**2.90%**	3.27%	0.57	2.149	0.730
Non-Energy Minerals	17	**1.43%**	1.44%	0.47	2.192	0.971

Table 4 summarizes the change in ranking from ROE to ROME in the rank change column. Consumer Durables moved up five positions from being in a middle quartile to the top, and the Finance sector increased ten spots in the rankings

Table 4. Industry Sector Rank Changes for ROME versus ROE.

Return on Market Equity (ROME) is defined as the ratio of Net Income from Continuing Operations to Market Value of Common Equity, and Return on Equity (ROE) is defined as the ratio of Net Income from Continuing Operations to Average Total Common Equity. Rank Change is difference in industry sector rank using ROME versus ROE. Data is obtained for all industry sectors listed in FactSet. All ratios are for North America for the year ended December 2015.

	Rank Change	ROME Rank	ROE Rank
Transportation	**0**	1	1
Consumer Durables	**5**	2	7
Finance	**10**	3	13
Electronic Technology	**-1**	4	3
Process Industries	**0**	5	5
Utilities	**6**	6	12
Producer Manufacturing	**4**	7	11
Industrial Services	**7**	8	15
Consumer Non-Durables	**-7**	9	2
Consumer Services	**-4**	10	6
Retail Trade	**-7**	11	4
Commercial & Distribution Services	**-3**	12	9
Technology & Health Services	**-5**	13	8
Communications	**0**	14	14
Health Technology	**-5**	15	10
Energy Minerals	**0**	16	16
Non-Energy Minerals	**0**	17	17

from the bottom quartile to the top; other sectors such as Transportation, Electronic Technology, Communications and Energy, experience minimal movement.

The ROME measure tends to improve the ranking of more tangible industries like Producer Manufacturing, Utilities, and Industrial Services while depressing the ranking of the industries that have more intangible assets. This highlights that ROME more accurately reflects investors' returns today but, similar to its reciprocal the P/E ratio, also captures the potential for future growth opportunities or potential over-valuation.

In Table 5, we compare ROME versus ROE in 1975 and 2015 to explore the impact of changes in book-to-market ratios over time across different industries. Since FactSet provides limited historical data, we used data from the CRSP and Compustat databases. Consequently, we used 4-digit GICS codes to group industry sectors (FactSet uses a proprietary industry classification method). While, on average for all industries, ROE has decreased a little over time (from 11.18%

Table 5. ROME versus ROE in 2015 compared to 1975.

Return on Market Equity (ROME) is defined as the ratio of Net Income from Continuing Operations to Market Value of Common Equity, Return on Equity (ROE) is defined as the ratio of Net Income from Continuing Operations to Average Total Common Equity, and Book-to-Market (B/M) is the ratio of Average Total Common Equity and Market Value of Common Equity. Return Gap is the difference between ROME and ROE. Data is obtained for all firms available in the CRSP and Compustat databases; industry sector groups are created using 4-digit GICS codes. All data are for the year ended December 2015 and December 1975.

	Rank	ROME =	ROE x	B/M	Return Gap
Panel A: 2015					
Financials	1	7.62%	8.52%	0.90	-0.89%
Telecom	2	5.98%	12.26%	0.49	-6.28%
Industrials	3	5.15%	15.42%	0.33	-10.27%
Consumer Discretionary	4	4.40%	15.03%	0.29	-10.62%
Information Technology	5	4.27%	16.10%	0.27	-11.83%
Consumer Staples	6	4.09%	17.57%	0.23	-13.48%
Healthcare	7	3.69%	14.87%	0.25	-11.18%
Utilities	8	3.48%	4.75%	0.73	-1.26%
Real Estate	9	3.05%	6.55%	0.47	-3.50%
Materials	10	-0.76%	-1.33%	0.57	0.57%
Energy	11	-6.19%	-7.22%	0.86	1.03%
Average		**3.16%**	**9.32%**	**0.49**	-6.16%
Panel B: 1975					
Utilities	1	15.08%	10.04%	1.50	5.04%
Energy	2	12.97%	13.08%	0.99	-0.11%
Financials	3	12.18%	10.88%	1.12	1.31%
Telecom	4	11.02%	9.48%	1.16	1.54%
Materials	5	9.58%	10.81%	0.89	-1.23%
Industrials	6	8.71%	9.11%	0.96	-0.40%
Consumer Staples	7	8.60%	14.25%	0.60	-5.64%
Consumer Discretionary	8	7.40%	8.82%	0.84	-1.42%
Healthcare	9	6.14%	13.24%	0.46	-7.10%
Information Technology	10	5.43%	13.67%	0.40	-8.23%
Real Estate	11	4.44%	9.62%	0.46	-5.19%
Average		**9.23%**	**11.18%**	**0.85**	-1.95%

in 1975 to 9.32% in 2015), ROME is dramatically lower from 92.23% in 1975 to 3.16% in 2015. This is driven primarily by the drop in the book-to-market ratio from 0.85 to 0.49. While the ranking again highlighted dramatic changes in industry profitability, we also examined the gap between ROME and ROE over

time. This gap widened significantly for 8 of 11 sectors except the ones that made significant losses and/or took large asset write-downs after the financial crisis of 2007-2009 (Energy, Materials, Real Estate, and to some extent Financials). These financial statement impacts lowered book values dramatically and increased ROE; market values did not drop as much, so ROME was impacted less.

Application in the Classroom

We believe using ROME as the starting point for students understanding financial ratios through the DuPont analysis is optimal. We propose that faculty begin with the traditional DuPont decomposition of ROE and have the students complete them for a series of firms similar to those in Table 1 that have different book-to-market ratios due to a variety of intangible asset characteristics. Then ask the students if the predicted ROEs and DuPont analysis make sense for the firms they are evaluating. It is likely the students will disagree about the relative value of firms, particularly within the financial industry. Then replace the denominator in ROE with market value of equity; to balance out the equation, the book-to-market ratio is added at the end of the traditional DuPont decomposition. It is likely students will overwhelmingly agree that this update provides a lot more clarity about actual returns to shareholders, and also reflects another class of ratios that they examine, namely market value or market perception ratios such as the price-to-earnings ratio, the market-to-book ratio etc.

The authors of this paper performed this exercise in multiple classes over the past two years. Students have overwhelmingly agreed that the ROME ratio and subsequent DuPont decomposition makes more sense to them, and is more consistent with what they learn in other classes. These classroom discussions led to conversations with other finance and accounting faculty members, most of whom readily admitted to dealing with similar issues in classes that were never ever fully resolved. Consequently, we decided to present this paper to highlight a common pedagogical issue, and to propose a simple, but elegant, solution.

Conclusion

We demonstrate that over the past forty years, book values of equity have diverged significantly from market values of equity, making ROE a less meaningful measure of investor returns. This divergence has been largely driven by an increase in intangible assets within firms. The corresponding traditional DuPont Analysis is then less valuable, particularly for industries that have higher levels of intangible assets. We instead propose using ROME which uses market value of equity in the denominator and aligns with other finance class teaching to focus on market values rather than book values. We essentially update the traditional DuPont Analysis by

adding the component of book-to-market ratio to the decomposition, which better captures shareholder returns, and still retains the benefits of a traditional DuPont Analysis.

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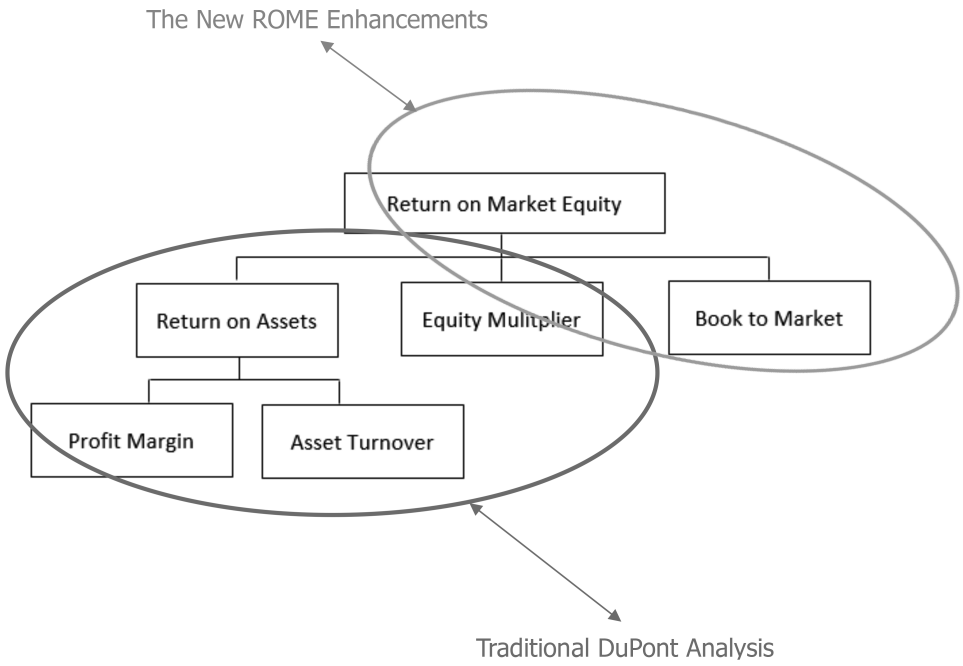
Appendix A1. DuPont Decomposition of the New ROME



Structured Notes: An Application of the Binomial Option Pricing Model

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We use structured notes with their embedded options in an undergraduate or masters level derivatives course to allow students to apply option pricing theory to publicly available data. We focus on equity-linked securities because of the straightforward nature by which embedded options can be valued using the binomial option pricing model (BOPM). A description of structured notes is followed by learning objectives and an outline of the assignment. Teaching notes that include a tutorial on the binomial option pricing model and an excel-based solution to the project are available upon request.
JEL Keywords: *Binomial option pricing model, embedded option, structured product, equity-linked notes*

Introduction

Finance students agree that the derivatives course is among the most rigorous in the finance curriculum, partly because the financial products are completely unfamiliar. While students are often intrigued by the intuition associated with option contracts, they find the mathematics of option pricing models difficult to grasp. Difficult or not, options cannot be avoided. Contingent claims are widely available in the form of exchange-traded or over-the-counter option contracts as well as embedded options in bond markets or as employee stock options. Naturally, students will encounter option markets upon their entry into the 'real world' and will therefore benefit from the ability to identify and price an option contract using real-world data.

We use structured notes with embedded options in an undergraduate or masters level derivatives course to allow students the opportunity to apply option pricing

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theory to publicly available data. We begin option pricing with a presentation of the binomial option pricing model introduced by Cox, Ross, and Rubenstein (1979). This model can be estimated using a simple computer spreadsheet and, upon completion of the project, students can easily transition to the Black Scholes (1973) and Merton (1973) model.

The value of project-based or problem-based learning is well documented (see Blumenfield et. al. 1991, among others) with one of the goals being to encourage student internal motivation. According to Hmelo-Silver (2004), "To be intrinsically motivating, problems should provide students with the proximal and tangible goal of applying their knowledge to solve a concrete problem" (p. 241). In financial education, several pedagogical papers suggest active learning techniques to clarify option pricing in the classroom. For example, Grant, Vora, and Weeks (1995) use Monte Carlo simulation to model the Black-Scholes model, while Arnold, Nixon, and Shockley (2003) create excel tables to make the Black-Scholes model more intuitive for students.

The introduction of structured products provides us with a sufficiently complex but easily digested hybrid security to use for an option pricing project. Structured notes are bonds issued by well-known banks. These bonds have one or more embedded options as part of the bond indenture, and in most cases, the underlying asset on the options is not the issuer of the bonds. In the case of equity-linked securities, the investor is long a bond issued by an investment bank and simultaneously is long and/or short a combination of one or more call or put options on some underlying shares of equity or on a stock index.

This paper presents a class project to be used in the derivatives course with upper level undergraduate students or MBA students. We focus on the equity-linked securities because of the straightforward nature by which the embedded option can be valued using the Binomial Option Pricing Model. The paper proceeds with a description of structured notes followed by the learning objectives and an outline of the assignment. Teaching notes that include a tutorial on the binomial option pricing model and an excel-based solution to the pricing model are available upon request.

Structured Notes

Structured notes are securities consisting of two or more component assets, often including a straight bond and a combination of derivatives (Wallmeier, 2011). Originally designed for retail investors, these securities have been sold by investment banks to both retail and institutional clients since the 1980s. Though the derivatives can be written on any type of underlying asset—commodities, interest rates, credit, or equities—equity-linked notes (ELNs) are popular among retail investors. In 2016, over $1.6 billion of global equity or index-linked structured

notes were issued, of which $34 million were registered with the SEC. Table 1 shows the trend in issuance since the data were tracked by Bloomberg.

Table 1: Equity/Index-Linked Structured Note Total Volume (in USD millions).

Year	Global ELN	SEC-Registered ELN
2016	1,622.83	34.01
2015	4,080.74	36.86
2014	9,983.13	23.73
2013	6,953.11	20.59
2012	2,289.33	19.21
2011	4,439.43	22.32
2010	6,263.54	19.85
2009	4,972.44	4.11
2008	35,762.13	-
2007	48,660.38	-
2006	19,343.16	-
2005	9,662.51	-
2004	4,823.20	-
2003	6,448.12	-
2002	504.03	-
2001	238.24	-
2000	221.03	-
1999	927.99	-

Source: Bloomberg

Structured notes serve an important market completion function. Stoimenov and Wilkens (2005) identify several benefits of structured notes, including:

1. Access to complex investment strategies that otherwise would not be available to retail investors,
2. Transaction costs that are lower than the sum of transaction costs for individual component securities, and
3. Option expirations that extend for several years, which is significantly longer than would be available on exchange-traded options.

Because of the variety of underlying assets and embedded options available on structured notes, no standard taxonomy exists. The notes are given unique names by the issuing banks, and comparing securities offered by different banks is not straightforward. Siera-Yanez (2013) describes three categories of structured notes based on FINRA documentation:

1. Capital/principal guaranteed products: offer partial or full principal protection but no income guarantee
2. Yield enhancement products: offer high yields but no principal guarantees
3. Participation products: offer potential high returns with some principal protection but no coupon payments.

Stoimenov and Wilkens (2005) classify equity-linked notes in Germany based on whether their embedded options are "plain-vanilla" or "exotic." An ELN with a classic plain-vanilla embedded option can be decomposed into a long bond position and a short put on shares of equity or on an equity index. More complex plain-vanilla embedded options can include call spreads (i.e. long a call with a lower strike price and short a call with a higher strike price) and combinations of multiple calls and puts. Exotic embedded options are often barrier options where the underlying asset must trade higher than or lower than a specific threshold before the option can "knock in" or "knock out" of the money.

While structured notes offer several benefits, the complexity of these instruments makes them difficult to value. Consequently, several studies have sought to determine whether structured notes are fairly priced. Benet, Giannetti, and Pissaris (2006) find that the initial coupon rates of their U.S. sample do not reflect the fair value of the embedded options and therefore do not properly compensate investors. In Germany, Stoimenov and Wilkens (2005) find overpricing of ELNs, and Rathberger and Wang (2011) find evidence of significant overpricing in credit-linked notes. Furthermore, Rathberger and Wang's (2011) results suggest that more complex structures are associated with more overpricing. Wallmeier and Diethelm (2009) find overpricing in the market for the highly complex multi-asset barrier reverse convertible securities in Switzerland. They find that the overpricing is positively correlated with the coupon rate, suggesting that investors are willing to pay a premium for a high coupon rate.

Overall, the market for structured notes is active. Investors are attracted to the promised yields and principal protection. However, the complexity of these instruments makes them opaque and subject to overpricing by investment banks. Thus, a class project to identify and value the embedded options in an equity-linked note is relevant and provides students the opportunity to connect option pricing theory with a real-world investment decision.

Project Requirements

The purpose of this project is to decompose an equity-linked note into its components and use the Binomial Option Pricing Model to value the embedded options.

Learning Objectives

By the end of this assignment, students should be able to demonstrate:

1. Information literacy by gathering real world data and transforming raw data into suitable inputs for the binomial option pricing model.
2. Content mastery by creating the lattice of values for the underlying asset as well as the lattices associated with each of the embedded options.
3. Ethical reasoning by determining whether ELNs are suitable investments for retail investors and what due diligence is necessary before such investments are recommended for retail investors.

Index-Linked Note Case Details

The structured note used in this project is the RBC1236 S&P 500 Buffered Protection Securities which is an index-linked note issued by Royal Bank of Canada (RBC) and is described in the pricing supplement found online at https://www.rbccm.com/usstructurednotes. The terms of this equity-linked note are as follows:

- Maturity of 5.5 years
- Reference asset is the S&P 500 Index
- Payout at maturity is based on the following scenarios:

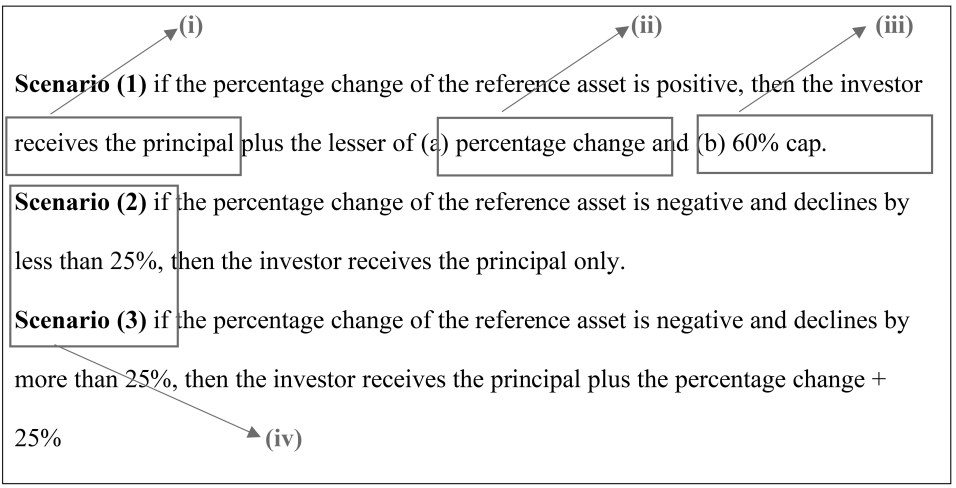
  Scenario (1) if the percentage change of the reference asset is positive, then the investor receives the principal plus the lesser of (a) percentage change and (b) 60% cap.
  Scenario (2) if the percentage change of the reference asset is negative and declines by less than 25%, then the investor receives the principal only.
  Scenario (3) if the percentage change of the reference asset is negative and declines by more than 25%, then the investor receives the principal plus the percentage change + 25%

The case facts are summarized in Figure 1.

Based on Figure 1, the structured note can be decomposed into the following items:

i. Long a zero-coupon bond with a face value of $1,000 that matures in 5.5 years

Figure 1: Embedded Options in RBC1236 Buffered Protection Security.



ii. Long a call with a strike price at the 0% return level (i.e. Scenario 1(a) above where the investor receives the percent change in the index multiplied by the principal value)
iii. Short a call with a strike price at the 60% return level
iv. Short a put with a strike price at the –25% return level

Students will likely need assistance decomposing the individual options in the scenarios above. First, the investor is long a zero-coupon bond with a face value of $1,000 that matures in 5.5 years. Scenario 1 corresponds to a bull call spread, which can be further decomposed into a long call with a strike price at the initial value of the S&P 500 index and a short call with a strike price at the 60% return level. Scenario 3 corresponds to a short put with a strike price at the –25% return level.

Project Instructions

1. Read this summary of RBC Structured Notes http://www.rbcnotes.com/content.aspx?key=4 as well as the details of the ELN in Appendix A.
2. Find the yield-to-maturity on the 6-month U.S. Treasury Bill to use as the risk free rate from Bloomberg.com, Yahoo Finance, or other source.
3. Prepare the inputs for the binomial model:
    a. Go to Yahoo Finance and download at least 2 years of weekly adjusted closing prices for the underlying asset PRIOR to the issue date of the note.

b. Convert the adjusted closing prices into WEEKLY RETURNS where return (R) is the percentage change in the price from one week to the next. $R = \frac{S_t - S_{t-1}}{S_{t-1}}$

c. Use excel to calculate the standard deviation of the returns using the Excel function =STDEV( )

d. Convert weekly standard deviation into an ANNUAL standard deviation using the following formula

$$\sigma_A = \sigma_W \sqrt{52}$$

Where σ_A is the annual standard deviation and
σ_W is the weekly standard deviation you calculated above

e. Assume that T = 5.5 years and n = 11 (i.e. 5.5 years to expiration and semi-annual nodes for a total of 11 nodes) and calculate the up factor (U) and down factor (D) where

$$U = e^{\sigma_A \sqrt{T/n}} \text{ and } D = \frac{1}{U}.$$

4. Create the lattice for the underlying asset
   b. Use Yahoo Finance to identify the starting value of the underlying asset
   c. Calculate each node using the U and D factors to create the full tree
4. Using the BOPM, calculate the values of each embedded option separately. Identify whether each option is long or short. What is the net value to the investor in this equity linked note?
5. Read the SEC and FINRA Investor Alerts below and any additional articles you may find at www.wsj.com or www.bloomberg.com that discuss suitability of ELNs for individual investors. Based on your analysis, what are the benefits and risks associated with this investment? Discuss whether ELNs and other structured notes are suitable for the individual investor.
   - http://www.sec.gov/investor/alerts/structurednotes.htm
   - http://www.finra.org/investors/alerts/reverse-convertibles-complex-investment-vehicles
   - https://www.investor.gov/news-alerts/investor-bulletins/investor-bulletin-structured-notes

Assessment

The rubric below is presented as an assessment tool for instructors to determine whether students achieved the learning objectives listed above.

Learning objective	Does not meet expectations	Meets expectations	Exceeds expectations
Information Literacy	• Missing data • Incorrect formulas	• Gathers correct data • Some hand calculations	• Correct data that is presented in clearly labeled tables • All formulas correct in Excel
Content Mastery	• Missing two or more components of the ELN • Significant errors in inputs or construction of binomial tree	• Missing one embedded option • Minor errors in inputs or construction of binomial tree	• Correctly identifies all individual options • No errors in inputs or construction of binomial tree
Ethical reasoning	Does not recognize ethical dimensions related to suitability and due diligence	Identifies ethical dimensions related to suitability and due diligence	Identifies ethical dimensions and discusses broader implications for financial markets and public policy.

Conclusions

If the inputs used throughout the analysis are correct, and if we assume that an 11-period model is reliable, then the results suggest that the structured note was overpriced. Investors would have paid 100 percent of par value for an instrument that was worth about 97 percent of par value when we sum the value of the zero-coupon bond, the long call, the short call, and the short put. Of course, the results should be taken with caution. A more robust analysis should consider more than 11 periods in the binomial tree, and should include more refined estimates of volatility, the risk-free rate, and the corporate bond yield to maturity.

From this analysis, students can draw their own ethical conclusions, taking into account the readings that discuss the complexity of such instruments. In our experience, student conclusions are mixed. Some find that structured notes are suitable because they grant investors exposure to equity markets with the protection of the 25% downside buffer. Others conclude that the investments are overly complex and opaque, and therefore are not suitable for retail investors.

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Sustainable versus Unsustainable Operating Cash Flows in UCA Cash Flow Analysis

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Previous research argues for the superiority of the Uniform Credit Analysis (UCA) Cash Flow Statement for commercial credit analysis. This study "drills down" into UCA operating cash flow to determine how much of a firm's cash after operations can be viewed as sustainable, i.e., driven by revenue growth, versus unsustainable, driven by changes in operating efficiency and working capital efficiency collectively termed "managerial efficiency." By analyzing these cash flow drivers, we provide a more complete picture of the firm's operating cash flow. Specifically, we identify any distortions in the firm's operating cash flow due to changes in managerial efficiency. This, in turn, allows us to isolate sustainable cash after operations, thereby enhancing cash flow trend analysis for commercial credit assessment. Finally, we recommend that banking and finance textbooks augment their discussions of financial statement analysis by addressing sustainable versus unsustainable operating cash flows in the context of UCA cash flow analysis.
Keywords: *financial statement analysis, operating cash flow, UCA cash flow analysis, sustainable vs unsustainable cash flow, commercial credit analysis*

Introduction

In a recent study Beach et al. (2017) compare the FASB 95 and Uniform Credit Analysis (UCA) cash flow statements and discuss the benefits of the UCA format for commercial credit analysis. Using financial data for 2014-15 from a fictional firm, Gulf States Distributors, Inc. (GSDI), the authors present the FASB 95 and UCA cash flow statements in a side-by-side format and argue for the superiority of the UCA cash flow statement for credit analysis.

Note: The authors thank Blake Butz for excellent research assistance.

The current study augments the UCA cash flow analysis of GSDI by adding another year (2016) of financial data and "drilling down" into the firm's operating cash flow, termed "cash after operations" in the UCA cash flow statement. Beach et al. (2017) presents GSDI financial data for only two years, 2014 and 2015. However, because of certain similarities in the operating cash flow data for these two years, data for a third year, 2016, showing a different cash flow scenario, is added in this study to provide a contrasting analysis of operating cash flows between 2014-15 and 2016. While GSDI consistently generated a positive cash after operations over the entire 2014-16 period, the question remains as to how much of GSDI's operating cash flow can be viewed as sustainable versus unsustainable. In other words, how much of GSDI's operating cash flow can be viewed as potentially growing without limit in the future (sustainable), and how much is effectively limited in the future (unsustainable)? Identifying the sustainable and unsustainable operating cash flows is particularly important in commercial credit analysis to assess a borrower's ability to repay debt.

To address the issue of cash flow sustainability/unsustainability we draw on the work of Mulford & Comiskey (2005), which defines 1) sustainable operating cash flow as cash flow driven by revenue growth and 2) unsustainable cash flow as cash flow driven by changes in operating efficiency and working capital efficiency, hereinafter lumped together as "managerial efficiency." Note that this does not mean that all of a firm's operating cash flow is either sustainable or unsustainable. In any given year a firm may record neither growth in sales revenue nor changes in managerial efficiency, in which case it will still generate operating cash flow equal to the prior year's gross profit (defined as sales revenue minus cost of goods sold) minus operating expenses net of any depreciation expense, termed "operating cushion" in Mulford & Comiskey (2005). However, with sales growth and/or changes in managerial efficiency, operating cash flow may be greater or less than the prior year's operating cushion. As such, the sustainable and unsustainable effects are essentially incremental effects on a firm's operating cushion for the year. Thus, it is important to identify these two effects to appreciate fully a firm's cash after operations along with the residual cash flows after subtracting each of the remaining disbursements in the UCA cash flow statement. (Note that Mulford & Comiskey (2005) do not use the terms "operating efficiency" and "working capital efficiency." Rather, they use the terms "profitability" and "efficiency," respectively. However, from an economics and finance perspective the terms "operating efficiency" and "working capital efficiency" more accurately capture the two dimensions of firm performance. Lumping them together as "managerial efficiency" simplifies the wording and recognizes that both dimensions of efficiency are, at least to some extent, under the control of the firm's management.)

Much has been written in the academic literature about a firm's cash flow, of which cash flow from operations is a major component. Thus, in the next section we examine the cash flow literature as a backdrop for an expanded discussion in the

third section of the operating cash flow impacts of revenue growth and changes in managerial efficiency, termed "cash flow drivers" in Mulford & Comiskey (2005). Specifically, in the third section we explain how to calculate the operating cash flow generated by revenue growth (sustainable) and changes in managerial efficiency (unsustainable) in any given year. Continuing the discussion in the fourth section, we provide a fictional scenario to accompany the added 2016 financial data for GSDI. The fifth section then presents an analysis of the cash flow drivers as applied to GSDI for each of the three years, 2014-16, including a discussion of the trend in sustainable operating cash flow for purposes of credit analysis. The last section is a summary and conclusion, including a suggestion for addressing sustainable versus unsustainable operating cash flows in banking and finance textbook discussions of financial statement analysis.

Annual financial data for GSDI are presented side-by-side in Table 1 (balance sheets for year-end 2013-16), Table 2 (income statements for 2013-16), and Table 3 (UCA cash flow statements for 2014-16). Data for 2013-15 are taken from Beach et al. (2017) while data for 2016 are newly constructed for this study.

Cash Flow Literature Review

Over the years numerous scholars in finance and accounting have written about a firm's cash flow. Their work can generally be divided into four related themes: 1) using cash flow data along with other firm-specific information to assess a firm's financial strength and performance, 2) valuing a firm or a project based on its discounted cash flows, 3) uncovering "creative" cash flow reporting designed to mislead investors as to the true financial condition of a firm, and 4) forecasting future cash flows of a firm for credit analysis and/or discounted cash flow valuation.

Recent studies focusing on the usefulness of cash flow information to assess a firm's financial strength and performance can, in turn, be divided into two veins of inquiry. One vein explores the use of alternative cash flow measures to assess a firm's current financial performance; see, for example, Arinovic-Barac (2011) and Brown & Christensen (2014). The second vein of study, including Gahlon & Vigeland (1988), Foster & Ward (1997), and Mazouz et al. (2012) focuses on using cash flow information to predict future firm performance including bankruptcy. Linked to this work is Harjoto & Turetsky (2006), which ties the probability of acquisition of an IPO to a cash flow measure of IPO managerial inefficiency.

The second theme of cash flow studies looks at the discounted cash flow (DCF) method for valuing a firm or project. Studies that focus solely on the DCF method include Carmichael & Balabat (2008), Simona et al. (2013), Conn (2013), and Gajek & Kucinski (2017). Other studies compare the DCF method and alternative valuation approaches, including Pettway & Blogett (1980), Hamadi & Hamadeh (2012), Jeletic (2012), Bilych (2013), Pivoriene (2017), and Stancu et al. (2017).

Table 1

Gulf States Distributors, Inc.

Balance Sheets

As of December 31

($ in thousands)

	2013	2014	2015	2016
Assets				
Cash & Marketable Securities	21,000	22,080	15,605	17,144
Accounts Receivable (net)	42,000	39,000	51,000	58,000
Inventory	71,657	94,373	117,459	121,125
Prepaid Expenses	1,200	1,100	2,000	1,500
Total Current Assets	135,857	156,553	186,064	197,769
Gross Fixed Assets	650,000	666,380	724,980	745,230
Less: Accumulated Depreciation	(364,000)	(394,000)	(434,000)	(477,750)
Net Plant and Equipment	286,000	272,380	290,980	267,480
Other Assets	0	18	54	15
Total Assets	421,857	428,951	477,098	465,264
Liabilities				
Accounts Payable	48,000	54,500	52,400	58,250
Accrued Wages/Salaries	0	2,500	3,125	3,720
Notes Payable	9,500	6,000	34,000	18,000
Current Maturities of Long-Term Debt	20,657	21,822	23,053	24,051
Federal Income Taxes Payable	0	4,760	4,960	5,921
Total Current Liabilities	78,157	89,582	117,538	109,942
Long-Term Debt	171,500	150,843	143,022	119,969
Total Liabilities	249,657	240,425	260,560	229,911
Stockholders' Equity				
Common Stock & Paid-In Capital	22,200	22,200	34,500	34,500
Retained Earnings	150,000	166,326	182,038	200,853
Total Stockholders' Equity	172,200	188,526	216,538	235,353
Total Liabilities and Stockholders' Equity	421,857	428,951	477,098	465,264

Table 2.

Gulf States Distributors, Inc.

Income Statements

($ in thousands)

	2013	2014	2015	2016
Sales	575,000	600,000	650,000	710,000
Cost of Goods Sold	(440,000)	(460,000)	(487,500)	(524,000)
Gross Income	135,000	140,000	162,500	186,000
Operating Expenses				
Selling, General and Administrative	(21,648)	(18,480)	(24,650)	(28,532)
Lease Expense	(5,750)	(6,000)	(6,500)	(6,500)
Officer Salaries	(3,300)	(2,520)	(4,350)	(4,850)
Depreciation	(27,500)	(30,000)	(40,000)	(43,750)
Operating Profit	76,802	83,000	87,000	102,368
Interest Income (Expense)	1,500	3,000	2,000	1,250
Earnings Before Interest and Taxes (EBIT)	78,302	86,000	89,000	103,618
Interest Expense	(7,058)	(8,082)	(7,346)	(8,110)
Earnings Before Taxes (EBT)	71,244	77,918	81,654	95,508
Income Taxes	(24,223)	(26,492)	(27,762)	(32,893)
Net Income	47,021	51,426	53,892	62,615
Net Income	47,021	51,426	53,892	62,615
Dividends Paid	(31,622)	(35,100)	(38,180)	(43,800)
Addition to Earnings	15,399	16,326	15,712	18,815
Beginning Retained Earnings	134,601	150,000	166,326	182,038
Addition to Retained Earnings	15,399	16,326	15,712	18,815
Ending Retained Earnings	150,000	166,326	182,038	200,853

Table 3.

Gulf States Distributors, Inc.

UCA Cash Flow Statements

($ in thousands)

	2014	2015	2016
Net Sales	600,000	650,000	710,000
Change in Receivables	3,000	(12,000)	(7,000)

Table 3. (Continued)

($ in thousands)	**2014**	**2015**	**2016**
Cash from Sales	603,000	638,000	703,000
Cost of Goods Sold	(460,000)	(487,500)	(524,000)
Change in Inventory	(22,716)	(23,086)	(3,666)
Change in Accounts Payable	6,500	(2,100)	5,850
Cash Production Costs	(476,216)	(512,686)	(521,816)
CASH FROM TRADING	**126,784**	**125,314**	**181,184**
Selling, General and Administrative Expenses	(18,480)	(24,650)	(28,532)
Other Operating Expenses	(8,520)	(10,850)	(11,350)
Change in Prepaid Expenses	100	(900)	500
Change in Accrued Expenses	2,500	625	595
Change in Other Current Assets & Liabilities	0	0	0
Cash Operating Costs	(24,400)	(35,775)	(38,787)
CASH AFTER OPERATIONS	**102,384**	**89,539**	**142,397**
Other Income (Expense)	3,000	2,000	1,250
Change in Other Liabilities	0	0	0
Income Tax Expense	(26,492)	(27,762)	(32,893)
Change in Deferred Income Taxes	0	0	0
Change in Income Taxes Payable	4,760	200	961
Taxes Paid & Other Income (Expense)	(18,732)	(25,562)	(30,682)
NET CASH AFTER OPERATIONS	**83,652**	**63,977**	**111,715**
Dividends or Owners Withdrawals	(35,100)	(38,180)	(43,800)
Change in Dividends Payable	0	0	0
Interest Expense	(8,082)	(7,346)	(8,110)
Change in Interest Payable	0	0	0
Cash Financing Costs	(43,182)	(45,526)	(51,910)
CASH AFTER FINANCING COSTS	**40,470**	**18,451**	**59,805**
Current Portion Long-Term Debt	(20,657)	(21,822)	(23,053)
CASH AFTER DEBT AMORTIZATION	**19,813**	**(3,371)**	**36,752**
Capital Expenditures	(16,380)	(58,600)	(20,250)
Change in Long-Term Investments	0	0	0

Table 3. (Continued)

($ in thousands)	**2014**	**2015**	**2016**
Change in Intangibles/Other Assets	(18)	(36)	39
Cash Used for Plant & Investment	(16,398)	(58,636)	(20,211)
FINANCING SURPLUS/REQUIREMENT	**3,415**	**(62,007)**	**16,541**
Change in Short-Term Debt	(3,500)	28,000	(16,000)
Change in Long-Term Debt	1,165	15,232	998
Change in Contributed Capital	0	12,300	0
Other Changes in Retained Earnings	0	0	0
Total External Financing	**(2,335)**	**55,532**	**(15,002)**
CHANGE IN CASH & EQUIVALENTS	**1,080**	**(6,475)**	**1,539**

The third theme focuses on cash flow management, including "creative" cash flow reporting to deceive investors, and the market's reaction to any such management. Studies in this group include Mulford & Comiskey (2002, 2005), Megan et al. (2009), Laura et al. (2011), Dukic & Pavlovic (2014), Lightstone & Wilcox (2014), and Arsenijevic & Dukic (2017). Related studies by Lee (2012) and Stevanovic et al. (2013) explore the incentives for firms to manipulate their cash flow data.

The fourth theme of cash flow studies centers on forecasting a firm's cash flows; see, for example, Finger (1994), Cheung et al. (1997), Krishnan & Largay III (2000), Hewitt (2009), and Call et al. (2013). A related study by Drougas & Johnson (2004) presents a simulation model for forecasting a firm's financial performance including its cash flows, and a recent study by DeBoeuf et al. (2015) incorporates a statement of cash flows into the pro forma financial forecasting process to estimate a firm's future cash position.

In addition to research studies within these four themes, several recent case studies/classroom exercises deal specifically with a firm's cash flow; see, for example, Tipton & Fletcher, Jr. (2007), Grady (2008), and Trifts & Asare (2015). A related study by Bhandari (2003) explores the pedagogical issues in analyzing the cash flow statement. Additionally, Deo (2012) identifies and examines various analytical tools that define and measure cash flow.

The focus of the current study fits within the first and fourth themes noted above, namely to separate the firm's sustainable and unsustainable operating cash flow to enhance our assessment of a firm's financial strength and to facilitate forecasting the firm's future cash flow. However, unlike Arinovic-Barac (2011), which looks at the use of cash flow ratios to forecast sustainable firm performance, this study focuses on the operating cash flows themselves. In that regard, a search of the literature found

only a handful of references to sustainable versus unsustainable cash flows. Early studies by Hull (1990) and Comiskey & Mulford (1992a,b) speak of the drivers that define sustainable and unsustainable cash flows without using these terms. Later, Mulford & Comiskey (2005) introduce the "sustainable/unsustainable" terms to identify these drivers. Recently, Dukic & Pavlovic (2014) cite Mulford & Comiskey (2005) in addressing sustainable cash flows in the context of creative cash flow reporting. After defining sustainable cash flows as annually repeating cash flows from operating activities, Dukic & Pavlovic (2014, esp. pp. 229-230) discuss the flexibility of accounting techniques to reclassify some cash flows as operating cash flows even though they are not repeating and thus are not sustainable. However, none of the authors addresses the implications of the operating cash flow sustainability/unsustainability dichotomy for analyzing a firm's operating cash flow in UCA cash flow analysis, which is the objective of this study.

Operating Cash Flow Drivers: Definitions, Measures, and Calculations

As argued in Mulford & Comiskey (2005), firm sales growth typically generates growth in both the cost of revenue and operating expenses. Concurrently, as a firm's sales grow, so do the major working capital accounts of the firm. Together, these growth effects impact the firm's operating cash flow by either generating cash flow or consuming it. Moreover, the growth impact on operating cash flow can be viewed as sustainable because, in theory, it can continue indefinitely.

To calculate the growth-related (sustainable) operating cash flow in $Year_t$ we multiply the nominal increase in total annual sales revenue ($Rev_t - Rev_{t-1}$) times each of the measures of managerial efficiency, including both operating efficiency and working capital efficiency (as defined in ratio form below), for $Year_{t-1}$. Summing the calculations gives the total growth-related operating cash flow for $Year_t$, holding constant the firm's managerial efficiency at $Year_{t-1}$ levels.

Operating cash flow may also be impacted by changes in operating efficiency and/or working capital efficiency over $Year_t$ independent of the effects of revenue growth. *Operating efficiency* can be measured by 1) the gross profit margin ratio, defined as sales revenue minus cost of goods sold, divided by total revenue; 2) the operating expense ratio, defined as selling, general, administrative, and other operating expenses net of any depreciation expense, divided by total revenue; and 3) the operating cushion ratio, defined as the gross profit margin ratio minus the operating expense ratio.

Similarly, *working capital efficiency* can be measured by ratios of individual working capital accounts divided by total revenue, including operating receivables, inventory, prepaid expenses, operating payables, and accrued expenses payable, as well as total working capital, defined as the sum of receivables plus inventory and prepaids less the sum of operating payables and accruals. Impacts on operating cash

flow owing to changes in any of these managerial efficiency ratios are considered unsustainable because there are practical limits to such changes and thus to the extent of any associated effects on operating cash flow. (Note that like Mulford & Comiskey (2005), we use the terms "operating receivables" and "operating payables" but intend them to be equivalent to "accounts receivable" and "accounts payable" in the UCA cash flow statement. Note, too, that in calculating measures of working capital efficiency we exclude the ratio of cash & equivalents divided by total revenue even though cash & equivalents is commonly included as a current asset and thus as part of a firm's working capital. The reason is that we focus on the growth and non-growth cash flow impacts on a firm's "operating" working capital, which typically excludes cash & equivalents. Similarly, both the FASB 95 and UCA cash flow statements omit changes in cash & equivalents in calculating cash from operations.)

To calculate the (unsustainable) operating cash flow effects of changes in managerial efficiency in $Year_t$ we multiply the nominal change from $Year_{t-1}$ to $Year_t$ in each of the operating and working capital efficiency ratios times the sales revenue in $Year_t$. Multiplying by Rev_t is necessary to recognize that when the various managerial efficiency ratios change, they affect all of the $Year_t$ revenue, including the revenue growth during $Year_t$. By contrast, when we calculated the effect of sales growth on operating cash flow, we assumed no change in any of the managerial efficiency measures from $Year_{t-1}$. Summing the cash flow calculations gives the total operating cash flow in $Year_t$ owing to changes in managerial efficiency from $Year_{t-1}$. And summing the effects of sales growth and changes in managerial efficiency generates the total impact of the two cash flow drivers.

As an example of the combined effect on operating cash flow of 1) revenue growth and 2) the change in one operating efficiency ratio, consider the sum of the two effects on the gross profit (GP = Sales revenue − Cost of goods sold). As shown below, the combined effect, as explained in the text above, is to generate GP_t from GP_{t-1}:

Growth Effect	Change in Ratio Effect

$$GP_{t-1} + \{[(Rev_t - Rev_{t-1})/Rev_{t-1}](GP_{t-1})\} + \{[(GP_t)/(Rev_t) - (GP_{t-1})/(Rev_{t-1})](Rev_t)\}$$
$$= [(GP_{t-1})(Rev_{t-1})]/(Rev_{t-1}) + \{[(Rev_t)/(Rev_{t-1})](GP_{t-1}) - [(Rev_{t-1})/(Rev_{t-1})](GP_{t-1})\}$$
$$+ \{[(GP_t)/(Rev_t)](Rev_t) - [(GP_{t-1})/(Rev_{t-1})](Rev_t)\}$$
$$= GP_t$$

Scenario to Accompany Added 2016 Financial Data for GSDI

In late 2015 GSDI, a distributor of high-end commercial and residential furniture manufactured overseas, received notification from several of its suppliers

that they would be increasing prices in 2016. Based on this information, GSDI management decided to purchase excess inventory to lock in 2015 prices. As a result, the firm increased its year-end inventory, shown in Table 1, from $94,373 in 2014 (15.73 percent of 2014 sales) to $117,459 in 2015 (18.07 percent of 2015 sales), thereby increasing its days sales in inventory from 57.41 days in 2014 to 65.96 days in 2015. The large inventory increase was financed by a $28,000 increase in short-term notes payable (from $6,000 in 2014 to $34,000 in 2015), concurrently with a $2,100 decrease in accounts payable.

To work down the excess inventory GSDI recorded an increase of only $3,666 in its 2016 year-end inventory, resulting in a decline in year-end inventory to 17.06 percent of 2016 sales and a decrease in days sales in inventory to 62.27 days. Over the same period the firm recorded a $16,000 decrease in short-term notes payable (from $34,000 in 2015 to $18,000 in 2016).

Cash Flow Drivers and GSDI's Cash Flow for 2014-16

The cash flow impacts of GSDI's (sustainable) sales growth and (unsustainable) changes in managerial efficiency for 2014 are presented in Tables 4a and 4b, respectively. Comparable results for 2015 are reported, respectively, in Tables 5a and 5b, and for 2016 in Tables 6a and 6b. All the tables are constructed using formats similar to those in Mulford & Comiskey (2005, Exhibits 9.18 and 9.21). Note: Calculated inflows/outflows may not be exact due to rounding.

Cash Flow Impacts for 2014

Looking first at Table 4a, the (sustainable) cash flow impact of sales growth in 2014 is divided between the effect on the firm's operating cushion and the effect on its operating working capital. Each of the computations presents the 2014 nominal increase in sales revenue of $25,000 times the respective prior year (2013) ratio. As in the accompanying tables, all dollar figures in the text are in thousands. As shown, the cash flow impact of revenue growth on the firm's 2014 operating cushion was a cash inflow of $4,534 owing to an increase in gross profit offset in part by an increase in operating expenses. Concurrently, the cash flow impact of sales growth on the firm's operating working capital was a cash outflow of $2,907 due to increases in operating receivables and inventory offset in part by an increase in operating payables. Combining the two effects of sales growth on the firm's operating cushion and operating working capital generated a net cash inflow of $1,627 [= $4,534 - $2,907].

Focusing on Table 4b, the (unsustainable) cash flow impact of changes in managerial efficiency in 2014 is divided between the effect on the firm's operating cushion and the effect on its operating working capital. Each of the computations

presents the 2014 change in an operating efficiency ratio or a working capital efficiency ratio, times the firm's 2014 sales. As shown, the 2014 cash flow impact of changes in operating efficiency is captured in the change in the operating cushion ratio, giving a cash inflow of $4,164 due to a significant decrease in the operating expense ratio. At the same time, the cash flow impact of changes in working capital efficiency is reflected in the change in the operating working capital ratio showing a cash outflow of $7,709 owing primarily to an increase in the inventory ratio. Combining the two effects of changes in managerial efficiency on the firm's operating cushion and operating working capital yielded a net cash outflow of −$3,545 [= $4,164 − $7,709]. (For an alternative presentation of the impacts of revenue growth and changes in managerial efficiency on GSDI's operating cash flow for each of the years 2014-16, see the Appendix at the end of the study.)

So how does this information enhance our understanding of GSDI's 2014 operating cash flow? Most importantly, to what extent did the (unsustainable) cash flow effects of changes in managerial efficiency distort GSDI's 2014 cash after operations? To address this question, suppose that the firm's 2014 revenue growth had proceeded as it did, but the managerial efficiency ratios had remained unchanged from the prior year. In that case, the firm would have generated $3,545 more in operating cash flow in 2014 than it did. As a result, looking at Table 3, GSDI would have increased its 2014 cash after operations from $102,384 to $105,929 [= $102,384 + $3,545], its financing surplus to $6,960 [= $3,415 + $3,545], and its change in cash & equivalents to $4,625 [= $1,080 + $3,545], assuming the same paydown of debt. Stated differently, the effect of the changes in the managerial efficiency ratios was to understate the firm's 2014 operating cash flow, thereby presenting a less attractive picture of GSDI's financial condition than what would have been recorded in the absence of these managerial changes.

Cash Flow Impacts for 2015

Turning to Table 5a and following the same set of steps as in Table 4a, we computed the (sustainable) cash flow impact of the $50,000 nominal increase in sales on the firm's operating cushion and operating working capital. The result was a cash inflow from the impact of revenue growth on the operating cushion of $9,418, due primarily to an increase in gross profit, along with a cash outflow from the impact of revenue growth on operating working capital of $6,456, due to an increase in operating receivables and especially inventory. Combining the two effects generated a net cash inflow from sales growth of $2,962 [= $9,418 − $6,456].

Similarly, for Table 5b we followed the same set of steps as in Table 4b to compute the (unsustainable) cash flow impact of the 2015 changes in managerial efficiency on the firm's operating cushion and operating working capital. The

Table 4a.

Sustainable Cash Flow Impacts of Revenue Growth, 2014

	2014 Nominal growth in Rev. ($000)	Prior Year (2013) % of Rev.	Footnote Reference	Inflow/ (Outflow) ($000)
Operating Efficiency				
Cash Flow Impact of Revenue Growth on Gross Profit	25,000	23.48%	a	5,870
Cash Flow Impact of Revenue Growth on Operating Expenses	25,000	5.34%	b	(1,336)
Total Cash Flow Impact of Revenue Growth on Operating Cushion	25,000	18.14%	c	**4,534**
	25,000			
Working Capital Efficiency	25,000			
Cash Flow Impact of Revenue Growth on Operating Receivables	25,000	7.30%	d	(1,826)
Cash Flow Impact of Revenue Growth on Inventory	25,000	12.46%	e	(3,116)
Cash Flow Impact of Revenue Growth on Prepaid Expenses	25,000	0.21%	f	(52)
Cash Flow Impact of Revenue Growth on Operating Payables	25,000	8.35%	g	2,087
Cash Flow Impact of Revenue Growth on Accrued Expenses	25,000	0.00%	h	0
Total Cash Flow Impact of Revenue Growth on Operating Working Capital	25,000	11.63%	i	**(2,907)**
Total Cash Flow Impact of Revenue Growth	25,000	6.51%	j	**1,627**

a Growth in revenue times prior year gross profit margin ratio

b Growth in revenue times prior year operating expense ratio

c Growth in revenue times prior year operating cushion ratio

d Growth in revenue times prior year receivables to revenue ratio

e Growth in revenue times prior year inventory to revenue ratio

f Growth in revenue times prior year prepaid expenses to revenue ratio

g Growth in revenue times prior year payables to revenue ratio

h Growth in revenue times prior year accrued expenses to revenue ratio

I Growth in revenue times prior year operating working capital to revenue ratio

j Growth in revenue times the prior year operating cushion ratio less operating working capital to revenue ratio

Table 4b.

Unsustainable Cash Flow Impacts of Change in Managerial Efficiency, 2014

	2014 Revenue ($000)	2014 Change in Percentage Points	Footnote Reference	Inflow/ (Outflow) ($000)
Operating Efficiency				
Cash Flow Impact of Change in Gross Profit Margin Ratio	600,000	−0.14	a	(870)
Cash Flow Impact of Change in Operating Expenses Ratio	600,000	−0.84	b	5,034
Total Cash Flow Impact of Change in Operating Cushion Ratio	600,000	0.69	c	**4,164**
	600,000			
Working Capital Efficiency	600,000			
Cash Flow Impact of Change in Receivables Ratio	600,000	−0.80	d	4,826
Cash Flow Impact of Change in Inventory Ratio	600,000	3.27	e	(19,600)
Cash Flow Impact of Change in Prepaid Expenses Ratio	600,000	−0.03	f	152
Cash Flow Impact of Change in Payables Ratio	600,000	0.74	g	4,413
Cash Flow Impact of Change in Accrued Expenses Ratio	600,000	0.42	h	2,500
Total Cash Flow Impact of Change in Operating Working Capital Ratio	600,000	1.28	i	**(7,709)**
Total Cash Flow Impact of Change in Managerial Efficiency	600,000	−0.59	j	**(3,545)**

a Change in gross profit margin ratio times current year revenue

b Change in operating expense ratio times current year revenue

c Change in operating cushion ratio times current year revenue

d Change in operating receivables to revenue ratio times current year revenue

e Change in inventory to revenue ratio times current year revenue

f Change in prepaid expenses to revenue ratio times current year revenue

g Change in payables to revenue ratio times current year revenue

h Change in accrued expenses to revenue ratio times current year revenue

I Change in operating working capital to revenue ratio times current year revenue

j Change in operating cushion ratio plus change in operating working capital to revenue ratio times current year revenue

Table 5a.

Sustainable Cash Flow Impacts of Revenue Growth, 2015

	2015 Nominal Growth In Rev. ($000)	Prior Year (2014) % of Rev.	Footnote Reference	Inflow/ (Outflow) ($000)
Operating Efficiency				
Cash Flow Impact of Revenue Growth on Gross Profit	50,000	23.33%	a	11,668
Cash Flow Impact of Revenue Growth on Operating Expenses	50,000	4.50%	b	(2,250)
Total Cash Flow Impact of Revenue Growth on Operating Cushion	50,000	18.83%	c	**9,418**
Working Capital Efficiency				
Cash Flow Impact of Revenue Growth on Operating Receivables	50,000	6.50%	d	(3,250)
Cash Flow Impact of Revenue Growth on Inventory	50,000	15.73%	e	(7,865)
Cash Flow Impact of Revenue Growth on Prepaid Expenses	50,000	0.18%	f	(90)
Cash Flow Impact of Revenue Growth on Operating Payables	50,000	9.08%	g	4,539
Cash Flow Impact of Revenue Growth on Accrued Expenses	50,000	0.42%	h	210
Total Cash Flow Impact of Revenue Growth on Operating Working Capital	50,000	12.91%	i	**(6,456)**
Total Cash Flow Impact of Revenue Growth	50,000	5.92%	j	**2,962**

a Growth in revenue times prior year gross profit margin ratio

b Growth in revenue times prior year operating expense ratio

c Growth in revenue times prior year operating cushion ratio

d Growth in revenue times prior year receivables to revenue ratio

e Growth in revenue times prior year inventory to revenue ratio

f Growth in revenue times prior year prepaid expenses to revenue ratio

g Growth in revenue times prior year payables to revenue ratio

h Growth in revenue times prior year accrued expenses to revenue ratio

i Growth in revenue times prior year operating working capital to revenue ratio

j Growth in revenue times the prior year operating cushion ratio less operating working capital to revenue ratio

Table 5b.

Unsustainable Cash Flow Impacts of Change in Managerial Efficiency, 2015

	2016 Revenue ($000)	2015 Change in Percentage Points	Footnote Reference	Inflow/ (Outflow) ($000)
Operating Efficiency				
Cash Flow Impact of Change in Gross Profit Margin Ratio	650,000	1.67	a	10.832
Cash Flow Impact of Change in Operating Expenses Ratio	650,000	0.96	b	(6,250)
Total Cash Flow Impact of Change in Operating Cushion Ratio	650,000	0.71	c	**4,582**
	650,000			
Working Capital Efficiency	650,000			
Cash Flow Impact of Change in Receivables Ratio	650,000	1.35	d	(8,750)
Cash Flow Impact of Change in Inventory Ratio	650,000	2.34	e	(15,222)
Cash Flow Impact of Change in Prepaid Expenses Ratio	650,000	0.121	f	(808)
Cash Flow Impact of Change in Payables Ratio	650,000	−1.02	g	(6,642)
Cash Flow Impact of Change in Accrued Expenses Ratio	650,000	0.06	h	417
Total Cash Flow Impact of Change in Operating Working Capital Ratio	650,000	4.77	i	**(31,005)**
Total Cash Flow Impact of Change in Managerial Efficiency	650,000	−4.06	j	**(26,423)**

a Change in gross profit margin ratio times current year revenue

b Change in operating expense ratio times current year revenue

c Change in operating cushion ratio times current year revenue

d Change in operating receivables to revenue ratio times current year revenue

e Change in inventory to revenue ratio times current year revenue

f Change in prepaid expenses to revenue ratio times current year revenue

g Change in payables to revenue ratio times current year revenue

h Change in accrued expenses to revenue ratio times current year revenue

i Change in operating working capital to revenue ratio times current year revenue

j Change in operating cushion ratio plus change in operating working capital to revenue ratio times current year revenue

TABLE 6a.

Sustainable Cash Flow Impacts of Revenue Growth, 2016

	2016 Nominal Growth in Rev. ($000)	Prior Year (2015) % of Rev.	Footnote Reference	Inflow/ (Outflow) ($000)
Operating Efficiency				
Cash Flow Impact of Revenue Growth on Gross Profit	60,000	25.00%	a	15,000
Cash Flow Impact of Revenue Growth on Operating Expenses	60,000	5.46%	b	(3,278)
Total Cash Flow Impact of Revenue Growth on Operating Cushion	60,000	19.54%	c	**11,722**
Working Capital Efficiency				
Cash Flow Impact of Revenue Growth on Operating Receivables	60,000	7.85%	d	(4,708)
Cash Flow Impact of Revenue Growth on Inventory	60,000	18.07%	e	(10,842)
Cash Flow Impact of Revenue Growth on Prepaid Expenses	60,000	0.31%	f	(185)
Cash Flow Impact of Revenue Growth on Operating Payables	60,000	8.06%	g	4,837
Cash Flow Impact of Revenue Growth on Accrued Expenses	60,000	0.48%	h	288
Total Cash Flow Impact of Revenue Growth on Operating Working Capital	60,000	17.68%	i	**(10,610)**
Total Cash Flow Impact of Revenue Growth	60,000	1.86%	j	**1,112**

a Growth in revenue times prior year gross profit margin ratio

b Growth in revenue times prior year operating expense ratio

c Growth in revenue times prior year operating cushion ratio

d Growth in revenue times prior year receivables to revenue ratio

e Growth in revenue times prior year inventory to revenue ratio

f Growth in revenue times prior year prepaid expenses to revenue ratio

g Growth in revenue times prior year payables to revenue ratio

h Growth in revenue times prior year accrued expenses to revenue ratio

i Growth in revenue times prior year operating working capital to revenue ratio

j Growth in revenue times the prior year operating cushion ratio less operating working capital to revenue ratio

TABLE 6b.

Unsustainable Cash Flow Impacts of Change in Managerial Efficiency, 2016

	2016 Revenue ($000)	2016 Change in Percentage Points	Footnote Reference	Inflow/ (Outflow) ($000)
Operating Efficiency				
Cash Flow Impact of Change in Gross Profit Margin Ratio	710,000	1.20	a	8,500
Cash Flow Impact of Change in Operating Expenses Ratio	710,000	0.16	b	(1,104)
Total Cash Flow Impact of Change in Operating Cushion Ratio	710,000	1.04	c	**7,396**
Working Capital Efficiency				
Cash Flow Impact of Change in Receivables Ratio	710,000	0.32	d	(2,292)
Cash Flow Impact of Change in Inventory Ratio	710,000	-1.01	e	7,176
Cash Flow Impact of Change in Prepaid Expenses Ratio	710,000	-0.10	f	685
Cash Flow Impact of Change in Payables Ratio	710,000	0.14	g	1,013
Cash Flow Impact of Change in Accrued Expenses Ratio	710,000	0.04	h	307
Total Cash Flow Impact of Change in Operating Working Capital Ratio	710,000	-0.97	i	**6,889**
Total Cash Flow Impact of Change in Managerial Efficiency	710,000	2.01	j	**14,285**

a Change in gross profit margin ratio times current year revenue

b Change in operating expense ratio times current year revenue

c Change in operating cushion ratio times current year revenue

d Change in operating receivables to revenue ratio times current year revenue

e Change in inventory to revenue ratio times current year revenue

f Change in prepaid expenses to revenue ratio times current year revenue

g Change in payables to revenue ratio times current year revenue

h Change in accrued expenses to revenue ratio times current year revenue

i Change in operating working capital to revenue ratio times current year revenue

j Change in operating cushion ratio plus change in operating working capital to revenue ratio times current year revenue

result was a cash inflow from the impact of changes in operating efficiency on the operating cushion ratio of $4,582 due to a significant increase in the gross profit margin ratio. Concurrently, the firm generated a cash outflow from the impact of changes in working capital efficiency on the operating working capital ratio of −$31,005, owing primarily to increases in the operating receivables ratio and especially the inventory ratio. Combining the two effects yielded a net cash outflow from changes in managerial efficiency of −$26,423 [= $4,582 − $31,005].

Again, how does this information, particularly the (unsustainable) cash flow effects of changes in managerial efficiency, distort GSDI's 2015 cash after operations? As in our analysis of 2014, suppose that the firm's 2015 revenue growth had proceeded as it did, but the managerial efficiency ratios had remained unchanged from the prior year. In that case, the firm would have generated $26,423 more in operating cash flow in 2015 than it did. As a result, GSDI would have increased its 2015 cash after operations from $89,539 to $115,962 [= $89,539 + $26,423], decreased its financing requirement to $35,584 [= $26,423 − $62,007], and reversed the decrease in cash & equivalents to an increase of $19,948 [= −$6,475 + $26,423], assuming the same increase in external financing. So as in 2014, the effect of the changes in the managerial efficiency ratios was to understate the firm's 2015 operating cash flow, thereby presenting a less attractive picture of GSDI's financial condition than what would have been recorded in the absence of these managerial changes.

Finally, note that in both 2014 and 2015 the total cash impact of a change in operating working capital was negative owing primarily to large increases in inventory in both years. But what if GSDI had reduced inventory in one or both years, resulting in positive impact(s) on operating working capital? We see the effect of such an inventory reduction in the data for 2016.

Cash Flow Impacts for 2016

Turning to Table 6a and following the same set of steps as in Tables 4a and 5a, we computed the (sustainable) cash flow impact of the $60,000 nominal increase in sales on the firm's operating cushion and operating working capital. The result was a cash inflow from the impact of revenue growth on the operating cushion of $11,722 due primarily to an increase in gross profit, coupled with a cash outflow from the impact of revenue growth on operating working capital of −$10,610 due to an increase in operating receivables and especially inventory. Combining the two effects generated a net cash inflow from sales growth of $1,112 [= $11,722 − $10,610].

Similarly, for Table 6b we followed the same set of steps as in Tables 4b and 5b to compute the (unsustainable) cash flow impact of the 2016 changes in managerial efficiency on the firm's operating cushion and operating working capital. The result was a cash inflow from the impact of changes in operating efficiency of

$7,396 due largely to an increase in the gross margin ratio. At the same time, the firm generated a cash inflow from the impact of changes in working capital efficiency on the operating working capital ratio of $6,889 owing primarily to a decrease in the inventory ratio. Combining the two effects yielded a net cash inflow from changes in managerial efficiency of $14,285 [= $7,396 + $6,889].

Again, how does this information, particularly the (unsustainable) cash flow effects of changes in managerial efficiency distort GSDI's 2016 cash after operations? As in our analysis of 2014 and 2015, suppose that the firm's 2016 revenue growth had proceeded as it did, but the managerial efficiency ratios had remained unchanged from the prior year. In that case, the firm would have generated $14,285 less in operating cash flow in 2016 than it did. As a consequence, GSDI would have decreased its 2016 cash after operations from $142,397 to $128,112 [= $142,397 − $14,283], resulting in a decreased financing surplus of $2,256 [= $16,541 − $14,285] and a negative cash & equivalents of -$12,746 [= $1,539 − $14,285], assuming the same paydown of debt. So in contrast with 2014 and 2015, the effect of the 2016 changes in the managerial efficiency ratios was to overstate the firm's 2016 operating cash flow, thereby presenting a more attractive picture of GSDI's financial condition than what would have been recorded in the absence of these managerial changes.

GSDI's Trend in Sustainable Operating Cash Flow

Finally, one may ask what would have been the firm's cash after operations over 2014-16 with only the impact of (sustainable) revenue growth and no (unsustainable) changes in managerial efficiency? The answer to this question can be seen in summary Table 7.

First, Table 7 presents the annual cash flow impacts of revenue growth together with changes in managerial efficiency (from Tables 4a-6b) for each year, 2014-16, along with the total cash after operations for each year. As implied earlier in the text, cash after operations can be computed each year as the prior-year operating cushion plus the cash flow impacts of revenue growth and changes in managerial efficiency. Doing so gives total cash after operations of $102,384 in 2014, $89,539 in 2015, and $142,397 in 2016, which is identical to cash after operations on the UCA cash flow statement for each year in Table 3.

As noted earlier, the effect of changes in the managerial efficiency ratios was to distort (by overstating or understating) the firm's operating cash flow each year. But such cash flow impacts are unsustainable as they cannot continue indefinitely. By reversing them we can calculate the sustainable cash after operations for each year. These calculations, shown at the bottom of Table 7, show a clear upward trend, rising from $105,929 in 2014 to $115,962 in 2015, and $128,112 in 2016. Thus, by eliminating the unsustainable cash flow impacts, we have a more accurate picture of the firm's operating cash flow over the period studied. Specifically, we

are left with sustainable cash after operations, thereby enhancing trend analysis within UCA cash flow analysis for commercial credit assessment.

Summary and Conclusion

Previous research by Beach et al. (2017) compares the FASB 95 and the Uniform Credit Analysis (UCA) cash flow statements and argues for the superiority of the UCA format for commercial credit analysis. The current study "drills down" into a firm's operating cash flow, termed "cash after operations" in the UCA cash flow statement, to determine how much of a firm's operating cash flow in any given year can be viewed as sustainable versus unsustainable. As defined by Mulford and Comiskey (2005), sustainable operating cash flow is cash flow driven by revenue growth whereas unsustainable is cash flow driven by changes in operating efficiency and working capital efficiency, collectively termed "managerial efficiency" in this study. Identifying the sustainable and unsustainable operating cash flows is important for analyzing a firm's cash flow picture in credit analysis.

To begin, we explain how to calculate operating cash flow owing to the "cash flow drivers" of revenue growth (sustainable) and changes in managerial efficiency (unsustainable). That discussion is followed by an analysis of these cash flow drivers as applied to a fictional firm, Gulf States Distributors, Inc. (GSDI) for 2014-16. GSDI data for 2014-15 are taken from Beach et al. (2017) while data for 2016 are newly constructed for the current study.

By separating the cash flow impacts of revenue growth from those of changes in managerial efficiency, we provide a more complete picture of the firm's operating cash flow. Specifically, we can determine if the firm's cash after operations was distorted by changes in managerial efficiency, thereby generating an understatement or overstatement of operating cash flow in any given year. If understated, as in 2014 and 2015, GSDI's operating cash flow would have been higher without the cash flow impacts and, therefore, would have given a more attractive picture of the firm's financial condition for commercial credit analysis. By contrast, if overstated, as in 2016, GSDI's operating cash flow would have been lower without the cash flow impacts and thus would have provided a less attractive picture of the firm's financial condition. Finally, by reversing the unsustainable cash flow impacts, we are left with the sustainable cash after operations, thereby enhancing trend analysis within UCA cash flow analysis for commercial credit assessment.

Beach et al. (2017) concludes by recommending that financial management textbooks, as well as books on commercial banking and financial statement analysis, introduce students to the UCA cash flow statement. We suggest further that such books augment their discussion of UCA cash flow analysis by addressing

TABLE 7.
Gulf States Distributors, Inc.

Total Cash After Operations vs. Sustainable Cash After Operations

	2014		2015		2016	
Prior Year Operating Cushion[1]		104,302		113,000		127,000
Sustainable Cash Flow Impacts						
Cash Flow Impact of Growth on Operating Cushion	4,534		9,418		11,722	
Cash Flow Impact of Growth on Operating Working Capital	(2,907)		(6,456)		(10,610)	
Total Sustainable Cash Flow Impacts		1,627		2,962		1,112
Unsustainable Cash Flow Impacts						
Cash Flow Impact of Change in Operating Cushion Ratio[2]	4,164		4,582		7,396	
Cash Flow Impact of Change in Operating Working Capital	(7,709)		(31,005)		6,889	
Total Unsustainable Cash Flow Impacts		(3,545)		(26,423)		14,285
Total Cash After Operations		102,384		89,539		142,397
Reversal of Unsustainable Cash Flow Impacts						
Cash Flow Impact of Change in Operating Cushion Ratio	(4,164)		(4,582)		(7,396)	
Cash Flow Impact of Change in Operating Working Capital	7,709		31,005		(6,889)	
Reversal of Total Unsustainable Cash Flow Impacts		3,545		26,423		(14,285)
Sustainable Cash After Operations		105,929		115,962		128,112

[1] Operating Cushion = (Sales revenue – Cost of goods sold) – Operating expenses net of any depreciation expense. Thus, Prior Year Operating Cushion is calculated for each of the years, 2014 – 2016 from Table 2 data for 2013 – 2015, respectively:

2014 = (575,000 – 440,000) – (21,648 + 5,750 + 3,300) = 104,302
2015 = (600,000 – 460,000) – (18,480 + 6,000 + 2,520) = 113,000
2016 = (650,000 – 487,500) – (24,650 + 6,500 + 4,350) = 127,000

[2] Operating Cushion Ratio = Gross profit margin ratio (sales revenue minus cost of goods sold, divided by total revenue) minus the Operating expense ratio (selling, general, administrative, and other operating expenses net of any depreciation expense, divided by total revenue).

sustainable versus unsustainable operating cash flows to provide a more complete picture of a firm's financial condition.

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Appendix

Cash Flow Impacts of Sales Growth and Changes in Managerial Efficiency on Each of GSDI's Operating Cushion and Operating Working Capital Components, 2014-16

Appendix Tables A, B and C present an alternative to Tables 4a&b, 5a&b, and 6a&b, respectively, by showing the 2014, 2015, and 2016 cash flow impacts of revenue growth and changes in managerial efficiency on each of GSDI's operating cushion and operating working capital components.

2014

Looking first at Appendix Table A, column A presents the 2013 level of each of the components. Next, column B gives the projected 2014 level of each component based on GSDI's 2014 sales growth of 4.348%. Subtracting column A figures from those in column B gives column C, which presents the cash flow impact of sales growth on each component. As shown, the summation of column C figures for the operating cushion components gives the total cash flow impact of sales growth on the operating cushion of $4,534, identical to the comparable figure shown in Table 4a. Likewise, the summation of the column C figures for the operating working capital components gives the total cash flow impact of sales growth on the operating working capital of -$2,907, identical to the comparable figure shown in Table 4a.

Continuing in Appendix Table A, column D gives the actual 2014 level of each of the components. Finally, column E shows the cash flow impact of changes in managerial efficiency by subtracting column B figures from those in column D. As shown, the summation of the column E figures for the operating cushion gives the total cash flow impact of changes in managerial efficiency, specifically, operating efficiency, of $4,164, identical to the comparable figure shown in Table 4b. Likewise, the summation of the column E figures for the operating working capital gives the total cash flow impact of changes in managerial efficiency, specifically, working capital efficiency, of -$7,709, identical to the comparable figure shown in Table 4b.

2015

Turning to Appendix Table B for 2015 and following the same sequence of steps as for 2014 shows in column C the total cash flow impact of sales growth on the operating cushion and operating working capital of $9,418 and -$6,456, respectively, identical to the comparable figures shown in Table 5a. Likewise, following the same sequence of steps as for 2014 shows in column E the total

cash flow impact of changes in managerial efficiency on the operating cushion and operating working capital of $4,582 and -$31,005, respectively, identical to the comparable figures shown in Table 5b.

2016

Finally, turning to Appendix Table C for 2016 and following the same sequence of steps as for 2014 and 2015 shows in column C the total cash flow impact of sales growth on the operating cushion and operating working capital of $11,722 and -$10,610, respectively, identical to the comparable figures shown in Table 6a. Likewise, following the same sequence of steps as for 2014 and 2015 shows in column E the total cash flow impact of changes in managerial efficiency on the operating cushion and operating working capital of $7,396 and $6,889, respectively, identical to the comparable figures shown in Table 6b.

APPENDIX TABLE A.

GSDI 2014 Cash Flow Impacts of Sales Growth and Changes in Managerial Efficiency (Based on 2014 Sales Growth of 4.348%)

	2013 Level (A)	Projected 2014 Level Based on Sales Growth (B)	Cash Flow Impact of Sales Growth (C = B − A)	Actual 2014 Level (D)	Cash Flow Impact of Changes in Mgr. Efficiency (E = D − B)
Operating Cushion Components					
Sales	575,000	600,000	25,000	600,000	0
COGS	(440,000)	(459,131)	(19,131)	(460,000)	(869)
Gross Profit	135,000	140,869	5,869	140,000	(869)
Sales, General and Administrative Expenses	(21,648)	(22,589)	(941)	(18,480)	4,109
Officers' Salaries	(3,300)	(3,443)	(143)	(2,520)	923
Lease and Rent Expense	(5,750)	(6,000)	(250)	(6,000)	0
Operating Cushion	104,302	108,836	4,534	113,000	4,164
Operating Working Capital Components					
Accounts Receivable	42,000	43,826	(1,826)	39,000	4,826
Inventory	71,657	74,773	(3,116)	94,373	(19,600)
Prepaid Expenses	1,200	1,252	(52)	1,100	152
Accounts Payable	48,000	50,087	2,087	54,500	4,413
Accrued Expenses	0	0	0	2,500	2,500
Operating Working Capital	66,857	69,764	(2,907)	77,473	(7,709)

APPENDIX TABLE B.

GSDI 2015 Cash Flow Impacts of Sales Growth and Changes in Managerial Efficiency

(Based on 2015 Sales Growth of 8.333%)

	2014 Level (A)	Projected 2015 Level Based on Sales Growth (B)	Cash Flow Impact of Sales Growth (C = B − A)	Actual 2015 Level (D)	Cash Flow Impact of Changes in Mgr. Efficiency (E = D − B)
Operating Cushion Components					
Sales	600,000	650,000	50,000	650,000	0
COGS	(460,000)	(498,332)	(38,332)	(487,500)	10,832
Gross Profit	140,000	151,668	11,668	162,500	10,832
Sales, General and Administrative Expenses	(18,480)	(20,020)	(1,540)	(24,650)	(4,630)
Officers' Salaries	(2,520)	(2,730)	(210)	(4,350)	(1,620)
Lease and Rent Expense	(6,000)	(6,500)	(500)	(6,500)	0
Operating Cushion	113,000	122,418	9,418	127,000	4,582
Operating Working Capital Components					
Accounts Receivable	39,000	42,250	(3,250)	51,000	(8,750)
Inventory	94,373	102,237	(7,864)	117,459	(15,222)
Prepaid Expenses	1,100	1,192	(92)	2,000	(808)
Accounts Payable	54,500	59,041	4,541	52,400	(6,641)
Accrued Expenses	2,500	2,708	208	3,125	417
Operating Working Capital	77,473	83,929	(6,456)	114,934	(31,005)

APPENDIX TABLE C.

GSDI 2016 Cash Flow Impacts of Sales Growth and Changes in Managerial Efficiency

(Based on 2016 Sales Growth of 9.231%)

	2015 Level (A)	Projected 2016 Level Based on Sales Growth (B)	Cash Flow Impact of Sales Growth (C = B − A)	Actual 2016 Level (D)	Cash Flow Impact of Changes in Mgr. Efficiency (E = D − B)
Operating Cushion Components					
Sales	650,000	710,000	60,000	710,000	0
COGS	(487,500)	(532,501)	(45,001)	(524,000)	8,501
Gross Profit	162,500	177,499	14,999	186,000	8,501
Sales, General and Administrative Expenses	(24,650)	(26,925)	(2,275)	(28,532)	(1,607)
Officers' Salaries	(4,350)	(4,752)	(402)	(4,850)	(98)
Rent and Lease Expense	(6,500)	(7,100)	(600)	(6,500)	600
Operating Cushion	127,000	138,722	11,722	146,118	7,396
Operating Working Capital Components					
Accounts Receivable	51,000	55,708	(4,708)	58,000	(2,292)
Inventory	117,459	128,302	(10,843)	121,125	7,177
Prepaid Expenses	2,000	2,185	(185)	1,500	685
Accounts Payable	52,400	57,237	4,837	58,250	1,013
Accrued Expenses	3,125	3,413	288	3,720	307
Operating Working Capital	114,934	125,544	(10,610)	118,655	6,889

Inventory Methods, Inflation, and Phantom Profits: Liquidity Issues and Pedagogical Opportunities

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This paper discusses the impact of inflation on the inventory cost flow assumption made by corporations. Specifically, it examines potential liquidity problems associated with using FIFO for those firms that are susceptible to inflationary pressures. Pedagogical examples are provided for use in introductory accounting or finance courses as well as courses requiring more in-depth analysis. Its relevance is magnified by the IFRS requirement which prohibits the use of LIFO.
Keywords: *Inventory methods, inflation, phantom profits, liquidity, pedagogy*

Introduction

The origin for this paper is a recent anomaly observed in undergraduate financial analysis courses. One item of emphasis in texts designed for this course is the examination of the impact of inventory cost flow assumption choices on the financial statements. However, lately we have noticed that students have a difficult time with this concept which is puzzling as it is one of the more basic constructs from principles of accounting. For example, in the last two years, we have noticed considerable difficulty with the following multiple choice question (n=81):

During a period of rapidly rising prices and increasing inventory, which cost flow assumption would provide a company with the greatest cash position?

A. FIFO (47students or 58% incorrect)
B. LIFO (19 students or 23.5% correct)
C. Average cost method (10 students or 12.3% incorrect)
D. The cost flow assumption would not impact liquidity (5 students or 6.2% incorrect)

We have wondered about the source of this confusion. Perhaps, students have become less cognizant of different tax and accounting requirements between FIFO and LIFO. This does not seem likely as neither we nor the texts have deemphasized this idea over the years. Another possibility is that students ignore International Financial Reporting Standards (IFRS) which current texts have used to highlight the impact of using FIFO and prohibiting LIFO. The final possibility that we hypothesize is that this generation of undergraduates are too young to take the impact of inflation seriously. After all, during the last six or seven years, deflation has been feared and discussed as often as inflation. And they have certainly been aware of the loss in value of many American homes during the Great Recession that has, in some cases, persisted to this very day.

In an effort to improve student comprehension and performance in this area, an applied exercise was developed for use in the analysis course. The new assignment replaced several previously used traditional textbook problems. The examples and analysis along with the results of student performance will be provided.

Literature Review

Three issues that students must be cognizant of when considering inventory options are Generally Accepted Accounting Principles (GAAP) and tax laws in the U.S., International Financial Reporting Standards (IFRS), and inflationary pressures. GAAP allows corporations several options involving the cost flow assumption for their inventory. The two most popular methods are FIFO (First In First Out) and LIFO (Last In First Out). These assumptions have dramatic impacts on the balance sheet, income statement and statement of cash flows.

Susceptibility to inflation is a major rationale for corporations to favor LIFO. LIFO reduces tax payments and increases liquidity when inventory is increasing in price over time and has been used by many companies since 1939 when the IRS first allowed it. (See Leone (2010) for an interesting history of LIFO and for information on the LIFO Coalition of more than 100 major corporations lobbying Congress against LIFO repeal.) For high tech companies where costs tend to decrease, FIFO is preferred for the same reason. If a company uses LIFO for tax purposes then the Internal Revenue Service (IRS) mandates (and enforces) that it use LIFO for reporting purposes. This is one of very few areas where the IRS requires choosing the same method for reporting purposes. (For example, corporations may use accelerated depreciation for tax purposes thereby reducing taxes but choose straight line for reporting purposes which increases net income.) The result of the LIFO requirement is that corporations "pay" for their tax savings by showing a lower net income.

Many textbooks suggest that corporations that choose FIFO when LIFO would result in tax savings do so to impress different stakeholder groups with higher net

income. For example, some stockholders and small banks may be more swayed by higher profitability and overlook the tax savings that the corporation gives up. Arline (2015) continues to give merit to this argument.

GAAP allows a corporation to use as many different inventory cost flow assumptions as it chooses. This allows more flexibility in case of acquisition of domestic companies that use alternate methods that the parent is not interested in changing. And since international companies generally use FIFO, it is quite common to observe U.S. companies using several methods. FIFO is used for international operations and primarily LIFO for domestic operations.

IFRS allows firms to use only FIFO or weighted average cost flow assumptions. LIFO is strictly prohibited. Additionally, flexibility is reduced because the international standards also require similar inventory (wherever it may be located) to use only one method. Fazal (2011) explains that IFRS stresses a "balance sheet" approach and FIFO produces the best valuation. However, proponents of FIFO who utilize this argument are not presenting the entire "quality" issue. High quality financial statements are those that portray true economic reality best. For firms facing an inflationary environment, FIFO produces the higher quality balance sheet and the lower quality income statement. LIFO, in turn, produces the higher quality income statement i.e., it matches current revenues with current costs. It does, as FIFO advocates suggest, produce a lower quality balance sheet. The point is neither method can give you the highest quality for both statements. However, LIFO requires that companies restate their inventory to FIFO in the footnotes. Thus, stakeholders of corporations using LIFO have the best of both worlds and considerably more information.

The auditing firm KPMG (2014) explains that there are certain items, such as leasing, that are preventing full convergence of GAAP with IFRS. For now, the groups have agreed to disagree and the standards are still considered separate. Katz (2007) argues that the easiest way to attain convergence on the inventory issue is for the IRS to agree to allow corporations to use LIFO for taxes but opt for FIFO for financial reporting. That seems unlikely at present. As Arline (2015) points out, the Obama administration continues pushing hard for LIFO repeal.

In late 2008, the Federal Reserve (Fed) began the first of three quantitative easing (QE) rounds that lasted through late 2014. The Fed's initial intent was to fight deflationary pressures during the Great Recession and to prevent another depression. The Fed's balance sheet expanded tremendously as it purchased treasury and mortgage-backed securities.

The impact of QE was to reduce borrowing costs and bankruptcies for corporations during the crisis. Additionally, low interest mortgages helped to support and eventually stimulate the housing market. The Federal Funds Rate, the interest rate that banks charge each other, remained at zero from the inception of QE until December 2015. The global equity sell-off in January of 2016, Britain's vote

to exit the EU ("Brexit") in the summer of 2016, and an overall tepid economy put the Federal Reserve on hold until the end of 2016. Because the plunge in oil prices has kept inflation at sub-normal rates even as the economy has modestly improved, most pundits agree that relatively low interest rates will continue for some time.

As a result of recent history, many students today are unfamiliar with normal inflation! For that reason alone, it is probably best to emphasize that monetary easing cannot last forever although it may seem that way. Most economists believe that at some point the U.S. will face above normal inflation for a significant period. (See Tackett and Wolf (2012), Wolf and Tackett (2010), and Wolf and Tackett (2011) for a summary of these issues.) As the examples will demonstrate, this could result in an extra tax burden on phantom profits as well as liquidity issues for certain firms using FIFO.

Even the tame inflation that the country has experienced in recent years could hamper companies that choose FIFO. The additional information provided in footnotes for companies using LIFO provides illustrations of this phenomenon. Easton, Wild, Halsey, and McAnally (2013) illustrate this with the Dow Chemical Company in 2010. They show that had the company used FIFO for all inventory that year, they would have shown an additional $64 million more in taxes. That would have impacted cash as well as cash flow from operations and free cash flow.

Examples and Analysis

Several examples are used to explain the phantom profit situation involving the use of FIFO to students. An overview using the actual purchase and sale of inventory and its impact on the income statement and cash flow statement is shown. This is a great introduction to the concept that could be used in any accounting or finance course. It also gives a "big picture" demonstration in a financial analysis course where you want to expand on the analysis.

Next we provide the example where students can perform more in-depth analysis. In this illustration, students not only see the potential liquidity problem but are able to provide an examination of profitability and financial leverage over more than one time period.

The first example shows the impact of inventory alone on taxation, profitability and liquidity. Partial income statements, balance sheets and a cash flow reconciliation are computed by the students. It demonstrates that the firm using FIFO is more profitable but at the expense of higher taxes. This is the result of not matching current expenses with current revenues. It also shows a negative cash flow even when considering the initial $1,000 in cash.

The second example is a multi-period examination of the original problem with a more complete income statement, balance sheet and cash from operating section of the cash flow statement. In addition to the original assumptions for

Example #1, we assume in this example that the new firm wants to maintain the $1,000 minimum cash balance and to do so must increase its financial leverage. For simplification, we assume that other operating expenses stay the same over the two periods although in an inflationary environment, this is unlikely to be the case. Also, no additional depreciation charges are taken. By the end of the second period, both inventory and fixed assets to total assets are what Fraser and Ormiston (2016) report is common for retail sporting good stores.

The analysis of the income statement in the second example shows that revenues are increasing while gross profit and operating profit remain the same and net income declines. However, gross profit, operating profit and net profit ratios are all deteriorating. This is a good time to point out to students that the gross profit ratio is deteriorating due to the company's inability to pass along increased costs to their customers. Specifically in this case revenues (or prices) are increasing 33% while costs are increasing 50%.

Additionally, on the income statement, students should note that while dollar taxes are decreasing in period two, this is due to the tax shield of debt. From a liquidity perspective, the company's cash outflow has increased from a tax payment of $120 to a tax and interest payment of just over $199. So while the use of debt is helpful from a tax perspective, liquidity and riskiness of debt must also be considered.

The balance sheet changes are quite dramatic. We can compare the company after incorporation but before inventory purchases and the need for debt financing at the end of periods 1 and 2. The decreasing liquidity and increasing need for financing should be emphasized with a discussion of financing options available. The critique of various financing choices is a natural possible topic as well.

Cash flows from operations are negative each period. The reason that they are less negative in the 2nd period is the result of looking at a company that has just begun operations and has initial cash flow for inventory purchases in year one. Additionally, if a company were growing, then inventory units would be increasing each year in addition to price increases. This would result in a larger cash outflow thus exacerbating the situation even more.

Results

As previously presented, an exam question regarding this material and associated student performance were (n=81):

During a period of rapidly rising prices and increasing inventory, which cost flow assumption would provide a company with the greatest cash position?

A. FIFO (47students or 58% incorrect)
B. LIFO (19 students or 23.5% correct)
C. Average cost method (10 students or 12.3% incorrect)

Example 1. Choosing FIFO Instead of LIFO:
Cash Flow & Liquidity Implications for AAA Sporting Goods

Assumptions:

1. Transactions are all in Cash
2. Beginning Cash Balance: $1000
3. Buy 100 units @ $10 each
4. Sell 100 units @ $15 each
5. Buy 100 units @ $15 each (replenish inventory with inflation)
6. Tax rate = 40%

Income Statement

	FIFO	LIFO	Comments
Revenue	$1500	**$1500**	U.S. GAAP: LIFO tries to match
−COGS	1000	**1500**	revenues & expenses. Items sold
Earnings before Tax	500	0	during this period reflect recent costs.
Tax (.40)	200	0	Income Statement focus.
Net Income	300	0	

Partial Balance Sheet (at end of period)

	FIFO	LIFO	
Cash	$ 0	$ 0	IFRS emphasis on current inventory
Inventory	**1500**	**1000**	values w/ FIFO (Balance Sheet focus).
Taxes Payable	200	0	U.S. GAAP values inventory at old, "stale" price.

Cash Flow Reconciliation

	FIFO	LIFO	
Beginning Cash Balance	$1000	$1000	
−Purchase of Inventory	1000	1000	
+Sale of Inventory	1500	1500	
−Purchase of Inventory	1500	1500	
−Taxes	200	0	
Cash Needs	**$(200)**	$ 0	Liquidity concerns under FIFO.*

*By prohibiting LIFO (i.e., by using FIFO), IFRS can create liquidity issues for firms during periods of inflation due to the additional ("phantom") taxable income being reported.

Example 2. Multi-Period Analysis for AAA Sporting Goods.

AAA Sporting Goods	**Before Inv.**					
Balance Sheet (FIFO)	**Purchase**		**EOP 1**		**EOP 2**	
Cash	$ 1,000	58.8%	$ 1,000	31.3%	$ 1,000	23.8%
Inventory	-	0.0%	1,500.0	46.9%	2,500	59.5%
PPE	700	41.2%	700.0	21.9%	700	16.7%
Total Assets	$ 1,700	100.0%	$ 3,200	100.0%	$ 4,200	100.0%
Debt	0	0.0%	$ 1,320	41.3%	2,219.2	52.8%
Stockholder's equity	1,700	100.0%	1,880.0	58.8%	1,980.8	47.2%
Total L & SE	$ 1,700	100.0%	$ 3,200	100.0%	4,200.0	100.0%
Revenues			$ 1,500	100.0%	$ 2,000	100.0%
−COGS			1,000	66.7%	1,500	75.0%
Gross Profit			$ 500	33.3%	$ 500	25.0%
−Other Op expense			200	13.3%	200	10.0%
EBIT			$ 300	20.0%	$ 300	15.0%
− Int. Expense			-	0.0%	132	6.6%
EBT			$ 300	20.0%	$ 168	8.4%
Tax (.40)			120	8.0%	67.2	3.4%
Net income			$ 180	12.0%	$ 100.8	5.0%
CFO						
Operating Cash Flows						
−Inv. Purchase (initial)			(1,000)			
+Sale of Inventory			1,500		2,000.0	
−Replenish Inv. Purchase			(1,500)		(2,500.0)	
−Taxes			(120)		(67.2)	
−Cash Oper. Expense			(200)		(200.0)	
−Interest Expense					(132.0)	*
Oper. Cash Before Fin'g			$ (1,320)		$ (899.2)	

Assumptions:
1. Sold 100 un. @ $20 (Pd. 2)
2. Purch. 100 un. @ $25 (Pd. 2)
3. Interest rate on debt is 10%
4. Min. $1,000 Cash Balance

* Int. Exp. is financing but is in NI which is usually first line on statement of cash flow & in CFO

D. The cost flow assumption would not impact liquidity (5 students or 6.2% incorrect)

After implementing the examples and analysis presented in this paper, performance on the same exam question was (n=78):

During a period of rapidly rising prices and increasing inventory, which cost flow assumption would provide a company with the greatest cash position?

A. FIFO (21 students or 26.9% incorrect)
B. LIFO (53 students or 67.9% correct)
C. Average cost method (3 students or 3.8% incorrect)
D. The cost flow assumption would not impact liquidity (1 student or 1.3% incorrect)

As can be seen, a considerably higher percentage of students identified the correct answer. The exercise has proven to be very effective and has been retained in subsequent classes.

Limitations and Comments

We began our research as a way of rectifying confusion among students as to benefits and risks of choosing FIFO over LIFO. We hypothesized that millennials were struggling with the concept due to little or no experience with inflation in their lifetime. Our underlying assumption (inflation as a foreign topic to students) was never formally tested.

While our examples did appear to improve student comprehension of the specific material as reflected by improved examination results, this was based upon only a year of results. A larger sample size over a longer time period may be beneficial.

Finally, the results may be biased. The exercise was designed with the purpose of addressing low student scores on one particular exam question and improving student comprehension of a specific concept. In doing so, the study's subsequent results may have been unduly influenced.

Conclusion

On the surface, the choice of inventory method (FIFO, LIFO) may not appear to be a significant decision. However, under inflationary conditions, the ramifications are numerous. Of additional concern, students in financial analysis courses were having considerable difficulty comprehending and evaluating these issues. This paper illustrated several of them for students in a clear, concise analysis. The traditional differences in inventory values (balance sheet), cost of goods sold (income statement), and net income (income statement) were shown.

Also, and more importantly, this paper developed examples that brought to light the associated complications related to cash flow and financing (e.g., maintaining a minimum operating cash balance, leverage, interest expense, taxes, etc.) when FIFO was used under such conditions. After implementing the examples and analysis, considerable improvement in student exam performance was observed. Finally, the topic and discussion are timely given that 1) LIFO is prohibited by IFRS and 2) future inflationary concerns have been expressed by many analysts and economists.

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Deriving Three Key Cash Flow Equations Using the Dynamic Identity Approach

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This study derives the Statement of Cash Flows, the Cash Flow Identity, and the Capital Budgeting Cash Flow Equation from a dynamic version of the Balance Sheet Identity and tells a unique, critical story about the cash flow activity of a company or a project. Our derivations proceed in a straightforward, easily-understood manner that helps students to comprehend where these equations come from and how they relate to other financial statements. More importantly, this approach provides a basis that is more intuitive than a traditional debits-and-credits approach for students to understand how changes in balance sheet and income statement accounts affect the cash flow of a firm. This approach strengthens students' intuition for cash flows in advanced finance and accounting courses, and is also useful to non-finance and non-accounting students in introductory finance courses. We provide examples for use in the classroom to illustrate the instructional method that we refer to as the Dynamic Identity Approach.
Keywords: *dynamic identity, statement of cash flows, cash flow identity, capital budgeting, pedagogy*

Introduction

Cash flow analysis is an essential component of much financial analysis. Most approaches to firm valuation, securities valuation, project valuation, capital budgeting, and identification of free cash flow require the development of past and *pro forma* cash flows. For entrepreneurial ventures, cash flow analysis is essential to forecasting future cash requirements. Most of the cash flow analyses for these various financial tasks derive from the Statement of Cash Flows or the Cash Flow

Identity. While users of financial statements generally have an understanding that the Statement of Cash Flows and Cash Flow Identity derive from the balance sheet, this essential linkage is not as obvious to students.

Within the first few chapters of introductory finance textbooks, students almost always find coverage of the Cash Flow Identity, the Statement of Cash Flows, or both. Furthermore, the typical student in an introductory finance course will have already completed at least one basic accounting course, in which case the student will surely have been exposed to the Balance Sheet Identity. Some textbooks explain *why* each term is included in an equation, and even why each term is slotted into a particular place in one of the two equations. Our contribution to the pedagogy of finance and accounting is that we provide a method of explaining and demonstrating why the presented equation (be it the Cash Flow Identity or the Statement of Cash Flows) necessarily *must* be true. We show how these equations derive from the Balance Sheet Identity.

In a proof pertaining to the Cash Flow Identity, Baigent (2005) worked exclusively with that identity and proved the equivalency of two alternate expressions for Cash Flow from Assets. In another related paper, Petty and Rose (2009) established the relationship between the Statement of Cash Flows and the Cash Flow Identity, by deriving the former from the latter. The authors acknowledged that most textbooks do not clearly develop the relationship between the Statement of Cash Flows and the free cash flow from the Cash Flow Identity. Petty and Rose (2009) advocated that textbooks should clarify the linkage, to provide a more complete understanding of these tools and their application in financial management and analysis. These two papers take the Cash Flow Identity as given and either develop the Statement of Cash Flows (Petty and Rose (2009)) or prove that two formulas within the Cash Flow Identity are equivalent (Baigent (2005)). Our approach develops both of these key equations by *starting with* the Balance Sheet Identity.

In a similar spirit of promoting stronger intuition for cash flow relationships for financial management at a more fundamental level, we develop a framework for understanding and interpreting changes in financial statement accounts. We advocate that this approach provides a more intuitive, clearer path toward mastering the relationships among the balance sheet and income statement accounts than debit-and-credit accounting techniques provide. Students and users of financial statements will more ably interpret the relationships captured by the Statement of Cash Flows and the Cash Flow Identity. More importantly, these clienteles will intuitively understand the free cash flow analysis that is the basis for much of financial management, including valuation and capital budgeting.

In addition to deriving the Cash Flow Identity and the Statement of Cash Flows directly from the Balance Sheet Identity, we also demonstrate how to derive the Capital Budgeting Equation used in investment decisions from the Statement

of Cash Flows equation. We refer to our derivations-based instructional method as the Dynamic Identity Approach.

The Dynamic Identity Approach (DIA) ties the Cash Flow Identity and the Statement of Cash Flows to two balance sheets and one income statement that completely describe the results of any operating period. This DIA provides a flexible, generalizable framework that allows students to adapt in cases wherein the set of accounts is different from that which typically appears in introductory textbooks.

The DIA can be deployed as a complete package of materials. It develops all three equations from the fundamental financial statements, as opposed to prescribing a series of calculations (or steps) that students perform by rote. If students can internalize the Dynamic Identity, they can build and understand any of the other equations and can comprehend relationships among financial statement accounts better than they would under a more traditional debits-and-credits framework.

Our paper proceeds with the development of the Dynamic Identity, followed by five key tenets that show how the DIA provides a clear framework for students to understand how transactions necessarily affect relationships among accounts. Then, we derive both the indirect and direct method Statements of Cash Flows using the DIA. We follow with derivations of the Cash Flow Identity (from the Dynamic Identity) and the Capital Budgeting Cash Flow Equation (from the Statement of Cash Flows). To illustrate the usefulness of the Dynamic Identity Approach, we offer specific examples for use in the classroom. These examples are designed for students to strengthen their understanding of relationships among the various financial statement accounts. We then conclude.

The Dynamic Identity

The derivation of the Dynamic Identity begins with the Balance Sheet Identity:

$$\text{Assets} = \text{Liabilities} + \text{Owners' Equity.} \quad (1a)$$

The Balance Sheet Identity is recognized as a financial statement equation that is based on static account balances (or levels), and which must necessarily be true at any instant in time. To facilitate the derivation of our equations and to first incorporate changes in balance sheet accounts, we introduce a dynamic version of the Balance Sheet Identity:

$$\Delta\text{Assets} = \Delta\text{Liabilities} + \Delta\text{Owners' Equity.} \quad (1b)$$

The Balance Sheet Identity necessarily holds at any point in time, so changes in balance sheet accounts also must necessarily be offsetting. These offsetting changes can be instantaneous (such as when a firm buys a new truck with a down payment and some debt, and thus shows simultaneous, equal (net) increases in

Assets and Liabilities) or intertemporal (such as when a firm uses cash to make periodic principal payments on its debt, and thus shows equal decreases in Assets and Liabilities across the period). In Appendix A, we provide a simple but useful diagram that can assist students in visualizing equation 1b.

The first step in the derivation is to expand the three terms in equation 1b into those components that are most commonly employed at the introductory finance level:

$$\begin{array}{c}\Delta\text{Cash} + \Delta\text{Accounts Receivable} \\ + \Delta\text{Inventory} + \Delta\text{Net Fixed Assets}\end{array} = \begin{array}{c}\Delta\text{Accounts Payable} + \Delta\text{Accrued} \\ \text{Liabilities} + \Delta\text{Debt} + \Delta\text{Common} \\ \text{Stock} + \Delta\text{Retained Earnings},\end{array} \quad (1c)$$

where ΔNet Fixed Assets = ΔGross Fixed Assets – ΔAccumulated Depreciation.

If a textbook excludes ΔAccrued Liabilities, it necessarily *proceeds as if* ΔInterest Payable, ΔTaxes Payable, and ΔDividends Payable are all zero. This simplification, in turn, implies that the corresponding items from the income statement (namely, Interest Expense, Tax Expense, and Dividends) fully capture the actual cash flows associated with paying interest, taxes, and dividends.

The next step recognizes that (1) Additions to Retained Earnings are equal to the difference between Net Income and Dividends and (2) ΔRetained Earnings equals Additions to Retained Earnings. Thus, ΔRetained Earnings equals Net Income – Dividends. This substitution introduces the entire income statement, as well as Dividends, into the Dynamic Identity. In Appendix A, we present a diagram that can serve as a visual aid in helping students to understand how income statement terms enter the Dynamic Identity (and the balance sheet):

$$\begin{array}{c}\Delta\text{Cash} + \Delta\text{Accounts Receivable} \\ + \Delta\text{Inventory} + \Delta\text{Net Fixed Assets}\end{array} = \begin{array}{c}\Delta\text{Accounts Payable} + \Delta\text{Accrued} \\ \text{Liabilities} + \Delta\text{Debt} + \Delta\text{Common} \\ \text{Stock} + \text{Net Income} - \text{Dividends}.\end{array} \quad (1d)$$

Equation 1d is one version of what we call the Dynamic Identity. The Dynamic Identity is neither the static nor the dynamic version of the Balance Sheet Identity, as it contains not only changes in balance sheet accounts but also terms from the income statement. Finally, substituting an income statement equation (namely, Net Income = Operating Income – Interest Expense + Gain on Asset Sales – Tax Expense) provides an expanded version of the Dynamic Identity:

$$\begin{array}{c}\Delta\text{Cash} + \Delta\text{Accounts} \\ \text{Receivable} + \Delta\text{Inventory} \\ + \Delta\text{Net Fixed Assets}\end{array} = \begin{array}{c}\Delta\text{Accounts Payable} + \Delta\text{Accrued Liabilities} \\ + \Delta\text{Debt} + \Delta\text{Common Stock} + \text{Operating} \\ \text{Income} - \text{Interest Expense} + \text{Gain on Asset Sales} \\ - \text{Tax Expense} - \text{Dividends}.\end{array} \quad (1e)$$

Note that we use the term 'Interest Expense' in equation 1e rather than other common alternatives such as Interest or Interest Paid. The term 'Interest' is unclear

in that it does not distinguish between Interest Expense and Interest Payable. Interest Paid is calculated as Interest Expense – ΔInterest Payable, and is only equal to Interest Expense in cases when ΔInterest Payable is zero. Similarly, we use the term 'Tax Expense' rather than Taxes. The term 'Taxes' does not distinguish between Tax Expense and Taxes Payable. We can infer that textbook authors typically intend for Taxes to be a synonym for Taxes Paid, and we also observe that Taxes usually appear on the income statement where we would expect to see Tax Expense. We remind the reader that Taxes reflect (or Tax Expense reflects) the actual cash flow related to tax payments only if ΔTaxes Payable is zero. Finally, Gain on Asset Sale equals Selling Price of Asset – Asset's Net Book Value at Time of Sale, and we allow for Gain on Asset Sales to be either a positive or negative number.

Equation 1d will be used to derive the indirect method Statement of Cash Flows, and equation 1e will be used to derive the direct method Statement of Cash Flows and the Cash Flow Identity. We need these separate starting points because the indirect method Statement of Cash Flows includes Net Income and the other two equations include Operating Income, Interest Expense, Gain on Asset Sales, and Tax Expense.

The Dynamic Identity Approach: Emphasizing Relationships among Accounts

Equation 1e, the expanded Dynamic Identity, has 13 items that define the transactional activity of a company. The primary purpose of this Identity is to focus directly on the relationships among accounts, keeping in mind that the Dynamic Identity *must always* be in balance. To focus on debits and credits is unnecessary and potentially obfuscating for anyone who is not specifically pursuing a career in bookkeeping. From the Dynamic Identity, students can easily visualize and understand the following necessary combinations of relationships among accounts:

1. If a transaction involves two balance sheet terms on the left-hand (i.e., the "assets") side of the Dynamic Identity, one change must be positive and the other change must be negative and of the same magnitude.
2. If a transaction involves two balance sheet terms on the right-hand (i.e., the "liabilities & owners' equity") side of the Dynamic Identity, one change must be positive and the other change must be negative and of the same magnitude.
3. If a transaction involves any revenue account on the Dynamic Identity's right-hand side (including Gain), it also must necessarily involve either an increase to the left-hand side (i.e., to an asset account) or a decrease to the right-hand side (i.e., to a liability account).

4. If a transaction involves any expense account on the right-hand side (including a negative Gain), it must also necessarily involve either a decrease to the left-hand side or an increase to the right-hand side of the Dynamic Identity.
5. If a transaction involves one asset term and one liability or owners' equity term, the two terms must change in the same direction.

Later in this paper, we provide representative transactions to illustrate how any given transaction ***must*** result in a balanced Dynamic Identity.

Deriving the Statement of Cash Flows

The Statement of Cash Flows derives from the Dynamic Identity. The basic format of the Statement of Cash Flows is:

$$\Delta\text{Cash} = \begin{array}{c}\text{Cash Flow from}\\ \text{Operations}\end{array} + \begin{array}{c}\text{Cash Flow from}\\ \text{Investing}\end{array} + \begin{array}{c}\text{Cash Flow from}\\ \text{Financing.}\end{array} \quad (2a)$$

The derivation starts with the first version of the Dynamic Identity (namely, with equation 1d) and we move all of the terms but ΔCash to the right side of the equation, yielding:

$$\begin{aligned}\Delta\text{Cash} = {} & -\Delta\text{Accounts Receivable} - \Delta\text{Inventory} + \Delta\text{Accounts}\\ & \text{Payable} + \Delta\text{Accrued Liabilities} - \Delta\text{Net Fixed Assets}\\ & + \Delta\text{Debt} + \Delta\text{Common Stock} + \text{Net Income} - \text{Dividends.}\end{aligned} \quad (2b)$$

We rearrange the terms on the right-hand side of equation 2b so that they coincide with the basic format of the Statement of Cash Flows (with the gaps amidst the first two sets of brackets being intentional):

$$\Delta\text{Cash} = \left(\begin{array}{c}\text{Net Income}\\ \\ \\ -\Delta\text{Accounts}\\ \text{Receivable}\\ -\Delta\text{Inventory}\\ +\Delta\text{Accounts Payable}\\ +\Delta\text{Accrued}\\ \text{Liabilities}\end{array}\right) + \left(\begin{array}{c}-\Delta\text{Net Fixed Assets}\\ \\ \\ \\ \\ \\ \\ \\ \end{array}\right) + \left(\begin{array}{c}\Delta\text{Debt}\\ +\Delta\text{Common Stock}\\ -\text{Dividends}\end{array}\right). \quad (2c)$$

Although equation 2c holds, some additional terms must be included to make the first two components of the equation accurate. In the Cash Flow from Operations component, Depreciation Expense must be added and Gain on Asset Sales must be subtracted. These two adjustments are necessary in order for the calculation to accurately reflect the correct numerical value for Cash Flow from Operations.

In order to maintain the equality, and for the calculation to accurately reflect the right value for Cash Flow from Investing, the same two items are conversely subtracted and added in the Cash Flow from Investing component. These additions and subtractions are italicized for emphasis in equation 2d, which is the indirect method Statement of Cash Flows:

$$\Delta\text{Cash} = \begin{pmatrix} \text{Net Income} \\ + \textit{Deprec. Expense} \\ - \textit{Gain on Asset Sales} \\ - \Delta\text{Accounts Receivable} \\ - \Delta\text{Inventory} \\ + \Delta\text{Accounts Payable} \\ + \Delta\text{Accrued Liabilities} \end{pmatrix} + \begin{pmatrix} - \Delta\text{Net Fixed Assets} \\ - \textit{Deprec. Expense} \\ + \textit{Gain on Asset Sales} \end{pmatrix} + \begin{pmatrix} \Delta\text{Debt} \\ + \Delta\text{Common Stock} \\ - \text{Dividends} \end{pmatrix}. \quad (2d)$$

On a teaching note, the explanation typically offered by instructors (including at least one author of this paper) is lacking for why Depreciation Expense must be added back in as part of the transformation of Net Income into Cash Flow from Operations. The reason most commonly cited is that Depreciation Expense is a non-cash expense, which is nice and intuitively appealing. Yet, most students (and surely some instructors) find the notion of Gain on Asset Sales being a non-cash revenue to be intuitively unappealing! Just as unappealing are the at-times-convoluted stories that instructors use while trying to explain why Depreciation Expense must be subtracted, and Gain on Asset Sales added, as part of the calculation for Cash Flow from Investing.

The explanation typically goes like this. Net Fixed Assets can change in three ways in any operating period: (1) it decreases with increases in Accumulated Depreciation caused by regular depreciation activity, (2) it increases due to any long-term asset purchase by precisely the increase in Gross Fixed Assets, and (3) it decreases due to any asset sale by precisely the net book value of the asset at time of sale. By subtracting Depreciation Expense, we unwind the first way by which Net Fixed Assets change during a period. The remaining two ways by which Net Fixed Assets can change are truly related to investing activities (i.e., purchases and sales). A purchase of a fixed asset increases Gross Fixed Assets; Net Fixed Assets increase by the same amount, and no adjustments are necessary. Finally, for any asset sale, the reduction in net book value is nearly always different from the actual cash flow from the sale. Thus, we need to add the Gain on Asset Sale so that the reduction in Net Fixed Assets plus the Gain on Asset Sale precisely captures the proceeds from the sale.

In comparison, our preferred explanation is that if Depreciation Expense and Gain on Asset Sales were not added and subtracted, respectively, the equation for Cash Flow from Operations would otherwise misstate the correct underlying

value. As for explaining the converse operations in the Cash Flow from Investing component, we prefer to reduce the explanation to either of the following two options. First, our derivation-based approach shows that Depreciation Expense and Gain on Asset Sales are added and subtracted on the right-hand side of the Statement of Cash Flows equation. In order to preserve the equality, these same terms must be subtracted and added, respectively, elsewhere on the right side and the only logical place is in the Cash Flow from Investing section. An alternate explanation is that the calculation would yield the wrong answer for this component if Depreciation Expense and Gain on Asset Sales were not subtracted and added, respectively. Appendix B includes examples that demonstrate how Cash Flow from Operations and Cash Flow from Investing will be incorrect if these adjustments are not included.

Equation 2d is recognizable as the indirect method Statement of Cash Flows; the three calculations in brackets correspond to the three general terms in equation 2a. In practice, this equation may have more terms, but the ones shown here are commonly included in introductory textbooks.

Our method stands in contrast to the approach that is typically used in teaching the Statement of Cash Flows. For example, for Cash Flow from Operations, students are told something like this: "Start with Net Income. Add back Depreciation Expense and any other non-cash expenses. Subtract Gain on Asset Sales and any other non-cash revenues. Subtract [add] any increases [decreases] in Current Asset accounts and, finally, add [subtract] any decreases [increases] in Current Liability accounts. If you complete these five steps, you will have calculated Cash Flow from Operations." We could offer similar typical explanations for Cash Flow from Financing and Cash Flow from Investing. But these approaches are just rote methodology; often, very little intuition develops in students for the interplay among financial statements.

Also noteworthy is the fact that many finance textbooks employ a more simplified version of the Statement of Cash Flows that assumes that no assets are ever sold. Under such a simplifying assumption, Gain on Asset Sales always equals \$0 and we can replace the two remaining terms in the Cash Flow from Investing section (i.e., $-\Delta$Net Fixed Assets and $-$ Depreciation Expense) with a single term: $-\Delta$Gross Fixed Assets. This replacement works *in the absence of any asset sales* because the change in Accumulated Depreciation will always be equal to the Depreciation Expense, but the simplification is inappropriate when asset sales do exist or occur.

The condition of no asset sales in any operating period is unrealistic, and students may be confused if they have learned only the simplified version. Consider the following example that demonstrates the difference between using our richer equation and using the simplified version containing only $-\Delta$Gross Fixed Assets. Suppose that, at the end of an operating period, a firm sells an asset with a Gross Book Value of \$1.0M and Accumulated Depreciation of \$200K

for $830K. In addition, during the period, the firm depreciated this same asset by $50K (and this amount is already included in the end-of-period Accumulated Depreciation of $200K). Thus, at the beginning of the period, Gross Fixed Assets equal $1.0M and Accumulated Depreciation equals $150K for a Net Fixed Assets value of $850K. The sale, viewed in isolation in the richer version of the Statement of Cash Flows, causes ΔNet Fixed Assets to be −$850K (as this subtotal's balance goes from $850K at the start of the period to $0 after the asset is sold). In turn, the overall calculation of Cash Flow from Investing will be: − ΔNet Fixed Assets − Depreciation Expense + Gain on Asset Sale = − (−$850K) − $50K + $30K = $830K, precisely capturing the actual cash flow associated with the sale of the asset. In contrast, the ΔGross Fixed Assets across the same operating period will be −$1.0M, incorrectly yielding a Cash Flow from Investing of − (−$1.0M), or $1.0M, strikingly different from the correct figure of $830K.

Also, in the eventual coverage of capital budgeting in any textbook, any representative asset is typically shown as being sold, at termination, at a Gain (be it positive or negative). Thus, for consistency, Gains should be introduced in coverage of the Cash Flow Identity and the Statement of Cash Flows if the intent is to later allow for the presence of Gains in the Capital Budgeting Cash Flow Equation.

With all of this said, we still feel obligated to include the more simplified version of the indirect method Statement of Cash Flows, because it may better align with some textbooks:

$$\Delta\text{Cash} = \left(\begin{array}{c}\text{Net Income}\\ + \text{Deprec. Expense}\\ - \Delta\text{Accounts Receivable}\\ - \Delta\text{Inventory}\\ + \Delta\text{Accounts Payable}\\ + \Delta\text{Accrued Liabilities}\end{array}\right) + \left(-\Delta\text{Gross Fixed Assets}\right) + \left(\begin{array}{c}\Delta\text{Debt}\\ + \Delta\text{Common Stock}\\ - \text{Dividends}\end{array}\right). \quad (2e)$$

Direct Method Statement of Cash Flows

Other textbooks present the direct method Statement of Cash Flows. Instead of using Net Income to capture every single income statement term, these books' Statements of Cash Flows employ a more detailed set of terms, namely Operating Income − Interest Expense + Gain on Asset Sales − Tax Expense. With this expanded list of income statement terms, the derivation would start with equation 1e and yield an equation that looks like this:

$$\begin{aligned}\Delta\text{Cash} = {} & -\Delta\text{Accounts Receivable} - \Delta\text{Inventory} + \Delta\text{Accounts Payable} + \Delta\text{Accrued}\\ & \text{Liabilities} - \Delta\text{Net Fixed Assets} + \Delta\text{Debt} + \Delta\text{Common Stock} + \text{Operating}\\ & \text{Income} - \text{Interest Expense} + \text{Gain on Asset Sales} - \text{Tax Expense} - \text{Dividends}.\end{aligned} \quad (3a)$$

Rearranging the terms on the right-hand side of equation 3a to fit the basic format of the Statement of Cash Flows, and adding Depreciation Expense in Cash Flow from Operations and subtracting it in Cash Flow from Investing, yields:

$$\Delta\text{Cash} = \begin{pmatrix} \text{Operating Income} \\ + \text{ Deprec. Expense} \\ - \text{ Tax Expense} \\ - \Delta\text{Accounts Receivable} \\ - \Delta\text{Inventory} \\ + \Delta\text{Accounts Payable} \\ + \Delta\text{Accrued Liabilities} \\ - \text{ Interest Expense} \end{pmatrix} + \begin{pmatrix} - \Delta\text{Net Fixed Assets} \\ - \text{ Deprec. Expense} \\ + \text{ Gain on Asset Sales} \end{pmatrix} + \begin{pmatrix} \Delta\text{Debt} \\ + \Delta\text{Common Stock} \\ - \text{ Dividends} \end{pmatrix}. \quad (3b)$$

If a student is doubtful about the equivalency of the two variations of Cash Flow from Operations, the following proof provides insight. Start with terms from the indirect method's version (namely, Net Income + Depreciation Expense – Gain on Asset Sales from equation 2d) and then substitute for Net Income: [Operating Income – Interest Expense + Gain on Asset Sales – Tax Expense] + Depreciation Expense – Gain on Asset Sales, which simplifies to Operating Income + Depreciation Expense – Tax Expense – Interest Expense, precisely the same four income statement terms that are in the Cash Flow from Operations component under the direct method version immediately above.

Interest Expense

The inclusion of Interest Expense in the Cash Flow from Operations section creates an intuitive burden in any introductory finance course because it *functionally* is more related to Cash Flow from Financing than to Cash Flow from Operations (White, Sondhi, & Fried, 2003, p. 97). The burden is exacerbated because Interest Expense is included in the Cash Flow to *Creditors* section of the Cash Flow Identity. The Interest Expense term is subsumed by Net Income in the indirect approach to the derivation of the Statement of Cash Flows, necessarily forcing this term to be included in the Cash Flow from Operations. Interest Expense is explicitly accounted for in the direct approach for deriving the Statement of Cash Flows and thus again appears in Cash Flow from Operations. Statement of Financial Accounting Standard 95, Statement of Cash Flows indicates that "cash payments to lenders and other creditors for interest" (Financial Accounting Standards Board, 1987, p. 9) should be included in Cash Flow from Operations.

Deriving the Cash Flow Identity

Introductory finance textbooks typically define the Cash Flow Identity as:

$$\text{Cash Flow flow Assets} = \begin{matrix}\text{Cash Flow to}\\ \text{Creditors}\end{matrix} + \begin{matrix}\text{Cash Flow to}\\ \text{Shareholders}\end{matrix}. \quad (4a)$$

The left side of this equation typically is expanded as follows:

$$\begin{matrix}\text{'Operating'}\\ \text{Cash Flow}\end{matrix} - \begin{matrix}\Delta\text{Net Working}\\ \text{Capital}\end{matrix} - \begin{matrix}\text{Net Capital}\\ \text{Spending}\end{matrix} = \begin{matrix}\text{Cash Flow to}\\ \text{Creditors}\end{matrix} + \begin{matrix}\text{Cash Flow to}\\ \text{Shareholders,}\end{matrix} \quad (4b)$$

where, at the introductory level, 'Operating' Cash Flow equals Operating Income + Depreciation Expense – Tax Expense, ΔNet Working Capital equals ΔCash + ΔAccounts Receivable + ΔInventory – ΔAccounts Payable – ΔAccrued Liabilities, and Net Capital Spending equals ΔNet Fixed Assets + Depreciation Expense – Gain on Asset Sales.

We derive the Cash Flow Identity starting with the second version of the Dynamic Identity (i.e., equation 1e), which is repeated here for convenience:

$$\begin{matrix}\Delta\text{Cash} + \Delta\text{Accounts}\\ \text{Receivable} + \Delta\text{Inventory}\\ + \Delta\text{Net Fixed Assets}\end{matrix} = \begin{matrix}\Delta\text{Accounts Payable} + \Delta\text{Accrued Liabilities}\\ + \Delta\text{Debt} + \Delta\text{Common Stock} + \text{Operating}\\ \text{Income} - \text{Interest Expense} + \text{Gain on Asset Sales}\\ - \text{Tax Expense} - \text{Dividends.}\end{matrix} \quad (1e)$$

Collecting all of the terms that relate to a firm's assets, current liabilities, and operations on the left side of the equation, and all of the terms that relate to a firm's creditors and shareholders on the right side yields:

$$\begin{matrix}\Delta\text{Cash} + \Delta\text{Accounts Receivable} + \Delta\text{Inventory}\\ - \Delta\text{Accounts Payable} - \Delta\text{Accrued Liabilities}\\ + \Delta\text{Net Fixed Assets} - \text{Operating Income}\\ - \text{Gain on Asset Sales} + \text{Tax Expense}\end{matrix} = \begin{matrix}\Delta\text{Debt}\\ + \Delta\text{Common Stock}\\ - \text{Interest Expense}\\ - \text{Dividends.}\end{matrix}$$

Now, (1) arrange the left-side terms into the three components of Cash Flow from Assets, (2) rearrange the right-side terms so that the creditor-related terms are adjacent and the shareholder-related terms are also adjacent, and (3) multiply both sides by –1:

$$\left(\begin{matrix}\text{Operating}\\ \text{Income}\\ \\ -\text{ Tax}\\ \text{Expense}\end{matrix}\right) - \left(\begin{matrix}\Delta\text{Cash}\\ + \Delta\text{Accounts}\\ \text{Receivable}\\ + \Delta\text{Inventory}\\ - \Delta\text{Accounts}\\ \text{Payable}\\ - \Delta\text{Accrued}\\ \text{Liabilities}\end{matrix}\right) - \left(\begin{matrix}\Delta\text{Net Fixed}\\ \text{Assets}\\ \\ \\ -\text{ Gain on}\\ \text{Asset Sales}\end{matrix}\right) = \left(\begin{matrix}-\Delta\text{Debt}\\ +\text{ Interest}\\ \text{Expense}\end{matrix}\right) + \left(\begin{matrix}-\Delta\text{Common}\\ \text{Stock}\\ +\text{ Dividends}\end{matrix}\right). \quad (4c)$$

In order for the first term to accurately reflect 'Operating' Cash Flow and the third term to accurately reflect Net Capital Spending, we add Depreciation Expense to the first term and also add it to the third term (since the third term is preceded by a minus sign):

$$\left(\begin{array}{c}\text{Operating}\\ \text{Income}\\ +\ \text{Deprec.}\\ \text{Expense}\\ -\ \text{Tax}\\ \text{Expense}\end{array}\right) - \left(\begin{array}{c}\Delta\text{Cash}\\ +\ \Delta\text{Accounts}\\ \text{Receivable}\\ +\ \Delta\text{Inventory}\\ -\ \Delta\text{Accounts}\\ \text{Payable}\\ -\ \Delta\text{Accrued}\\ \text{Liabilities}\end{array}\right) - \left(\begin{array}{c}\Delta\text{Net Fixed}\\ \text{Assets}\\ +\ \text{Deprec.}\\ \text{Exprense}\\ -\ \text{Gain on}\\ \text{Asset Sales}\end{array}\right) = \left(\begin{array}{c}-\ \Delta\text{Debt}\\ +\ \text{Interest}\\ \text{Expense}\end{array}\right) + \left(\begin{array}{c}-\ \Delta\text{Common}\\ \text{Stock}\\ +\ \text{Dividends}\end{array}\right), \quad (4d)$$

or in simpler categories, as captured earlier by equation 4b:

$$\begin{array}{c}\text{'Operating'}\\ \text{Cash Flow}\end{array} - \begin{array}{c}\Delta\text{Net Working}\\ \text{Capital}\end{array} - \begin{array}{c}\text{Net Capital}\\ \text{Spending}\end{array} = \begin{array}{c}\text{Cash Flow to}\\ \text{Creditors}\end{array} + \begin{array}{c}\text{Cash Flow to}\\ \text{Shareholders,}\end{array} \quad (4b)$$

This derivation shows that the Cash Flow Identity comes directly from the Dynamic Identity.

Almost all textbooks label the first component as Operating Cash Flow. This title is a misnomer because the first two components of Cash Flow from Assets (excluding the ΔCash term) actually constitute Operating Cash Flow. Excluding ΔCash, the *first two* components from equation 4d yield Operating Income + Depreciation Expense − Tax Expense − ΔNoncash Net Working Capital, which *exactly* equals the Cash Flow from Operations component of the direct method Statement of Cash Flows (in equation 3b). Besley and Brigham (2015, p. 26) acknowledged that the first term in equation 4b is not really Operating Cash Flow: "The estimate of cash flows from the income statement is the primary operating cash flow, but changes in accounts payable, accounts receivable, inventories, and accruals are also classified as operating cash flows because these [terms] are directly affected by a firm's day-to-day operations." Perhaps a label such as 'Primary Operating Cash Flow' would be enough to help students understand that Operating Cash Flow (as typically presented in a Cash Flow Identity or in a capital budgeting context) is not the same thing as Cash Flow from Operations (in any Statement of Cash Flows context).

Similar to what some introductory finance textbooks do with the Statement of Cash Flows, most textbooks employ a simplified version of the Cash Flow Identity that assumes that assets are never sold. Under this simplifying assumption, Gain on Asset Sales always equals zero, and the two remaining terms in the Net Capital Spending component (namely, ΔNet Fixed Assets + Depreciation Expense) can be replaced with one term (ΔGross Fixed Assets) that will always be their equivalent. This substitution works because, *in the absence of any asset sales*, ΔAccumulated

Depreciation will always equal Depreciation Expense, resulting in the simpler version of the Cash Flow Identity:

$$\begin{pmatrix}\text{Operating}\\ \text{Income}\\ +\ \text{Deprec.}\\ \text{Expense}\\ -\ \text{Tax}\\ \text{Expense}\end{pmatrix} - \begin{pmatrix}\Delta\text{Cash}\\ +\ \Delta\text{Accounts}\\ \text{Receivable}\\ +\ \Delta\text{Inventory}\\ -\ \Delta\text{Accounts}\\ \text{Payable}\\ -\ \Delta\text{Accrued}\\ \text{Liabilities}\end{pmatrix} - \begin{pmatrix}\Delta\text{Gross}\\ \text{Fixed}\\ \text{Assets}\end{pmatrix} = \begin{pmatrix}-\ \Delta\text{Debt}\\ +\ \text{Interest}\\ \text{Expense}\end{pmatrix} + \begin{pmatrix}-\ \Delta\text{Common}\\ \text{Stock}\\ +\ \text{Dividends}\end{pmatrix}. \quad (4e)$$

This derivation approach contrasts with the more common (but less general) approach that is employed in most textbooks. The more common approach gives the students the equations for Operating Cash Flow, ΔNet Working Capital, and Net Capital Spending (also called Investment in Long-term Assets in some books) and shows an example in which data are pulled from the financial statements and used to calculate these three components. The textbooks' methods are similarly prescriptive for Cash Flows to Creditors and Shareholders. Both approaches yield the same ending result (Cash Flow from Assets = Cash Flow to Creditors + Cash Flow to Shareholders), but our approach develops all components in parallel rather than presenting each component in sequence.

Deriving the Capital Budgeting Equation

The capital budgeting decision is applied at the project level, whereas the equations presented thus far are firm-level equations. To transition to project analysis is simple, as long as students understand that a firm is essentially a complex mix of individual projects and that any individual project can be described, and evaluated, by its incremental contributions to these firm-level equations.

The Capital Budgeting Equation can be derived directly (and quickly) from the Statement of Cash Flows. Consider equation 3b, shown again for convenience:

$$\Delta\text{Cash} = \begin{pmatrix}\text{Operating Income}\\ +\ \text{Deprec. Expense}\\ -\ \text{Tax Expense}\\ -\ \Delta\text{Accounts}\\ \text{Receivable}\\ -\ \Delta\text{Inventory}\\ +\ \Delta\text{Accounts Payable}\\ +\ \Delta\text{Accrued}\\ \text{Liabilities}\\ -\ \text{Interest Expense}\end{pmatrix} + \begin{pmatrix}-\ \Delta\text{Net Fixed Assets}\\ -\ \text{Deprec. Expense}\\ +\ \text{Gain on Asset Sales}\end{pmatrix} + \begin{pmatrix}\Delta\text{Debt}\\ +\ \Delta\text{Common Stock}\\ -\ \text{Dividends}\end{pmatrix}. \quad (3b)$$

In typical capital budgeting analyses, financing costs (and proceeds) are excluded from the evaluation of cash flows of individual projects. This exclusion is because financing cash flows are not direct consequences of individual projects and thus do not affect the economic value of the project. Accordingly, the Capital Budgeting Equation develops the cash flows for a project independently from the financing decision, meaning that the three terms in the Cash Flow from Financing section, as well as Interest Expense in the Cash Flow from Operations section, should not be included. This concept is particularly troublesome for some students to understand. Therefore, it is worthwhile to emphasize that, while the financing decision is not relevant in evaluating the economic merits of an individual project, it is absolutely appropriate in a separate evaluation of financing options. The resulting equation is thus:

$$\Delta\text{Cash} = \begin{pmatrix} \text{Operating Income} \\ + \text{ Deprec. Expense} \\ - \text{ Tax Expense} \end{pmatrix} \begin{matrix} - \Delta\text{Accounts Receivable} \\ - \Delta\text{Inventory} \\ + \Delta\text{Accounts Payable} \\ + \Delta\text{Accrued Liabilities} \end{matrix} + \begin{pmatrix} - \Delta\text{Net Fixed Assets} \\ - \text{ Deprec. Expense} \\ + \text{ Gain on Asset Sales} \end{pmatrix}. \quad (5a)$$

Rearranging this equation into familiar categories, we get:

$$\Delta\text{Cash} = \begin{pmatrix} \text{Operating Income} \\ + \text{ Deprec. Expense} \\ - \text{ Tax Expense} \end{pmatrix} - \begin{pmatrix} \Delta\text{Accounts Receivable} \\ + \Delta\text{Inventory} \\ - \Delta\text{Accounts Payable} \\ - \Delta\text{Accrued Liabilities} \end{pmatrix} - \begin{pmatrix} \Delta\text{Net Fixed Assets} \\ + \text{ Deprec. Expense} \\ - \text{ Gain on Asset Sales} \end{pmatrix}, \quad (5b)$$

which corresponds neatly to the typical Capital Budgeting Cash Flow Equation:

$$\Delta\text{Cash} = \begin{matrix} \text{'Operating'} \\ \text{Cash Flow} \end{matrix} - \begin{matrix} \Delta\text{Noncash Net} \\ \text{Working Capital} \end{matrix} - \begin{matrix} \text{Net Capital} \\ \text{Spending} \end{matrix}. \quad (5c)$$

Note that the second term on the right-hand side of the equation is referred to as ΔNoncash Net Working Capital, in contrast to our earlier usage of the term 'ΔNet Working Capital'. The distinction is that, in the context of the Cash Flow Identity, ΔNet Working Capital includes ΔCash, whereas ΔCash (or Cash Flow) is the dependent variable in any capital budgeting setting. We are influenced by Damodaran's (2001) usage of the term to describe the change in Net Working Capital without the change in Cash.

Equation 5b is similar to the capital budgeting equation that is in most introductory finance textbooks but is in a format that illustrates some important issues. First, recall that Operating Income is calculated by subtracting operating expenses and Depreciation Expense from annual (net) Revenue. Our derivation

demonstrates the two simple reasons for why Depreciation Expense is added in the first component and effectively subtracted in the third component: (1) because adding and subtracting a term on the same side of an equation preserves the equality and (2) because those two components' values would otherwise be misstated by precisely the magnitude of the Depreciation Expense.

Next, as also discussed earlier in the context of the Cash Flow Identity, to call the first component Operating Cash Flow is inaccurate. If we combine the *first two* components from equation 5b, we get Operating Income + Depreciation Expense − Tax Expense − ΔNoncash Net Working Capital, which is *precisely* equal to Cash Flow from Operations in the direct method Statement of Cash Flows (in equation 3b). Again following the lead of Besley and Brigham (2015), we suggest calling the first term 'Primary Operating Cash Flow' to emphasize that what educators have traditionally called Operating Cash Flow in a capital budgeting context is *different* from the Statement of Cash Flows' Cash Flow from Operations.

Examples: Emphasizing Relationships

This section contains a set of exercises that might be useful to instructors who want to present a complete package of equations that combine to depict the activities of a firm via a triad of useful financial tools, namely, the Dynamic Identity, Statement of Cash Flows, and Cash Flow Identity.

Examples: Dynamic Identity

The Dynamic Identity (presented in two alternate versions as equations 1d and 1e) allows for a direct analysis of the impact of any single transaction on the financial position of a firm; the impact can be seen in the overarching Dynamic Identity equation that shows changes in asset accounts on one side and changes in liability accounts, changes in common stock, and income statement terms on the other side. In contrast, students may fail to see such an isolated impact if using the traditional t-account, debits-and-credits approach that is taught in the first basic accounting course because, when recording a single transaction, a student might not be thinking any further than "debit one account, credit another account". The insightfulness of the Dynamic Identity becomes apparent to anyone who works through the following set of representative transactions and sees each transaction's impact on the firm (as captured by the Dynamic Identity).

This set of transactions can be used in whole or in part to illustrate and apply the derivations-based approach. We suggest presenting the transactions below to students after deriving the Dynamic Identity but before working through the other equations, and asking students how the Dynamic Identity is affected by each. This exercise will offer a different viewpoint from the debits-and-credits approach. Then, after completing the derivations, these same transactions can be used in a

classroom workday to further ensure mastery of the Statement of Cash Flows and the Cash Flow Identity, as well as to identify areas in which students might need additional clarification or review. We suggest only providing the transactions, and blocking the answers for each.

The Dynamic Identity is generalizable and flexible enough to include more sophisticated transactions than are presented here, but to do so is beyond the scope of this paper. Consider the following representative transactions and how each affects the Dynamic Identity (equation 1e):

Transactions	**Dynamic Identity Effects**
1. Issue $4M Stock for Cash	ΔCash = +4M ΔCommon Stock = +4M
2. Issue $1.5M Debt for Cash	ΔCash = +1.5M ΔDebt = +1.5M
3. Buy a $1.2M Facility and $250K worth of Trucks for Cash	ΔCash = −1.45M ΔNet Fixed Assets (which encompasses ΔGross Fixed Assets) = +1.45M
4. Buy $1.1M Inventory, $620K with Cash and $480K on Credit	ΔCash = −620K ΔInventory = +1.1M ΔAccounts Payable = +480K
5. Pay $435K Accounts Payable in Cash	ΔCash = −435K ΔAccounts Payable = –435K
6. Generate Sales Revenues by selling $980K of Inventory for $3M, $1.3M paid for by customers with Cash and $1.7M paid for with credit	Operating Income (which encompasses Revenues) = 3M ΔCash = +1.3M ΔAccounts Receivable = +1.7M Operating Income (which encompasses Cost of Goods Sold) = –980K ΔInventory = –980K
7. Collect $1.63M of Accounts Receivable	ΔCash = +1.63M ΔAccounts Receivable = −1.63M
8. Depreciate the facility by $60K and the trucks by $5K	Operating Income (which encompasses Depreciation Expense) = −65K ΔNet Fixed Assets (which encompasses ΔAccumulated Deprecation) = −65K
9. Sell the partially-depreciated facility for $1.24M in Cash	ΔCash = +1.24M ΔNet Fixed Assets = −1.14M (encompassing both the ΔGross Fixed Assets of −1.2M and the ΔAccumulated Deprecation of −60K, as the asset is removed from the books) Gain on Asset Sale = 100K
10. Calculate the period's Tax Expense to be $682K, with the cash payment to occur a few months into the following operating period	Tax Expense = 682K ΔAccrued Liabilities = +682K
11. Pay Dividends of $163K with Cash	Dividends = 163K ΔCash = −163K

These effects on the two most basic financial statements will feed into the equations for both the Statement of Cash Flows and the Cash Flow Identity, so we will summarize those effects here before moving on to the next section.

Balance Sheet Effects

Assets		***Liabilities***	
Cash	↑ 7.002M	Accounts Payable	↑ 45K
Accounts Receivable	↑ 70K	Accrued Liabilities	↑ 682K
Inventory	↑ 120K	Debt	↑ 1.5M
Gross Fixed Assets	↑ 250K	***Total Liabilities***	↑ 2.227M
Accumulated Depreciation	↑ 5K	***Owners' Equity***	
Net Fixed Assets	↑ 245K	Common Stock	↑ 4M
Total Assets	↑ 7.437M	Retained Earnings	↑ 1.21M
		Total Owners' Equity	↑ 5.21M
		Total Liabilities & Owners' Equity	↑ 7.437M

Income Statement Effects

Revenues	3M
Cost of Goods Sold	980K
Depreciation Expense	65K
Operating Income	1.955M
Gain on Asset Sales	100K
Taxable Income	2.055M
Tax Expense	682K
Net Income	1.373M
Dividends	163K
Additions to Retained Earnings	1.21M

We can also see that the Dynamic Identity holds for the overall operating period:

$$\begin{array}{ccc} \Delta\text{Cash} + \Delta\text{Accounts Receivable} + \Delta\text{Inventory} + \Delta\text{Net Fixed Assets} & = & \Delta\text{Accounts Payable} + \Delta\text{Accrued Liabilities} + \Delta\text{Debt} + \Delta\text{Common Stock} + \text{Operating Income} - \text{Interest Expense} + \text{Gain on Asset Sales} - \text{Tax Expense} - \text{Dividends} \\ [+7.002\text{M}] + [+70\text{K}] + [+120\text{K}] + [+245\text{K}] & = & [+45\text{K}] + [+682\text{K}] + [+1.5\text{M}] + [+4\text{M}] + 1.955\text{M} - \text{n/a} + 100\text{K} - 682\text{K} - 163\text{K} \\ 7.437\text{M} & = & 7.437\text{M}. \end{array} \quad (1e)$$

Examples: Statement of Cash Flows

Once students become comfortable with the relationships among accounts, as emphasized using the Dynamic Identity in the section above, they should have

little difficulty making the next step of thoroughly understanding how the different terms play into either the Statement of Cash Flows or the Cash Flow Identity. The same thought processes will apply; the differences will simply be in how the terms are arranged.

The same eleven transactions from above are repeated here, but in this section the transactions are viewed within the context of the indirect method Statement of Cash Flows (equation 2d). We analyze the impact of the transactions on the right-hand side of the Statement, to see how each transaction (in isolation) affects or does not affect ΔCash (or Cash Flow), the stand-alone variable on the left side of the equation. (Note: In the following solutions that accompany the transactions, CFO, CFI, and CFF represent, respectively, Cash Flow from Operations, Cash Flow from Investing, and Cash Flow from Financing.)

Transactions	**Statement of Cash Flows Effects**
1. Issue $4M Stock for Cash	ΔCommon Stock = +4M → CFF = 4M
2. Issue $1.5M Debt for Cash	ΔDebt = +1.5M → CFF = 1.5M
3. Buy a $1.2M Facility and $250K worth of Trucks for Cash	ΔGross Fixed Assets = +1.45M (thus, ΔNet Fixed Assets = +1.45M) → CFI = −1.45M
4. Buy $1.1M Inventory, $620K with Cash and $480K on Credit	ΔInventory = +1.1M & ΔAccounts Payable = +480K → CFO = −620K
5. Pay $435K Accounts Payable in Cash	ΔAccounts Payable = −435K → CFO = −435K
6. Generate Revenues by selling $980K of Inventory for $3M, $1.3M paid for by customers with Cash and $1.7M paid for with credit	Revenues = 3M (thus, Net Income = 3M) & ΔAccounts Receiv. = +1.7M → CFO = 1.3M, & Cost of Goods Sold = 980K (thus, Net Income = −980K) & ΔInventory = −980K → CFO = 0
7. Collect $1.63M of Accounts Receivable	ΔAccounts Receiv. = −$1.63M → CFO = 1.63M
8. Depreciate the facility by $60K and the trucks by $5K	Depreciation Expense = 65K (thus, Net Income = −65K) & ΔAccum'd Depreciation = +65K (thus, ΔNet Fixed Assets = −65K) → CFO = 0 & CFI = 0
9. Sell the partially-depreciated facility for $1.24M in Cash	ΔGross Fixed Assets = −1.2M, ΔAccumulated Deprecation = −60K (thus, ΔNet Fixed Assets = −1.14M), & Gain = 100K → CFI = 1.24M
10. Calculate the period's Tax Expense to be $682K, with cash payment to occur a few months into the following period	Tax Expense = 682K (thus, Net Income = −682K) & ΔAccrued Liabilities = +682K → CFO = 0
11. Pay Dividends of $163K with Cash	Dividends = 163K → CFF = −163K

The cumulative results from these eleven transactions are summarized at the end of the previous section and are next entered into equation 2d (the indirect method Statement of Cash Flows) for additional demonstration:

$$\Delta\text{Cash} = \begin{pmatrix} \text{Net Income} \\ + \text{ Deprec. Expense} \\ - \text{ Gain on Asset Sales} \\ - \Delta\text{Accounts Receivable} \\ - \Delta\text{Inventory} \\ + \Delta\text{Accounts Payable} \\ + \Delta\text{Accrued Liabilities} \end{pmatrix} + \begin{pmatrix} - \Delta\text{Net Fixed Assets} \\ - \text{ Deprec. Expense} \\ + \text{ Gain on Asset Sales} \end{pmatrix} + \begin{pmatrix} \Delta\text{Debt} \\ + \Delta\text{Common Stock} \\ - \text{ Dividends} \end{pmatrix} \quad (2d)$$

$$\Delta\text{Cash} = \begin{pmatrix} 1.373\text{M} \\ + 65\text{K} \\ - 100\text{K} \\ - [+70\text{K}] \\ - [+120\text{K}] \\ + [+45\text{K}] \\ + [+682\text{K}] \end{pmatrix} + \begin{pmatrix} - [+245\text{K}] \\ - 65\text{K} \\ + 100\text{K} \end{pmatrix} + \begin{pmatrix} [+1.5\text{M}] \\ + [+4\text{M}] \\ - 163\text{K} \end{pmatrix}$$

$$\Delta\text{Cash} = \begin{pmatrix} \text{Cash Flow} \\ \text{from Operations} \\ 1.875\text{M} \end{pmatrix} + \begin{pmatrix} \text{Cash Flow} \\ \text{from Investing} \\ -210\text{K} \end{pmatrix} + \begin{pmatrix} \text{Cash Flow} \\ \text{from Financing} \\ 5.337\text{M} \end{pmatrix}.$$

From this single set of representative transactions, Cash Flow equals 7.002M.

Examples: Cash Flow Identity

Finally, we turn attention to how the same eleven transactions will affect the Cash Flow Identity for the operating period. Let us now plug numbers into the Cash Flow Identity:

$$\begin{pmatrix} \text{Operating Income} \\ + \text{ Deprec. Expense} \\ - \text{ Tax Expense} \end{pmatrix} - \begin{pmatrix} \Delta\text{Cash} \\ + \Delta\text{Accounts Receivable} \\ + \Delta\text{Inventory} \\ - \Delta\text{Accounts Payable} \\ - \Delta\text{Accrued Liabilities} \end{pmatrix} - \begin{pmatrix} \Delta\text{Net Fixed Assets} \\ + \text{ Deprec. Exprense} \\ - \text{ Gain on Asset Sales} \end{pmatrix} = \begin{pmatrix} - \Delta\text{Debt} \\ + \text{ Interest Expense} \end{pmatrix} + \begin{pmatrix} - \Delta\text{Common Stock} \\ + \text{ Dividends} \end{pmatrix} \quad (4d)$$

$$\begin{pmatrix} 1.955\text{M} \\ + 65\text{K} \\ - 682\text{K} \end{pmatrix} - \begin{pmatrix} [+7.002\text{M}] \\ + [+70\text{K}] \\ + [+120\text{K}] \\ - [+45\text{K}] \\ - [+682\text{K}] \end{pmatrix} - \begin{pmatrix} [+245\text{K}] \\ + 65\text{K} \\ - 100\text{K} \end{pmatrix} = \begin{pmatrix} - [+1.5\text{M}] \\ + 0 \end{pmatrix} + \begin{pmatrix} - [+4\text{M}] \\ + 163\text{K} \end{pmatrix}.$$

So,

$$\begin{pmatrix} \text{'Operating' Cash Flow} \\ 1.338\text{M} \end{pmatrix} - \begin{pmatrix} \Delta\text{Net Working Capital} \\ +6.465\text{M} \end{pmatrix} - \begin{pmatrix} \text{Net Capital Spending} \\ 210\text{K} \end{pmatrix} = \begin{pmatrix} \text{Cash Flow to Creditors} \\ -1.5\text{M} \end{pmatrix} + \begin{pmatrix} \text{Cash Flow to Shareholders} \\ -3.837\text{M} \end{pmatrix}.$$

The identity plays out exactly as it should: Cash Flow from Assets (−5.337M) equals Cash Flow to Creditors (−1.5M) + Cash Flow to Shareholders (−3.837M).

Conclusion

The Cash Flow Identity, the Statement of Cash Flows, and the Capital Budgeting Cash Flow Equation are cornerstone equations for financial analysis and valuation, at both firm and project levels. Typically, students learn these equations separately and without ever building the intuitive bases for how they depend on, and derive from, fundamental balance sheet and income statement relationships. This paper presents a new approach to developing a stronger understanding of these financial statement truisms and dependencies. Our approach begins with the Balance Sheet Identity, transforms it into a dynamic version, substitutes income statement information (in place of ΔRetained Earnings), and reaches the Dynamic Identity. This Dynamic Identity is then an important, overarching equation that contains changes in various balance sheet accounts, along with a handful of income statement terms, and it must always hold true (either for an instantaneous transaction or for an entire operating period filled with transactions). In turn, all three cornerstone equations can be derived from this Dynamic Identity, providing an intuitive basis for users of financial statements to understand how these equations tie directly back to the most fundamental financial statements. Our derivations-based approach should prove useful for instructors and students alike.

If any readers are interested in integrating these various key equations in any of their courses, we would eagerly share our materials and offer insight into how we teach these cash flow equations. We have spent a decade constructing, revising, and refining what is now a rather abundant set of resources related to the topics in this paper. We will be glad to help any instructors reduce their implementation costs. Please contact us with any requests.

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Appendix A

Diagram to Demonstrate the Dynamic Balance Sheet Identity

From any introductory accounting course, students will have already learned the Balance Sheet Identity: Assets = Liabilities + Owners' Equity. The following figure, albeit simple, can serve as an effective aid for visual learners. It allows them to see that, for a single operating period, the dynamic version of the Balance Sheet Identity must hold true.

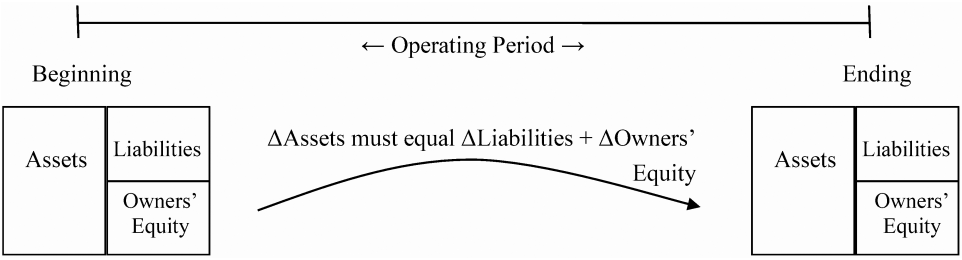
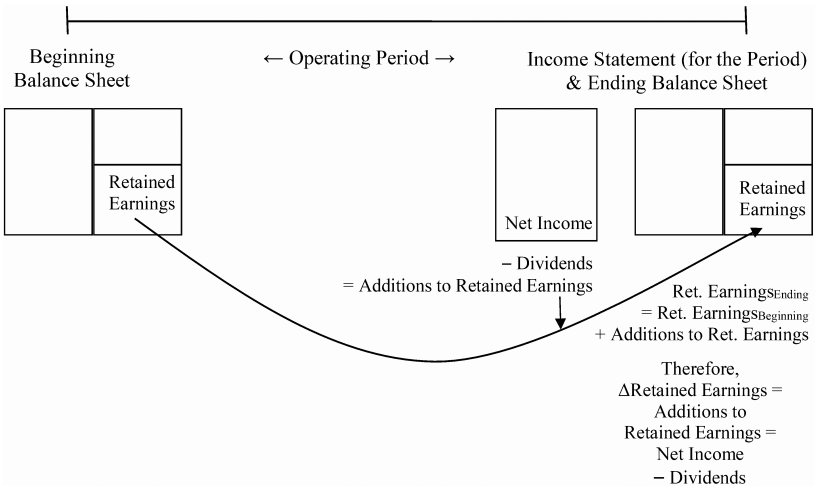


Diagram to Demonstrate How Income Statement Terms Enter the Dynamic Identity

We have found the following diagram to be useful for students. Retained Earnings are often first taught as being "money being put back into the firm". This diagram offers a different perspective, showing that Retained Earnings is nothing more than an account that accumulates the numerical values of every single income-statement item, along with Dividends, from every income statement since the firm's inception.



Appendix B

We provide three examples to demonstrate the necessity of (1) adding Depreciation Expense and subtracting Gain on Asset Sales in the equation for Cash Flow from Operations and (2) doing the opposite in the Cash Flow from Investing section. We present these examples in the context of the indirect method Statement of Cash Flows, but their lessons are equally applicable for the direct method Statement of Cash Flows, the Cash Flow Identity, and even the Capital Budgeting Cash Flow Equation.

Case 1: **An asset is depreciated during the operating period**: Suppose that Depreciation Expense is $100K and, thus, Accumulated Depreciation increases by $100K. Ignoring all other transactions, as well as taxes, consider Cash Flow from Operations *without* the two terms of interest. Net Income would be –$100K and, hence, Cash Flow from Operations would equal –$100K. In addition, Accumulated Depreciation would increase by $100K, making Net Fixed Assets decline by $100K and yielding a Cash Flow from Investing of $100K. Of course, for this transaction in isolation, Cash Flow from Operations and Cash Flow from Investing should both be $0, which they are once we add Depreciation Expense in the Cash Flow from Operations component and subtract it in the Cash Flow from Investing section.

Case 2: **An asset is sold at a Gain**: Suppose that a long-term asset has a gross book value of $1.1M and has $300K of Accumulated Depreciation against it. Suppose that this asset is sold for $830K, making for a Gain on Asset Sale of $30K. Ignoring all other transactions, as well as taxes, and *in the absence of* the two key terms, Net Income would equal $30K and, hence, Cash Flow from Operations would equal $30K. In addition, Gross Fixed Assets will decline by $1.1M and Accumulated Depreciation would decline by $300K, making Net Fixed Assets decline by $800K and yielding a Cash Flow from Investing of $800K.

However, for this transaction in isolation, Cash Flow from Operations should be $0 and Cash Flow from Investing should be $830K. Once we subtract and add Gain on Asset Sales in the respective sections, Cash Flow from Operations and Cash Flow from Investing will accurately represent the true activity related to this isolated transaction.

Case 3: **An asset is depreciated during the operating period and then sold at a Gain**: Suppose that an asset is first depreciated by $100K and then sold at the very end of the operating period under the same conditions as in Case 2 above. (The ending Accumulated Depreciation of $300K already includes this period's depreciation.) The Depreciation Expense is $100K, Gain on Asset Sale is $30K, and Net Income is thus –$70K. Gross Fixed Assets decline by $1.1M (due to the asset sale). Accumulated Depreciation increases by $100K (due to the regular

depreciation activity) and declines by $300K (due to the asset sale). Ignoring all other transactions (and taxes), and *without* the two terms of interest, Net Income would equal −$70K and, hence, Cash Flow from Operations would equal −$70K. In addition, Net Fixed Assets will decline by $900K, yielding a Cash Flow from Investing of $900K.

However, for these two transactions in isolation, Cash Flow from Operations should be $0 and Cash Flow from Investing should be $830K. Once we include the four terms (two in the Operations component and two in the Investing piece), the numbers will be correct.

Teaching Finance in a Technology Lab: Does it Improve with Age?

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Finance labs have been utilized by business schools for many years. This case study reviews the experience of undergraduate students and faculty at one university. The pedagogy used within lab courses is different than was used in a traditional classroom, with more emphasis on data analysis. Over the lab's first five years, enrollment in the finance major increased even though course grades fell. Students report satisfaction with the learning experience and that their own research and technology skills have improved. Finance majors are performing well on standardized assessments.

Keywords: *Lab classroom, Grade inflation, Pedagogy, Major choice*

Introduction

Business schools have been utilizing finance labs for many years. According to the latest survey on universityfinancelab.com, 367 of 1722 (20.4%) business schools in the U.S. and Canada offer finance labs. The majority, 274, are at AACSB accredited schools, with 53% of all AACSB schools offering labs. Only 45 ACBSP accredited schools offer labs, which is 6% of ACBSP schools. The average size of labs is 27 positions.

In 2012, Wingate University became one of the few schools with ACBSP accreditation to offer a finance lab. The university received a donation for the new finance computer lab from a local businessman. The lab was designed by the primary finance professor and the IT department. The lab originally included 20 computer stations that are linked into a central switching system. The lab was expanded in fall 2013 to 24 computers due to demand for finance courses, putting this lab just below the average lab size for all schools.

There are five large screen TV monitors and an electronic drop-down screen in the front of the classroom. The switching system allows the professor to display one student computer per table on the TV monitors in the front of the room. The professor can easily change the student screens that are projected on the TV's for

instruction and monitoring. The lab computers also have access to Capital IQ and CRSP databases, which have an ongoing budget impact as annual subscriptions are paid. Those are not available in other computer labs across campus. Computers do have statistical analysis software; however, this lab offers neither Bloomberg terminals nor a simulation platform. Six years is the average time frame between hardware upgrades (Keeping up, 2012). Over the time period of the study, the hardware was not updated.

The senior level Investments & Portfolio Management course (FINA 414), senior level Corporate Finance course (FINA 418), and senior level International Finance course (FINA 420) have been taught full time in the lab since the 2012/13 academic year. Prior to the opening of the lab, all of these courses were taught in a traditional classroom with limited Excel assignments completed outside of class for homework. Other courses in management, finance, economics and accounting have been utilizing the lab at least part-time.

Moving to a lab environment involved redesigning courses to take advantage of the technology and the new databases. All of the senior level finance courses utilize daily technology activities, with minimal class time devoted to passive lecture. The classes use fewer textbook examples and more real data examples. The course content is similar to that of traditional classrooms, but the delivery method had been adapted to better utilize lab resources.

An observation is that students are less experienced in Excel than expected. More time than originally planned is devoted to basic spreadsheet skills, like freezing cells when copying. This deficiency has been recognized by the School of Business faculty. There is a concerted effort to utilize Excel in lower-level courses and to introduce a new freshman-level technology course for business majors.

The primary questions raised are whether or not the finance lab has encouraged more finance majors and if the educational experience is perceived as positive by the students. This paper will review literature concerning finance labs and analyze data relating to finance enrollment, course grades, and the educational experience provided for students.

Literature Review

The benefits and pitfalls of teaching in computer labs have been documented in the literature. Technology labs allow students to access real world data and to work with larger sets of data than in a traditional classroom. Clinebell and Clinebell (2008) point out that business schools struggle to balance practical experience with academic rigor, with many business schools relying on practitioners as adjunct faculty to fill the gap. Perhaps the use of technology labs is another way to provide practical experience. In addition to building technical skills, the experience gained in labs may boost students' confidence in their job search prospects (Noguera, Budden & Silva, 2011).

Unfortunately, computer access can be a distraction to students by allowing them to surf the web, check email and message each other during class. Martin (2011) compared two class sections, one in a lab and one in a traditional classroom. Students in the traditional class performed slightly better on exams than students in the lab. Martin attributed the lower scores to students using the lab computers for internet use rather than class work.

Skolnik and Puzo (2008) studied the use of laptop computers in business courses. Initially, students in finance courses used university laptops secured to tables, not personal laptops. An expansion to the study evaluated other business courses in which personal computers were allowed in classrooms. In the initial experiment, student surveys found that students felt the technology improved learning and increased Excel skills. In the second part, learning enhancement fell and distraction rose. A survey of faculty found they felt computers were most beneficial when demonstrating spreadsheets and less beneficial when lecturing.

La Roche and Flanigan (2013) found that while the highest percentage of students say they use technology to takes notes, distractions like Facebook and email are also commonly reported. They find students preferred low-tech classroom experiences and that technology is not viewed as a way to increase engagement in the course.

Students may not be aware of available resources, even after taking classes in a lab. Noguera, Boden and Silva (2011) found that resources such as FTS and Bloomberg terminals went unrecognized by nearly a quarter of students; many even failed to notice the ticker/data boards mounted at the entrance to their lab.

Unfortunately, the literature lacks exploration of whether technology labs influence major choice. Studies indicate that a student's choice of major is determined by the student's preferences and characteristics, the department and course characteristics, and expected labor market outcomes. Letter grades may not influence students' course-taking decisions (Main & Ost, 2014). Beggs, Bantham and Taylor (2008) found that few students collected comprehensive information on prospective majors or career paths. Student interests and attributes of the major were the two most important factors, followed by job characteristics and financial considerations. Similarly, Noble-Calkins and Welki (2006) found that the most important factor in determining whether or not a student chose an economics major was the student's own interest. Other significant factors were expected marketability of the degree, expected academic performance, the friendliness of the faculty, and the teaching reputation of the faculty. Student personality traits influence satisfaction with the chosen major, and students are most likely to be satisfied in majors that align with interests (Pritchard, Fudge, Crawford & Jackson, 2018).

Work in subjective expectations models have helped identify key variables in student choice. Both Wiswall and Zafar (2015) and Arcidiacono, Hotz and Kang (2012) estimated structural models which found expected earnings and student

ability to be the two most important variables. High achieving students expected to be high income earners regardless of major, yet leaned toward the major in which they would do the best.

Building on the choices of student majors, this case study addresses three primary research questions regarding the Finance Lab:

1. What has been the impact upon enrollment in the Finance major?
2. What has been the impact upon grades in Finance courses?
3. What is student perception of the impact upon their learning experience?

Methodology and Data Analysis

Enrollment in the Finance Major

The finance lab opened in 2012, one year before the university underwent a large increase in enrollment. Table 1 shows the steady increase in undergraduate students until 2013, when there was a large increase from 1,767 to 2,003 students (13%). The School of Business did not experience the same enrollment growth as the university as a whole; it actually saw its share of the undergraduate student population fall from a high of almost 19% in 2008 to a low of 12.5% in 2014.

When looking at the finance major individually; however, there is an opposite result. The number of finance majors increased the year after the lab opened, from 34 in 2012 to 59 in 2013 (+73%). Finance majors grew as both a percent of business majors and as a percent of total undergraduate students. In 2012, finance majors were just under 15% of business majors and in 2013 were 23%. The share has remained above 20% since the lab opened. Finance majors increased from 2% to 3% of the total undergraduate population. This increase came even as the School of Business saw a decline relative to the total student population.

The jump in Finance majors in 2013 was separate from the university's growth. Many students do not declare finance as a major until their sophomore or even junior year, so there is a lag as the large freshman classes move through their programs. Most students take their 400-level finance courses as seniors.

Course Content and Grading

As the finance major becomes more popular, the lab courses become more important to the learning experience. Some faculty have expressed concern that the lab is attracting students because of the perception that it is easier than taking courses in a regular classroom. To understand this better, both course content and overall grades for the senior level finance courses were compared prior to the lab opening and after the lab opened.

Table 1: Enrollment Data.

	Academic Year									
	2007	**2008**	**2009**	**2010**	**2011**	**2012***	**2013**	**2014**	**2015**	**2016**
Total number of undergraduate students	1458	1442	1414	1618	1721	1767	2003	1941	2016	2076
Business Majors										
ACCT	37	38	44	50	66	63	50	45	56	69
FINA	27	31	22	24	31	34	59	53	55	66
MARK	67	71	58	43	39	45	59	56	64	60
MGMT	119	129	114	105	107	89	87	88	89	107
Total business majors	250	269	238	222	243	231	255	242	264	302
Business majors as % of total undergraduate students	17.1%	18.7%	16.8%	13.7%	14.1%	13.1%	12.7%	12.5%	13.1%	14.5%
Finance Majors										
Finance majors as % of total undergraduate students	1.9%	2.1%	1.6%	1.5%	1.8%	1.9%	2.9%	2.7%	2.7%	3.2%
Finance majors as % of total business majors	10.8%	11.5%	9.2%	10.8%	12.8%	14.7%	23.1%	21.9%	20.8%	21.9%
Enrollment in finance lab courses										
FINA 414 (Fall only)	14	16	10	15	14	16	23	15	18	22
FINA 418 (Fall only)	15	10	9	14	14	13	24	18	21	20
FINA 420 (Spring only)		12	9	10	16	12	12	29	20	17

* Finance lab opened

The same professor has taught all sections of all three courses during the time frame studied. Each course has used a consistent textbook, with similar chapter coverage (Fundamentals of Investments by Jordan, Miller & Dolvin, 5th-7th editions; Fundamentals of Corporate Finance by Ross, Westerfield & Jordan, 9th-10th editions; International Financial Management by Madura, 9th – 11th editions). In the lab classes, the textbook problems are supplemented with problems and cases using actual data. Students learn how and where to find data utilizing multiple databases and web sites. Tests and evaluative tools have been adjusted to incorporate Excel instead of calculators, which allows for larger data sets. Topics and subject matter covered have not changed. The continuity in coverage is one sign that the classes are not made easier to attract students.

Three senior level finance courses have been taught full-time in the lab since Fall 2012: FINA 414 (Investments), FINA 418 (Corporate Finance) and FINA 420 (International Finance). Grades for fall courses (414 and 418) from 2007-2011 were compared to grades from 2013-2017. Grades for the spring course (420) from 2008-2012 were compared to grades from 2013-2017. Table 2 shows the comparison

of means. Originally the lab was going to be used as a supplement to the regular classroom, but due to a lack of classroom space, the lab was unexpectedly required to be used full-time. This left little time for preparation the first semester it was open, Fall 2012. It was a quick, drastic change for both students and the primary professor, so grades for that semester were excluded from comparative analysis.

On average, the final grades for classes taught in the lab are significantly lower than the final grades for classes taught in the traditional classroom ($\alpha = 10\%$). The biggest difference in grades has been for FINA 420, International Finance. The average grade dropped from 87.1% to 83.7%. It is encouraging that the finance major has continued to attract more students, even though grades are lower.

Table 2: Comparison of Grades.

	Lab Mean ***Std dev*** ***Observations***	**Prior classroom Mean** ***Std dev Observations***	**p value**
FINA 414	83.8% *7.3%* *79*	85.8% *7.2%* *69*	0.093
FINA 418	83.8% *7.5%* *83*	86.2% *8.3%* *62*	0.065
FINA 420	83.7% *9.2%* *99*	87.1% *6.5%* *59*	0.007

Lab: 2013-2016 for Fall, 2013-2017 for Spring (excludes first semester in lab: Fall 2012) Prior classroom: 2007-2011 for Fall, 2008-2012 for Spring

Table 3 provides further confirmation that grades in the lab courses have been lower than grades for the same courses when they were taught in the traditional classroom. Chi square testing indicates changes in the grade distribution for FINA 414 [χ^2 (3, n=148) = 75.2, p = .000], FINA 418 [χ^2 (3, n=145) = 150.0, p = .000] and FINA 420 [χ^2 (3, n=158) = 188.0, p = .000]. There are significantly fewer A's and significantly more C's for courses being taught in the lab than before, when they were in a traditional classroom. Note that the academic profile of the University's undergraduate students did not significantly change over the time period of the study. The SAT reading score at the 25th percentile ranged from 440 to 470. The SAT math score at the 25th percentile ranged from 450 to 470. For both, the higher scores came in more recent years.

Table 3: Grade distributions.

	FINA 414		FINA 418		FINA 420	
	Lab	Prior Classroom	Lab	Prior Classroom	Lab	Prior Classroom
A	32%	45%	29%	50%	36%	46%
B	38%	39%	47%	34%	33%	46%
C	29%	14%	22%	16%	26%	8%
D	0%	1%	2%	0%	4%	0%

Having a secondary assessment of student knowledge is beneficial. The School of Business recently began to use the ETS exam as an evaluation of graduating seniors. Unfortunately, there is only one year of data available with this standardized instrument. In 2016-17, finance majors scored in the 89th percentile in finance relative to students at peer institutions. The finance majors also scored in the 92nd percentile in economics, 74th percentile in accounting, 75th percentile in quantitative analysis and 82nd percentile in information systems. Even though the letter grades for finance majors have been lower since the classes transitioned to the lab, their performance in the primary areas is above the average for peers at other institutions. The data does not allow for comparison to prior finance majors who studied in a traditional classroom at this university.

Student Survey Methodology

At the end of every semester, students taking courses in the finance lab are given a survey to evaluate their experience. The questions are designed to measure students' assessment of their baseline skills, how the lab contributed to their learning, and how the lab affected engagement in the course (see the Appendix for survey questions). Students are instructed that it is not intended to substitute for the teaching evaluation, which is a separate electronic survey. They are to focus on the lab experience only, not teaching satisfaction.

The survey contains 17 questions, four demographic and 13 related to the lab. The survey has good internal consistency, with a Cronbach alpha coefficient of 0.828. The survey is distributed in printed form during class time. Students are asked to complete the survey, but doing so is voluntary. A student may have responded to the survey more than once, if he or she enrolled in multiple courses that utilized the lab. Surveys have been gathered every year for FINA 414, FINA 418 and FINA 420. Surveys have been gathered inconsistently for courses that use the lab part-time. This study will focus on only the upper-level courses using the lab full-time.

Student Survey Results

The demographic composition of the 400-level courses has remained fairly consistent, as reported in Table 4. In general, 34-38% of students are female and 56-64% are male. Like at other schools, finance remains a male-dominated major. Finance majors make up the majority of lab students. Eighty-five percent of the non-majors are finance minors. Few students take senior-level finance courses as an elective. Since all finance majors and minors take all three of these courses, there is significant overlap in the students; therefore, GPA or individual academic performance is unlikely to be different between the courses and was not measured.

In the fall semester, the majority of students are lab rookies, meaning they have not had a prior course in the lab. By spring, nearly 90% are lab veterans. This is due to advising and course sequencing. In the future, the number of fall rookies may drop due to faculty members using the lab in lower-level classes. It would be beneficial to introduce the lab earlier in the business core curriculum so that by senior year, the students are more comfortable with the format.

Table 4: Demographic Information.

Course number	**FINA 414**	**FINA 418**	**FINA 420**
Semester offered	Fall	Fall	Spring
Number of students	94	96	99
Number of respondents	86	84	95
Gender			
Females	29	30	36
% of respondents	34%	36%	38%
Males	55	51	53
% of respondents	64%	61%	56%
Prior lab experience			
Lab rookies	54	54	10
% of respondents	63%	64%	11%
Lab veterans	22	18	69
% of respondents	26%	21%	73%
Major			
Finance majors	65	64	72
% of respondents	76%	76%	76%
Non finance majors	19	19	21
% of respondents	22%	23%	22%

Totals may not sum to 100% due to omitted answers and/or to rounding.

General results of the survey by course are shown in Tables 5 through 7. Overall, students report a positive reaction to the lab environment. For all courses, the two highest scoring comments were "Using real data instead of textbook data helped me understand and apply the concepts better" and "The lab facilitated my analysis of problems and projects." Other highly scoring comments were "The lab was beneficial for my understanding course topics", "The lab improved my technology skills" and "The lab improved my research skills."

Many finance labs are dedicated trading environments for investment courses. According to universityfinancelab.com, 68% of labs use Bloomberg, which is a real-time data network and used as a trading platform. A far lower percentage (27% and 20%) use Morningstar and Capital IQ, which are research-oriented platforms. Research studies posted on the web site are also highly oriented to utilizing labs as trading rooms and for student managed investment funds. This study shows that there are benefits to using the lab for other courses such as corporate finance or international finance. Students rate the lab highly for all of the different courses. They like using real data and generally prefer the finance lab to a regular classroom.

One big concern of teaching in a lab environment is the distraction technology can create. Students responded to the comment, "I find it harder to pay attention in the lab than in a regular classroom" at a 3 or below (Neutral to Strongly Disagree). While there is some concern, distraction does not appear to be a big deterrent to teaching in a lab environment. Finding ways to keep the students engaged and on-task is especially important.

To investigate whether there have been differences between the assessments of different groups of students across the five years, Kruskal-Wallis tests were run. In FINA 414, there is a statistically significant difference for two comments: "The lab made me feel more engaged in the topic or assignment" [χ^2 (4, n = 86) = 12.165, p = 0.016] and (2) "The lab improved my technology skill" [χ^2 (4, n= 86) = 12.086, p = 0.017]. The most recent group of students contributed to the difference in assessments. In both FINA 418 and FINA 420, there were no significant differences in responses to any of the comments across semesters.

One goal of the lab is to improve both students' technology skills and research skills. As reported in Table 8, in all three courses, students' answers were different for the statement "Coming into the class at the beginning of the semester, I felt proficient in technology" compared to "The lab improved my technology skills." Mann-Whitney tests also showed significant differences in the answers to "Coming into the class at the beginning of the semester, I felt proficient in research" versus "The lab improved my research skills." Both of these skills can be useful when students are seeking internships or jobs after graduation.

Table 5: Survey means for FINA 414 (Equity Investing and Portfolio Management).

	2012, Fall Mean *Std dev*	2013, Fall Mean *Std dev*	2014, Fall Mean *Std dev*	2015, Fall Mean *Std dev*	2016, Fall Mean *Std dev*
1) The lab was beneficial for my understanding course topics.	4.36 *0.63*	4.42 *0.84*	4.82 *0.39*	4.69 *0.48*	4.40 *0.82*
2) The lab facilitated my analysis of problems and projects	4.43 *0.65*	4.68 *0.48*	4.59 *0.51*	4.69 *0.48*	4.55 *0.61*
3) The lab facilitated new ways to improve my own learning.	4.43 *0.65*	4.37 *0.76*	4.47 *0.62*	4.63 *0.62*	4.35 *0.59*
4) The lab made me feel more engaged in the topic or assignment.	4.14 *1.17*	4.16 *1.07*	4.65 *0.79*	4.63 *0.50*	3.95 *0.76*
5) Using real data instead of textbook data helped me understand and apply the concepts better.	4.50 *0.76*	4.28 *1.23*	4.53 *0.80*	4.94 *0.25*	4.80 *0.52*
6) The lab promoted a collaborative work environment among students.	4.00 0.78	3.79 1.03	3.71 1.11	4.06 0.93	4.00 0.80
7) The lab promoted an interactive work environment among students and the professor.	3.93 *1.00*	4.42 *0.84*	4.35 *0.79*	4.38 *0.72*	4.40 *0.68*
8) I prefer the lab to a regular classroom.	4.36 *1.15*	3.95 *1.39*	4.24 *1.15*	4.25 *1.00*	4.40 *0.82*
9) I find it harder to pay attention in the lab than in a regular classroom.	2.21 *1.19*	2.84 *0.83*	2.35 *1.17*	2.25 *1.13*	2.80 *1.32*
10) The lab improved my technology skills.	3.93 *1.07*	4.63 *0.50*	4.67 *0.49*	4.75 *0.45*	4.30 *0.66*
11) The lab improved my research skills.	4.64 *0.63*	4.37 *0.76*	4.47 *0.74*	4.44 *0.81*	4.40 *0.68*
12) Coming into the class at the beginning of the semester, I felt proficient in technology.	3.86 *1.10*	3.84 *0.77*	3.60 *1.18*	3.63 *0.89*	4.05 *0.89*
13) Coming into the class at the beginning of the semester, I felt proficient in research.	3.14 1.10	3.58 0.90	3.33 0.82	3.63 0.81	3.55 1.05

Note: Responses were on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 6: Survey means for FINA 418 (Corporate Finance).

	2012, Fall Mean *Std dev*	2013, Fall Mean *Std dev*	2014, Fall Mean *Std dev*	2015, Fall Mean *Std dev*	2016, Fall Mean *Std dev*
1) The lab was beneficial for my understanding course topics.	4.75 *0.45*	4.67 *0.59*	4.81 *0.40*	4.71 *0.56*	4.65 *0.61*
2) The lab facilitated my analysis of problems and projects	4.83 *0.39*	4.72 *0.58*	4.81 *0.40*	4.62 *0.59*	4.71 *0.47*
3) The lab facilitated new ways to improve my own learning.	4.58 *0.67*	4.56 *0.62*	4.44 *0.63*	4.57 *0.68*	4.47 *0.62*
4) The lab made me feel more engaged in the topic or assignment.	4.50 *0.67*	4.18 *1.02*	4.75 *0.45*	4.38 *0.74*	4.47 *0.87*
5) Using real data instead of textbook data helped me understand and apply the concepts better.	4.75 *0.62*	4.28 *1.07*	4.75 *0.45*	4.67 *0.73*	4.76 *0.56*
6) The lab promoted a collaborative work environment among students.	4.08 1.00	3.89 0.83	3.81 0.83	3.76 0.83	4.18 0.95
7) The lab promoted an interactive work environment among students and the professor.	4.50 *0.67*	4.22 *0.81*	4.31 *0.70*	4.24 *0.63*	4.47 *0.87*
8) I prefer the lab to a regular classroom.	4.73 *0.65*	4.06 *1.35*	475.00 *0.45*	4.24 *1.09*	4.47 *0.87*
9) I find it harder to pay attention in the lab than in a regular classroom.	2.27 *1.10*	3.17 *1.10*	2.75 *1.29*	2.76 *1.26*	3.06 *1.44*
10) The lab improved my technology skills.	4.45 *0.52*	4.78 *0.43*	4.44 *0.63*	4.29 *1.06*	4.29 *0.77*
11) The lab improved my research skills.	4.27 *0.65*	4.33 *0.69*	4.19 *0.91*	4.48 *0.68*	4.35 *0.79*
12) Coming into the class at the beginning of the semester, I felt proficient in technology.	3.73 *1.01*	4.00 *0.84*	3.56 *1.03*	3.86 *1.01*	4.00 *0.61*
13) Coming into the class at the beginning of the semester, I felt proficient in research.	3.55 *1.04*	3.89 *0.58*	3.38 *1.03*	3.43 *0.81*	3.76 *0.83*

Note: Responses were on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 7: Survey means for FINA 420 (International Finance).

	2013, Spring Mean *Std dev*	2014, Spring Mean *Std dev*	2015, Spring Mean *Std dev*	2016, Spring Mean *Std dev*	2017, Spring Mean *Std dev*
1) The lab was beneficial for my understanding course topics.	4.92 *0.29*	4.57 *0.50*	4.83 *0.38*	4.63 *0.62*	4.71 *0.46*
2) The lab facilitated my analysis of problems and projects	5.00 *0.00*	4.64 *0.62*	4.83 *0.38*	4.81 *0.40*	4.86 *0.36*
3) The lab facilitated new ways to improve my own learning.	4.83 *0.39*	4.57 *0.57*	4.67 *0.49*	4.75 *0.45*	4.38 *0.59*
4) The lab made me feel more engaged in the topic or assignment.	4.92 *0.29*	4.61 *0.50*	4.50 *0.62*	4.63 *0.72*	4.29 *1.01*
5) Using real data instead of textbook data helped me understand and apply the concepts better.	4.92 *0.29*	4.56 *0.70*	4.67 *0.59*	4.75 *0.58*	4.81 *0.40*
6) The lab promoted a collaborative work environment among students.	4.67 0.49	4.36 0.62	4.33 0.77	3.81 0.98	4.24 1.04
7) The lab promoted an interactive work environment among students and the professor.	4.83 *0.39*	4.50 *0.69*	4.39 *0.61*	4.44 *0.81*	4.38 *0.97*
8) I prefer the lab to a regular classroom.	4.75 *0.45*	4.43 *1.07*	4.72 *0.58*	4.81 *0.40*	4.48 *0.87*
9) I find it harder to pay attention in the lab than in a regular classroom.	2.33 *1.23*	2.39 *0.88*	1.94 *1.16*	2.38 *1.26*	2.76 *1.18*
10) The lab improved my technology skills.	4.83 *0.39*	4.74 *0.45*	4.59 *0.62*	4.56 *1.03*	4.45 *0.69*
11) The lab improved my research skills.	4.67 0.49	4.52 0.51	4.47 0.72	4.44 1.09	4.45 0.76
12) Coming into the class at the beginning of the semester, I felt proficient in technology.	4.33 *0.78*	4.23 *0.59*	4.12 *0.70*	4.31 *0.70*	4.15 *0.67*
13) Coming into the class at the beginning of the semester, I felt proficient in research.	3.92 *0.79*	3.93 *0.78*	3.76 *0.75*	3.94 *0.68*	3.90 *0.55*

Note: Responses were on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 8: Student perceptions of research and technology skills by course.

	FINA 414		FINA 418		FINA 420	
	Mean		**Mean**		**Mean**	
	Std dev	**p value**	***Std dev***	**p value**	***Std dev***	**p value**
Coming into the class at the beginning of the semester,	3.46	0.000	3.60	0.000	3.89	0.000
I felt proficient in research.	*0.937*		*0.855*		*0.703*	
The lab improved my research skills.	4.45		4.34		4.5	
	0.718		*0.737*		*0.719*	
Coming into the class at the beginning of the semester,	3.81	0.000	3.81	0.000	4.22	0.000
I felt proficient in technology.	*0.95*		*0.904*		*0.663*	
The lab improved my technology skills.	4.46		4.45		4.63	
	0.702		*0.753*		*0.658*	

Note: Responses were on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). FINA 414, N = 84; FINA 418, N = 83; FINA 420, N = 92

Another concern was the difference between lab rookies and lab veterans. The assumption would be that veterans would feel more proficient in technology and research coming into the lab environment compared to the rookies. Table 9 displays the results for this analysis. For the fall classes with few veterans, there was no difference in perceived proficiency. For the spring course FINA 420, there was a significant difference, with veterans were more confident in their research abilities than rookies. As indicated previously, 90 percent of the students in this course had taken a prior course in the lab. Having had lab experience helped them to have more confidence in their ability to perform research. In recognition of this, the School of Business recently added a new lab course for freshmen. As more students are exposed to the lab technology earlier in their college career, the rookie vs. veteran benefits will be able to be studied more explicitly and with a larger sample size.

Table 9: Student perceptions of research and technology skills by prior experience.

	FINA 414			FINA 418			FINA 420		
	Rookies Means	Veterans Mean		Rookies Mean	Veterans Mean		Rookies Mean	Veterans Mean	
	Std dev	*Std dev*	p value	*Std dev*	*Std dev*	p value	*Std dev*	*Std dev*	p value
Coming into the class at the beginning of the semester,	3.78	4.05	0.319	3.62	3.670	0.994	3.40	3.97	0.011
I felt proficient in research.	*0.925*	*0.785*		*0.88*	*0.767*		*0.699*	*0.69*	
Coming into the class at the beginning of the semester,	3.78	3.770	0.142	3.79	4.000	0.574	4.00	4.28	0.315
I felt proficient in technology.	*0.925*	*0.612*		*0.927*	*0.767*		*0.866*	*0.619*	
Observations	54	22		53	18		10	68	

Note: Responses were on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Conclusions

Technology classrooms have become popular additions to business schools. There is a general belief that these labs are useful in finance courses to simulate trading environments, but these labs can also be used to provide a platform for improving technology and research skills in other types of courses. This case study evaluates the growth of the finance major and feedback from students during the first five years of using a finance lab.

Even as this university had significant growth in undergraduate students, the school of business has attracted a lower percentage of majors. The finance major, however, has increased its market share since the lab opened. Feedback from students indicate that the finance lab is one factor contributing to the added interest in the finance major.

Grade inflation is always a concern in higher education. Can a program still attract majors if the expectations are high and grading is rigorous? To address this concern, grades for the senior level finance courses were compared pre-finance lab to post-finance lab. The material covered in the finance courses did not significantly change; however, the delivery method was updated to include more research and evaluation of actual data. The average numerical grade is significantly lower post-lab than pre-lab, and letter grades are lower. This indicates that the growth in the

finance major is not due to a relaxing of standards or an inflation of grades. Current ETS results show that the finance majors are performing very well against students at peer institutions in areas of finance, economics, accounting, quantitative analysis and information systems. Enrollment data from this university's finance program indicates that student interest is of more importance than letter grades.

Student feedback about the lab courses has been mostly positive. They report increases in technology and research skills. They also appreciate using real data and feel that the lab environment is beneficial to understanding the material. Just as technology can be beneficial to education, it can also be a distraction for students. The students surveyed indicated that distraction is a concern, but they still prefer taking courses in the lab over a regular classroom. An area of future research is the investigation of the specific distractions that are most bothersome to students: is it their own behavior (e.g. using social media or doing homework for other classes) or is it behavior by classmates?

In general, the lab appears to be a positive factor in finance education at Wingate University. Labs require ongoing expenses for databases and computer maintenance, but attracting more students to the major should justify the costs. Utilizing the lab for classes beyond stock trading and investments helps spread the fixed costs over more students, which is helpful as this university's administrators often review cost measures on a per-student basis. One area of future research is to conduct a detailed cost/benefit analysis of the Finance Lab. Technology labs are not just for large schools; smaller universities can see a significant benefit from investing in these labs for their students.

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Appendix: Student survey

Answer the following questions using the scale 1-Strongly Disagree to 5-Strongly Agree.

1. The lab was beneficial for my understanding course topics.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
2. The lab facilitated my analysis of problems and projects.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
3. The lab facilitated new ways to improve my own learning.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
4. The lab made me feel more engaged in the topic or assignment.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
5. Using real data instead of textbook data helped me understand and apply the concepts better.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
6. The lab promoted a collaborative work environment among students.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
7. The lab promoted an interactive work environment among students and the professor.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
8. I prefer the lab to a regular classroom.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
9. I find it harder to pay attention in the lab than in a regular classroom.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
10. The lab improved my technology skills.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
11. The lab improved my research skills.
   Strongly Disagree *Strongly Agree*
   1 2 3 4 5
12. Coming into the class at the beginning of the semester, I felt proficient in technology.

Strongly Disagree *Strongly Agree*
1 2 3 4 5

13. Coming into the class at the beginning of the semester, I felt proficient in research.

Strongly Disagree *Strongly Agree*
1 2 3 4 5

14. Course_____ How many times per week does class meet in lab? _____

15. How many classes have you had in the finance lab prior to this class (please answer with a number)
Part-time_____ Full-time_____

16. Please list any previous classes you have taken in the lab below

_____

_____

_____

17. What is your major?_____ Minor?_____
18. Freshman Sophomore Junior Senior
19. Male Female

Exploring Accounting and Financial Controversies via an Excel Simulation Exercise

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Successful accounting and finance practitioners position themselves as global business advisors, who utilize software and technical material as a platform to navigate through different cultural practices, institutional rules and regulations. While studies still suggest that a disconnect exists between academia and practice when preparing student for careers, professional regulatory bodies, such as the Association to Advance Collegiate Schools of Business (AACSB) and the American Accounting Association Pathways Commission, strongly advocate for the "development of signature pedagogies" which connect the mission of the business school and learning outcomes in support of a globally-diverse student body. This paper describes the development of a spreadsheet exercise which connects mission to the finance and accounting curriculum at a small, private AACSB-accredited business school. In keeping with the institution's charge of infusing technology, international issues, and mission into required coursework, finance and accounting faculty leverage a controversial issue, tax avoidance policy, to examine the impact of the locational choice of a subsidiary on financial statement analysis, and key financial indicators. Tax avoidance and transfer pricing policies serve to develop cultural awareness in accounting and finance students while stressing solid financial statement fundamentals and pro forma financial statement development.

Keywords: *financial statement analysis, international finance, financial reporting, risk, pedagogy*

Introduction

How do educators deliver pedagogical value to business students yet prepare students for ethics-centered careers (O'Leary, 2009; Sweeney and Costello, 2009; Phillips and Graeff, 2014; Patel, Millanta, Tweedie, 2016)? AACSB International (2011) suggested that business schools should pay more attention to preparing students to interact and gain experience with business practices different from their native country; however, Shooshtari and Manuel (2014) question whether academics possess the classroom time to do it. Can a business curriculum train students "to develop a global mindset" and still provide those students the technical training necessary to attain employment and professional certifications (Tucker and Lowe, 2014; Barker, Asare, and Brickman, 2016; Botes and Sharma, 2017)? While several academic papers suggest this can be done effectively (Choi and Liu, 2013; Lafond, McAleer, and Wentzel, 2016; West, 2017), creating assignments and projects underscores the pedagogical "tug-of-war" between dedicating time towards discipline-specific content (Tucker and Lowe, 2014; Barker, Asare, and Brickman, 2016; Botes and Sharma, 2017) and preparing students to think strategically in a global context (Hise & Koeplin, 2010; Holmes, Wilkins, & Zhang, 2017; Karmakar & Mukherjee, 2017), rather than arrive at a single, numerical answer. This paper presents an example of how a controversial topic, such as tax avoidance and the U.S. Tax Cuts and Jobs Act ("TCJA"), can be used as a vehicle to examine important pedagogical linkages in the curriculum, such as technology, foreign exchange rates, and financial statement analysis.

Literature Review

Lakshmi (2016) suggests that popular introductory financial textbooks (e.g., Arnold, 2013; Atrill, 2009; Bodie, Kane, & Marcus, 2013; Brealey, Myers, & Allen, 2013; Hillier, Ross, Westerfield, Jaffe, & Jordan, 2012) have only changed marginally over the past years and do not adequately reflect globalization or more timely topics, such as crowd funding, nonprofit finance and accounting. Finance is a vital component of the accounting curriculum and while most finance courses incorporate ethics (Boatright, 2013; Giacalone & Thompson, 2006; Laskshmi, 2016), existing curricular objectives tend to more strongly support the technical side of finance. This includes value maximization principles, time value of money, and quantitative techniques for assessing risk and return. Lakshmi (2016), Lorsch (et. al, 2008), and Podolny (et al., 2009) advocate for a "pedagogical toolset" which injects a "conscience" into the profession, particularly at the introductory level. By leveraging common language and core principles with financial accounting, managerial accounting, and corporate finance courses, issues such as tax avoidance could be debated, creating linkages to liberal arts education (Van der Wende, 2014) and injecting human behavior and practical applications into the technical toolset

(Botes & Sharma, 2017; Pathways Commission, 2012; Teal & Krishman, 2011; Tucker & Lowe, 2014).

Concepts such as tax havens, tax avoidance theory, and international taxation policy are often viewed as playing the role of the villain with respect to federal budget deficits, GDP growth, and production (Hebous, 2014). Yet, others suggest that designing accounting practices to reduce taxes is "normal" (Sikka, 2015). The 2017 TCJA, for example, suggests that the U.S. corporate income tax rate is "burdensome" in comparison to other countries; however, the Institute on Taxation and Economic Policy (2017) discovered that more than half of the largest 258 corporations in their study paid roughly 21.2% in tax from 2008-2015 and more than half paid *higher* corporate tax rates to foreign governments where they operate than they paid in the United States on their U.S. profits. In addition, roughly 100 companies found a way to 'zero out' federal income taxes in at least one year from 2008-2015.).

Therefore, introducing controversial international taxation issues and transfer pricing within business courses resonates with the millennial generation and underscores the importance of conducting business across borders in several ways (Nebus, 2016). First, roughly 73% of Fortune 500 companies maintain subsidiaries in offshore tax havens and roughly thirty of those companies are responsible for 66% of the $2.5 trillion held by offshore subsidiaries (Phillips, et al., 2016). With a millennial generation more concerned about corporate social responsibility (Deloitte Millennial Survey, 2017), exploring the tax avoidance structures of Apple, Google, Nike, and Goldman Sachs sparks student interest particularly when they learn that U.S. corporations avoided paying $717.8 billion in U.S. taxes in 2015 due to tax havens (Markle, 2016; Olibe, 2017; Phillips, et al., 2016). Muller and Kok (2012) discuss corporate social responsibility in the context of whether multinational firms truly "exploit their multinationality" to avoid paying tax. However, this issue seems secondary to the next generation of financial analysts and accountants who are less willing to sacrifice people for profits (Landrum, 2016).

Second, millennials believe that large multinational firms are not "fulfilling their potential to alleviate society's challenges" (Deloitte Millennial Survey, 2017) yet favorable tax treatment for multinational corporations necessarily leads to concerns about smaller domestic companies, which in turn are paying a disproportionate share of the taxes due to tax avoidance and transfer pricing (Clausing, 2016; Markle & Shackelford, 2009; Olibe, 2017; Sheppard, 2010). Students are exposed to corporations of interest to them, such as Google, which was charged with deliberately understating its profits by charging its UK operations too much for the use of overseas-owned intellectual property. The UK government responded by threatening to impose the measure that has become known as the "Google tax". It represents a revolution in tax policy, to the extent that it introduces the idea that the volume of sales in a particular country should determine the tax paid in that country (Clausing, 2016). Students develop a greater world view of

why large corporations open subsidiaries in countries such as Netherlands, Ireland, Luxembourg, Bermuda, Switzerland, Singapore, and the UK Caribbean Islands (including the Caymans). In addition, students learn that foreign investors can invest money in the United States with no taxation of interest or capital gains, and without being reported to their home governments (Mitchell, 2006).

Third, studies suggest that international tax issues (e.g., tax havens, transfer pricing) present provocative classroom discussions regarding profits attributing to the multinational corporations and whether it is ethical to utilize the tax laws to do so (Fuest, et al., 2013; Phillips, et al., 2016). For example, Wee (2017) suggests that the TCJA may be popular to multinationals like Apple who are becoming frustrated with China's legal system and increased labor costs; however, finance and accounting faculty should be poised to address how trade wars, tariffs, changing tax laws overseas, and WTO challenges to the TCJA will impact free cash flow. Will repatriating cash and a higher free cash flow yield to higher sustainable dividends or increased stock buybacks to fuel acquisitions (Bernstein, 2017, Pozen & Steel, 2018)? In addition, what is the impact of the large free cash flow infusion on earnings per share? If exchange rates fluctuate and the dollar appreciates, the simulation can be used to explore possible strategic options in accounting and finance classes.

Fourth, academics have found it difficult to publish pedagogical and strategy articles in tax policy, possibly because journal editors view this area as more "practitioner" in nature (Nebus, 2016; Phillips, et al., 2016). In order to connect the practitioner topic with academic learning, simulation modeling and interactive spreadsheets can be employed within a classroom to examine the impact of emerging tax avoidance strategies on subsidiaries and MNCs. Specifically, Ramachandran and Ragland (2016) identified a lack in the accounting pedagogical literature with respect to technology; possible disconnections exist between Excel skills faculty include in the accounting curriculum and specific Excel skills faculty believe new hires (i.e. recent accounting graduates) most often use in public accounting. While spreadsheet programs like Excel provide powerful, analytical tools for assessing businesses, Frownfelter-Lohrke (2017) suggest that many Excel-based activities in the accounting curriculum do not allow students to reflect upon their results and fewer still are international in scope. Students make critical errors in spreadsheets without analyzing the reasonableness of their results.

Fifth, McWilliams and Peters (2012) emphasized that course content within finance and accounting disciplines should naturally flow together via financial statement analysis, ratio analysis, and technology; however, both are often taught separately with little cross-communication among faculty. For example, Deloitte's (2018) transfer pricing website highlights the continued importance of transfer pricing in data analytics, financial reporting risk, and capital management risk. Tax avoidance strategies are included in textbooks such as Cost Accounting (Horngren, et. al., 2016), International Accounting (Doupnik & Perera, 2015),

Financial Management (Brigham & Ehrhardt, 2016), and International Finance (Eun & Resnick, 2018). While finance students are well-versed in time value of money and capital budgeting; the simulation provides students with examining the importance of free cash flow using financial statements as the building blocks for analysis. Tax avoidance strategies in the simulation provide teachable moments for establishing connections within accounting courses, developing stronger ties to IFRS standards, and the importance of corporate finance for those students intending careers as financial analysts at multinational firms.

This article intends to describe an integrative Excel-based exercise and simulation model which allows the accounting and finance students to explore how decisions regarding foreign exchange levels and the relationships between various financial statement components and sales will impact a firm's profitability, net worth, fundamental financial ratios, and economic value added (EVA). The simulation exercise emphasizes skill sets in application to relevant global issues, such as international tax loopholes, which impact profit and firm value.

Course Description and Learning Objectives

The spreadsheet exercise was introduced within a required MBA finance course, with prerequisites of financial accounting, managerial accounting, and business statistics. The specific course is required for all business students and serves as a launching point into strategic management, international finance, investment analysis, and international marketing.

The required MBA corporate finance course includes time value of money, financial statement analysis, bond and stock valuation, corporate governance, risk and return, capital budgeting, and select topics on initial public offerings, multinational finance, and mergers and acquisitions. As part of this course, student teams have traditionally adopted a firm and reviewed its annual report, assessed its bond and intrinsic stock price and calculated WACC for firms in the Dow Jones Industrial Average. In addition, student teams prepare papers every two to three weeks which assess their company using the tools and techniques of the chapter being studied at that point in the course.

In Fall 2016, students were provided the offshore tax avoidance report by Phillips (et al., 2016) and McIntyre (et al., 2015) in the first week of the semester, which lists the top twenty Fortune 500 companies with the most tax haven subsidiaries, along with the locations of those subsidiaries. For example, students learn that, in 2015, Bank of America has 109 subsidiaries, which include the Cayman Islands (18), the Netherlands (25), Luxembourg (8), and Ireland (3). Students formulated teams of two or three, and in addition to preparing assignments on financial statement analysis and required financial components for their company, the last module of the course infused tax avoidance with multinational finance and corporate governance. Students integrated the financials of the parent corporation (e.g., Bank

of America) into a prepackaged Excel simulation template, selected two subsidiary locations, and investigated the impact of the location of that subsidiary on financial statement items.

Learning objectives include:

1. To stress the increasing importance of international operations on financial reporting, centering on controversial issues.
2. To develop a broad based tool for satisfying curriculum and assessment goals regarding globalization
3. To review fundamental concepts regarding consolidated financial statement construction
4. To reinforce student appreciation for the connection between the income statement, the statement of retained earnings and the balance sheet
5. To review how foreign exchange rates are used to "translate" the financial statements of foreign subsidiaries under generally accepted accounting principles

Tax Avoidance and Transfer Pricing: What Does the Research Show?

Required MBA finance courses emphasize the importance of discounted cash flow and future free cash flows as measures of a firm's intrinsic value. While standard corporate finance texts do include mention of the impact of taxation on the risk of cash flows, priority is usually given to other topics and very few textbooks address controversial topics (Lakshmi, 2016). Students preparing for careers in financial management, particularly at U.S. multinational corporations, may not be exposed to simple tax implications which may impact business decisions, and the controversies (or ethical underpinnings) associated with those decisions.

Tax Deferrals, Havens, and Piggy Banks

Before presenting students with the spreadsheet simulation, students are exposed to the key terms and topics in the tax avoidance and transfer pricing literature via research papers and popular press articles. Russell and Brock (2016) broadly define tax avoidance as stemming from any policy, activity, or transaction that reduce "the total amount of explicit taxes paid by an individual or organization." Tax reducing strategies are not necessarily abusive; however, strategies can become abusive if they violate the intent or spirit of the law. For example, students learn that most U.S. multinational firms accumulate their foreign business income in foreign subsidiaries, what Boise (2007) refers to as "piggy banks." This action is known as a "deferral," as it allows the firm to defer the U.S. residual tax on their foreign earnings until those earnings are transferred to the U.S. parent company. In practice, this means that U.S. multinational corporations (MNCs) can defer the

American tax on the profits. By all accounts, deferrals have become a significant strategic objective for such firms. As of the third quarter of 2005, an estimated $650 billion in foreign earnings was being held by offshore foreign subsidiaries of U.S. corporations (Boise, 2007). This increased to more than $2 trillion by 2015 (Shapiro & Mathur, 2015).

The term "deferral" implies that the U.S. taxes will eventually be paid, as if the tax revenue is not lost, that it is just an issue of timing. This is simply not true. First, some U.S. corporations can deploy those earnings offshore and never repatriate them to the USA. However, even if the funds are eventually repatriated, extensive deferrals can make the present value of the funds approach zero. In either case, the end result is not a tax deferral, but rather a tax exemption. The report for fiscal year 2007 by the Office of Budget and Management estimated that deferrals would likely cost the government $68 billion in lost tax revenue between 2007 and 2011 (Boise, 2007).

Motivations for Avoidance: Corporate Culture and Ethical Underpinnings

Joulfaian (2000) shows that managerial preferences have a significant impact on a firm's compliance (or noncompliance) with the corporate income tax. His results indicate that noncompliant firms are three times more likely to be managed by executives who have understated their personal taxes, irrespective of firm size. His findings also suggest that the amount of under-reported income is significantly higher for firms run by such executives.

Like the culture, the firm's attitude toward taxes flows down from the top. A survey of executives of U.S. multinationals found that 44 percent said that they avoid repatriation taxes by borrowing funds in the United States rather than transferring funds from foreign subsidiaries, and nearly 20 percent said their company invested its foreign earnings in overseas assets with a lower return than they could have earned in the United States (Clausing, 2016).

Lastly, Crane and Nourzad (1990) reveal that tax evaders respond to higher marginal tax rates by increasing their evasion activities, and also that individuals with higher levels of income tend to evade more in taxes. Yet, when studying the owners of the firms instead of the managers, DeBacker (et. al, 2015) finds that the influence of corruption diminishes as firm size increases. This suggests to students that stronger separation between ownership and control, particularly in larger firms, underscore the importance of corporate governance in business core courses (DeBacker, et. al, 2015). Taken in conjunction with the findings by Fisman and Miguel (2007) and Joulfaian (2000), these results support the conclusion that it is the personal behavior and attitudes of the top executives that drive corporate tax avoidance efforts. Even corporations with owners from countries considered more corrupt evade taxes in the United States, particularly when the firm is smaller, as measured by total assets.

Transfer Pricing and Tax Havens

While transfer pricing theory is prevalent within accounting textbooks, its application with respect to tax avoidance has gained little traction, particularly in pedagogical business journals (Sikka & Willmont, 2010). Given the explosive growth in global trade and the rapidly increasing internationalization and intermarriage of worldwide corporate activities, and the concurrent need of nation states to partially fund their financial needs through corporate taxation, the issue of transfer pricing is reassuming its importance. Leone (2011) reports that million dollar tax disputes with large corporations like Xlinix and GlaxoSmithKline with the U.S. Internal Revenue Service suggest that transfer pricing is a topic which should be included within the business curriculum. Simply put, a "transfer price" is the internal price charged within a corporate entity's various segments or sub-entities for all kinds of goods and services. The problem arises because different tax jurisdictions (mostly nation states or regional economic alliances) have differing tax regimes and regulatory capacities.

Sheppard (2010) suggests that media use the term transfer pricing interchangeably with the practice by multinational corporations (MNCs) of shifting profits to tax havens in an effort to avoid taxation. It is widely suspected that large corporations use the aggressive transfer pricing for within-firm transactions in order to reduce their tax obligations (Desai et al., 2006; Egger et al., 2010).

Sikka and Willmott (2010) also report that public accounting firms, like KPMG, report that transfer pricing is used to successfully reduce tax obligations and maximize profits for their clients. PriceWaterhouseCoopers, Grant Thorton, and Deloitte and Touche all utilize complicated transfer pricing transactions with their clients; with the pending fruition of the UK's government proposal to make transparent transfer pricing schemes, Sikka (2015) reports that initiatives like those suggest by the UK will make the UK less competitive.

Integrative Excel Spreadsheet: Simulation Structure

After preparing financial statement analysis, bond and stock valuation, and WACC calculation for their firm listed on the Offshore Shell Games Report (Phillips, et al., 2016), student teams are ready to utilize the interactive spreadsheet to assess the impact of changes in foreign currency exchange rates, tax rates, and subsidiary location on key financial metrics (e.g., liquidity ratios, working capital, EVA). This section presents the Excel-based spreadsheet for translating financial statements of two subsidiaries for a fictitious firm. The initial spreadsheet is divided into three parts, each representing various points in time during the translation process. A copy of the integrated spreadsheet, as well as the simulation model, can be obtained from the corresponding author.

In this example, the parent corporation has established two subsidiaries in the Cayman Islands (Subsidiary 1) and Luxembourg (Subsidiary 2) on January 1st of fiscal year 20X1 and is attempting to assess the impact of each subsidiary's financial statements on the consolidated statements of the parent corporation. The development of the spreadsheet model consists of several steps – with the baseline model being utilized in scenario analysis and, subsequently, in a simulation exercise – based on the percentage of sales method.

Student teams selected Cayman Islands and Luxembourg for a variety of reasons. Thompson (2015) disclosed that companies like IKEA and Abbott Labs were taking advantage of tax havens in Luxembourg, citing three buildings in Luxembourg representing the mail addresses of roughly 4,000 subsidiaries. While Luxembourg's corporate tax rate is roughly 25%, its government offers many tax breaks which vary from firm to firm, possibly reducing that corporate rate to 5% (Erb, 2014; Thompson, 2015; Worstall, 2015). In addition, the Cayman Islands is perceived as a key Latin American business hub and has a zero effective tax rate. Both the Cayman Islands and Luxembourg were subsidiaries for major Fortune 500 companies (Phillips, et al., 2016).

Master Input Page and Date of Acquisitions

The simulation consists of thirteen interactive worksheets. Figure 1 presents the master input page where students make decisions regarding exchange rates, expected sales, operating income, and other key financial statement items in the simulation. These assumptions are then used to calculate the financial statements for year 20X2 for each legal entity individually. Key considerations include the following

1. Exchange rates should be entered as indirect quotes (i.e. the quantity of foreign currency required to exchange one USD). The exchange rates are required to be entered as of December 20X2 under two scenarios: worst case scenario and best case scenario. The average exchange rates during 20X2 are not required to be entered because they will be calculated by using the exchange rates at end of year 20X1 and 20X2.
2. Students are expected to estimate the effective tax rates for all entities and the pay-out ratio for parent company. If the parent company will not distribute cash dividends, the pay-out ratio should be 0%.
3. Expected sales and annual growth in operating income are required to be estimated under worst and best case scenarios. These estimations should be entered using the functional currency for each entity. Because the annual growth in operating income is one of the key factors in enterprise evaluation, instructors should work with students to ensure that the annual

growth in operating income does not exceed the weighted average cost of capital (WACC). This should avoid any technical problem with the simulation model.

4. Financial statements structure: these indicators are required to be estimated in order to create the needed financial statements. Keep in your mind that these indicators should be reasonable and attainable in order to create realistic pro forma financial statements.
5. The cost of capital matrix provides a pathway for evaluating a firm's optimal structure. It also may reinforce discussion as to whether firms operate at their optimal capital structure. However, instructors may wish to lock this matrix if the simulation is implemented in less advanced major course.
6. Special transactions and transfer pricing may be included in the simulation.

Figure 1: Master Input Sheet.

Master Sheet

Exchange rates at end of Year 20X1 and 20X2	20X1	20X2 Baseline	20X2 Worst case scenario	20X2 Best case scenario
LU / USD	1.12	1.12	0.88	1.13
KY / USD	1.22	1.21	0.82	1.24
Average exchange rates during 20X2				
LU / USD		1.12	1.00	1.13
KY / USD		1.22	1.02	1.23

Additional Assumptions	Parent	Sub #1	Sub #2
Effective tax rate	35%	29.22%	0%
Dividends	10.0%		

Expected sales	Currency	Baseline	Worst case scenario	Best case scenario
Parent	USD	70,000	63,000	77,000
Sub #1	LU	70,000	63,000	77,000
Sub #2	KY	40,000	36,000	44,000
Annual growth (operating income)				
Parent		5.0%	3.75%	11.0%
Sub #1		5.0%	3.75%	5.5%
Sub #2		4.0%	2.0%	4.4%

Financial Statements Structure	Baseline	Worst case scenario	Best case scenario
CGS (% of Sales)	65.0%	18.4%	60.0%
Operating expenses (% of Sales)	10.0%	27.1%	9.5%
Inventory (% of CGS)	25.0%	18.37%	14.3%
Accounts Receivable (% of Sales)	18.0%	54.0%	40.3%
Accounts Payable (% of expenses)	30.0%	28.5%	31.5%
Accruals (% of operating expenses)	25.0%	26.3%	26.17%
Fixed assets turnover	1.30	1.11	1.37
Long-term Debt to Long-term investment	40.0%	38.0%	44.1%

Cost of Capital Matrix

Long-term Debt to From	Long-term Debt to Up to	Cost of debt	Cost of Equity
-	0.45	7.0%	12.0%
0.45	0.75	7.5%	13.0%
0.75	∞	8.0%	15.0%

You have a client in USA. You can sell this client specific products for an amount of $1,000 from any entity. Insert this amount in one entity.

	USD	EX	Base currency
Parent	0	1.00	0
Sub #1	0	1.12	0
Sub #2	1,000	1.21	1,210

In addition, students alter expectations with respect to key financial statement items to define a baseline, worst case, and best case scenario. The simulation assumes that the difference between assets and sources of funding (liabilities and equity) is reported as cash and cash equivalent. Therefore, students will need to review the spreadsheet with the instructor to ensure that cash is within an acceptable range. If students discover that the cash balance is above an acceptable level, the student can adjust long-term debt and long-term investments gradually to define more reasonable assumptions.

Financial Statements for the Parent and Subsidiaries

The financial statements are presented for the parent (Figure 2), the first subsidiary (Figure 3), and the second subsidiary (Figure 4) by using the functional currency of each entity. Each balance sheet consists of four columns displaying

the current balance sheet (20X1), baseline scenario (20X2), worst case scenario (20X2), and best case scenario (20X2). The income statement and statement of retained earnings also consists of the same three columns.

The baseline model consists of three sections: the date of acquisition, subsequent acquisition, and the translated subsidiary statements. Lastly, students determine the dollar value of specific products sold from any entity. On the date of acquiring the Luxembourg (Subsidiary 1) and Cayman Islands (Subsidiary 2) firm, it is initially assumed that the parent corporation purchases each subsidiary for US$25,000 and US$40,000 respectively.

Figure 2: Parent Corporation Financial Statements (20X1 and 20X2).

Parent Company

USD

Balance Sheet

	Actual	Possible Outcomes		
		Baseline	Worst case scenario	Best case scenario
	20X1	**20X2**	**20X2**	**20X2**
Cash and cash equivalents	32,000	23,021	1,610	14,735
Receivables	12,000	12,600	34,014	31,054
Inventory	11,000	11,375	2,127	6,584
Total Current Assets	**55,000**	**46,996**	**37,751**	**52,373**
Equipment	50,000	53,846	56,757	56,410
Investment in Sub #1	25,000	34,958	48,102	38,524
Investment in Sub #2	40,000	47,749	59,024	50,379
Total Assets	**170,000**	**183,549**	**201,633**	**197,686**
Accounts Payable	22,000	15,750	8,161	16,857
Accruals	3,000	1,750	4,488	1,914
Total Current Liabilities	**25,000**	**17,500**	**12,649**	**18,771**
LT debt	45,000	47,538	46,268	53,542
Total Liabilities	**70,000**	**65,038**	**58,917**	**72,313**
Common Stock	5,000	5,000	5,000	5,000
Paid-In Capital	15,000	15,000	15,000	15,000
Retained Earnings	80,000	98,510	122,717	105,373
Total Common Equity	**100,000**	**118,510**	**142,717**	**125,373**
Total Liabilities & Equit	**170,000**	**183,549**	**201,633**	**197,686**

Income Statement

	Possible Outcomes		
	Baseline	Worst case scenario	Best case scenario
	20X2	**20X2**	**20X2**
Revenue	70,000	63,000	77,000
COGS	45,500	11,576	46,200
Gross Profit	**24,500**	**51,424**	**30,800**
Operating Expense	7,000	17,060	7,315
Income Sub #1	9,958	23,102	13,524
Income Sub #2	7,749	19,024	10,379
Operating Income (EBIT)	**35,207**	**76,490**	**47,388**
Interest expense	3,565	3,470	4,016
Income before tax (EBT)	**31,642**	**73,020**	**43,372**
Income tax	11,075	25,557	15,180
Income after tax	**20,567**	**47,463**	**28,192**

Statement of Retained Earnings

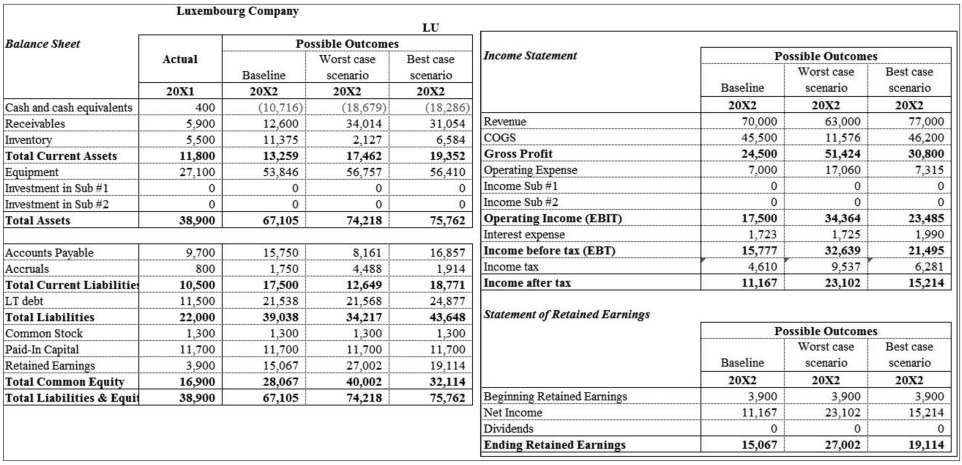
	Possible Outcomes		
	Baseline	Worst case scenario	Best case scenario
	20X2	**20X2**	**20X2**
Beginning Retained Earnings	80,000	80,000	80,000
Net Income	20,567	47,463	28,192
Dividends	2,057	4,746	2,819
Ending Retained Earnings	**98,510**	**122,717**	**105,373**

It is assumed that the initial purchase price for both subsidiaries appears as a credit on the date of acquisition (‘=F10 and ‘=F11) and that the difference between the initial purchase price and its book value (‘=E13) was debited to goodwill. Generally, this section of the spreadsheet is static in nature and may be used by an instructor to reinforce relationships between debits and credits as well as functional relationships between assets and liabilities.

Consolidated Financial Statements

Figure 5 presents the consolidated financial statements balance sheet in United States dollars in December 20X1. It also includes elimination entries which eliminate the common equity of the subsidiaries with the investment in first and second subsidiaries. Since the net assets’ fair value equals the book value, the simulation assumes that the difference between the subsidiaries’ common equity and the subsidiaries’ investments is reported as good will. In the baseline case, both subsidiaries base financial statement items as a percentage of sales. All percentages may be varied in order to emphasize how assets and liabilities are affected by

Figure 3: Subsidiary #1 Financial Statements (20X1 and 20X2).



Luxembourg Company

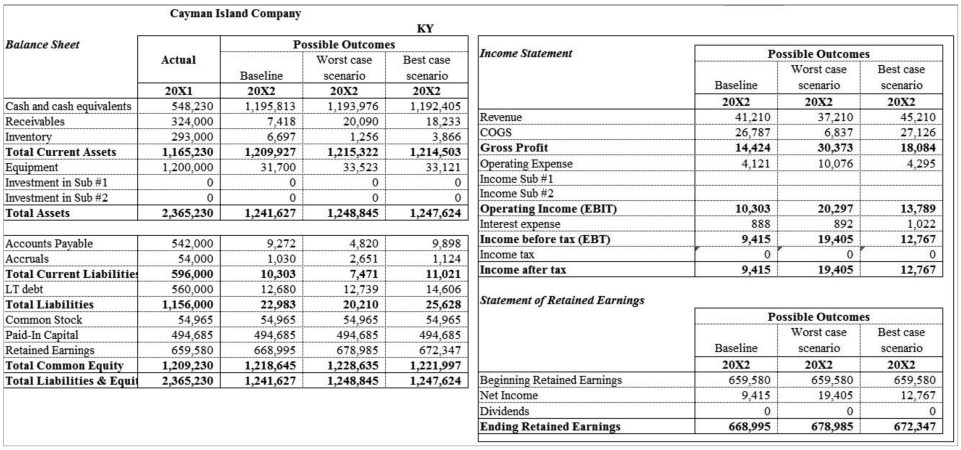
LU

Balance Sheet	Actual	Possible Outcomes		
		Baseline	Worst case scenario	Best case scenario
	20X1	20X2	20X2	20X2
Cash and cash equivalents	400	(10,716)	(18,679)	(18,286)
Receivables	5,900	12,600	34,014	31,054
Inventory	5,500	11,375	2,127	6,584
Total Current Assets	**11,800**	**13,259**	**17,462**	**19,352**
Equipment	27,100	53,846	56,757	56,410
Investment in Sub #1	0	0	0	0
Investment in Sub #2	0	0	0	0
Total Assets	**38,900**	**67,105**	**74,218**	**75,762**
Accounts Payable	9,700	15,750	8,161	16,857
Accruals	800	1,750	4,488	1,914
Total Current Liabilities	**10,500**	**17,500**	**12,649**	**18,771**
LT debt	11,500	21,538	21,568	24,877
Total Liabilities	**22,000**	**39,038**	**34,217**	**43,648**
Common Stock	1,300	1,300	1,300	1,300
Paid-In Capital	11,700	11,700	11,700	11,700
Retained Earnings	3,900	15,067	27,002	19,114
Total Common Equity	**16,900**	**28,067**	**40,002**	**32,114**
Total Liabilities & Equi	**38,900**	**67,105**	**74,218**	**75,762**

Income Statement	Possible Outcomes		
	Baseline	Worst case scenario	Best case scenario
	20X2	20X2	20X2
Revenue	70,000	63,000	77,000
COGS	45,500	11,576	46,200
Gross Profit	**24,500**	**51,424**	**30,800**
Operating Expense	7,000	17,060	7,315
Income Sub #1	0	0	0
Income Sub #2	0	0	0
Operating Income (EBIT)	**17,500**	**34,364**	**23,485**
Interest expense	1,723	1,725	1,990
Income before tax (EBT)	**15,777**	**32,639**	**21,495**
Income tax	4,610	9,537	6,281
Income after tax	**11,167**	**23,102**	**15,214**

Statement of Retained Earnings	Possible Outcomes		
	Baseline	Worst case scenario	Best case scenario
	20X2	20X2	20X2
Beginning Retained Earnings	3,900	3,900	3,900
Net Income	11,167	23,102	15,214
Dividends	0	0	0
Ending Retained Earnings	**15,067**	**27,002**	**19,114**

Figure 4: Subsidiary #2 Financial Statements (20X1 and 20X2).



Cayman Island Company

KY

Balance Sheet	Actual	Possible Outcomes		
		Baseline	Worst case scenario	Best case scenario
	20X1	20X2	20X2	20X2
Cash and cash equivalents	548,230	1,195,813	1,193,976	1,192,405
Receivables	324,000	7,418	20,090	18,233
Inventory	293,000	6,697	1,256	3,866
Total Current Assets	**1,165,230**	**1,209,927**	**1,215,322**	**1,214,503**
Equipment	1,200,000	31,700	33,523	33,121
Investment in Sub #1	0	0	0	0
Investment in Sub #2	0	0	0	0
Total Assets	**2,365,230**	**1,241,627**	**1,248,845**	**1,247,624**
Accounts Payable	542,000	9,272	4,820	9,898
Accruals	54,000	1,030	2,651	1,124
Total Current Liabilities	**596,000**	**10,303**	**7,471**	**11,021**
LT debt	560,000	12,680	12,739	14,606
Total Liabilities	**1,156,000**	**22,983**	**20,210**	**25,628**
Common Stock	54,965	54,965	54,965	54,965
Paid-In Capital	494,685	494,685	494,685	494,685
Retained Earnings	659,580	668,995	678,985	672,347
Total Common Equity	**1,209,230**	**1,218,645**	**1,228,635**	**1,221,997**
Total Liabilities & Equi	**2,365,230**	**1,241,627**	**1,248,845**	**1,247,624**

Income Statement	Possible Outcomes		
	Baseline	Worst case scenario	Best case scenario
	20X2	20X2	20X2
Revenue	41,210	37,210	45,210
COGS	26,787	6,837	27,126
Gross Profit	**14,424**	**30,373**	**18,084**
Operating Expense	4,121	10,076	4,295
Income Sub #1			
Income Sub #2			
Operating Income (EBIT)	**10,303**	**20,297**	**13,789**
Interest expense	888	892	1,022
Income before tax (EBT)	**9,415**	**19,405**	**12,767**
Income tax	0	0	0
Income after tax	**9,415**	**19,405**	**12,767**

Statement of Retained Earnings	Possible Outcomes		
	Baseline	Worst case scenario	Best case scenario
	20X2	20X2	20X2
Beginning Retained Earnings	659,580	659,580	659,580
Net Income	9,415	19,405	12,767
Dividends	0	0	0
Ending Retained Earnings	**668,995**	**678,985**	**672,347**

changes in working capital or additional financing. Figure 6 and Figure 7 present the consolidated financial statements (with debits and credits) and the financial analysis for the baseline case, including WACC and EVA.

Figure 5: Consolidated Financial Statements (20X1).

Consolidated Financial Statements
Year 20X1

Balance Sheet

	Parent	Sub #1	Sub#2	Debit	Credit	USD Total
Cash and cash equivalents	32,000	357	449,369			481,726
Receivables	12,000	5,268	265,574			282,842
Inventory	11,000	4,911	240,164			256,075
Total Current Assets	**55,000**	**10,536**	**955,107**	-	-	**1,020,642**
Equipment	50,000	24,196	983,607			1,057,803
Investment in Sub #1	25,000	-	-		25,000	-
Investment in Sub #2	40,000	-	-		40,000	-
Goodwill				(941,261)		(941,261)
Total Assets	**170,000**	**34,732**	**1,938,713**	**(941,261)**	**65,000**	**1,137,184**
Accounts Payable	22,000	8,661	444,262			474,923
Accruals	3,000	714	44,262			47,977
Total Current Liabilities	**25,000**	**9,375**	**488,525**	-	-	**522,900**
LT debt	45,000	10,268	459,016			514,284
Total Liabilities	**70,000**	**19,643**	**947,541**	-	-	**1,037,184**
Common Stock	5,000	1,161	45,053	46,214		5,000
Paid-In Capital	15,000	10,446	405,480	415,926		15,000
Retained Earnings	80,000	3,482	540,639	544,121		80,000
Cumulative Translation Adjustment						-
Total Common Equity	**100,000**	**15,089**	**991,172**	**1,006,261**	-	**100,000**
Total Liabilities & Equity	**170,000**	**34,732**	**1,938,713**	**1,006,261**	-	**1,137,184**

Figure 6: Consolidated Financial Statements (Baseline Scenario, Year 20X2).

Consolidated Financial Statements
Year 20X2 (Baseline)

Balance Sheet

	Parent	Sub #1	Sub#2	Debit	Credit	USD Total
Cash and cash equivalents	23,021	(9,544)	988,275			1,001,752
Receivables	12,600	11,222	6,130			29,952
Inventory	11,375	10,131	5,534			27,040
Total Current Assets	**46,996**	**11,809**	**999,940**	**0**	**0**	**1,058,745**
Equipment	53,846	47,957	26,198			128,002
Investment in Sub #1	34,958				34,958	0
Investment in Sub #2	47,749				47,749	0
Goodwill	0			(941,261)		(941,261)
Total Assets	**183,549**	**59,766**	**1,026,138**	(941,261)	**82,707**	**245,485**
Accounts Payable	15,750	14,027	7,663			37,440
Accruals	1,750	1,559	851			4,160
Total Current Liabilities	**17,500**	**15,586**	**8,514**	**0**	**0**	**41,600**
LT debt	47,538	19,183	10,479			77,201
Total Liabilities	**65,038**	**34,769**	**18,994**	**0**	**0**	**118,801**
Common Stock	5,000	1,161	45,053	46,214		5,000
Paid-In Capital	15,000	10,446	405,480	415,926		15,000
Retained Earnings	98,510	13,440	548,388	561,828		98,510
Cum. Transl. Adj.	0	(50)	8,224			8,173
Total Common Equity	**118,510**	**24,997**	**1,007,145**	**1,023,968**	**0**	**126,684**
Total Liabilities & Equity	**183,549**	**59,766**	**1,026,138**	**1,023,968**	**0**	**245,485**
	0	0	0			

Income Statement

	Parent	Sub #1	Sub#2	Debit	Credit	Total
Revenue	70,000	62,422	33,918			166,340
COGS	45,500	40,574	22,047			108,121
Gross Profit	**24,500**	**21,848**	**11,871**	**0**	**0**	58,219
Operating Expense	7,000	6,242	3,392			16,634
Income Sub #1	9,958	0	0	9,958		0
Income Sub #2	7,749	0	0	7,749		0
Operating Income (EBIT)	**35,207**	**15,605**	**8,479**	**17,707**	**0**	**41,585**
Interest expense	3,565	1,537	731			5,832
Income before tax (EBT)	**31,642**	**14,069**	**7,749**	**17,707**	**0**	**35,752**
Income tax	11,075	4,111	0			15,185
Income after tax	**20,567**	**9,958**	**7,749**	**17,707**	**0**	**20,567**

Statement of Retained Earnings

	Parent	Sub #1	Sub#2	Debit	Credit	Total
Beginning Retained Earnings	80,000	3,482	540,639	544,121		80,000
Net Income	20,567	9,958	7,749	17,707		20,567
Dividends	2,057	0	0			2,057
Ending Retained Earnings	**98,510**	**13,440**	**548,388**	**561,828**	**0**	**98,510**

Figure 7: Consolidated Financial Analysis (Baseline Scenario, Year 20X2).

Financial Analysis
Year 20X2 (Baseline)

Ratios	**Unit**	**Parent**	**Sub #1**	**Sub#2**	**Consolidated**
Liquidity Ratios					
Working Capital	USD	29,496	(3,777)	991,426	1,017,144
Cash Ratio	Times	1.32	(0.61)	116.07	24.08
Quick Ratio	Times	2.04	0.11	116.79	24.80
Current Ratio	Times	2.69	0.76	117.44	25.45
Profitability Ratios					
Net Profit Margin	%	29.4%	16.0%	22.8%	12.4%
Return on Assets	%	11.2%	16.7%	0.8%	8.4%
Operating Income	USD	22,884	11,046	8,479	42,409
Operating Income Margin	%	32.7%	17.7%	25.0%	25.5%
Return on Investment	%	12.4%	22.5%	0.8%	10.1%
Return on Equity	%	17.4%	39.8%	0.8%	16.2%
Gross Profit Margin	%	35.0%	35.0%	35.0%	35.0%
Financial Leverage Ratio					
Total Debts to Assets	%	35.4%	58.2%	1.9%	48.4%
Capitalization Ratio	%	90.5%	73.9%	99.2%	83.1%
Long-Term Debt to Equity	%	40.1%	76.7%	1.0%	60.9%
Interest Coverage Ratio	Times	9.87	10.16	11.61	7.13

Efficiency Ratios	**Unit**	**Parent**	**Sub #1**	**Sub#2**	**Consolidated**
Total Asset Turnover	Times	0.38	1.04	0.03	0.68
Fixed Asset Turnover	Times	1.30	1.30	1.29	1.30
Accounts Receivable Turnover	Times	5.56	5.56	5.53	5.55
Days' Sales in Receivables	Days	65.70	65.62	65.97	65.72
Inventory Turnover	Times	4.00	4.00	3.98	4.00
Days' Sales in Inventory	Days	91.25	91.14	91.63	91.28
Payables Turnover	Times	2.89	2.89	2.88	2.89
Payables Turnover in Days	Days	126.35	126.19	126.87	126.39
Cash Conversion Cycle	Days	30.60	30.57	30.73	30.62
Altman Z-Score	Number	3.45	2.93	59.63	7.76
Valuation					
Operating Capital	USD	166,049	44,180	1,017,624	203,884
Cost of Debt	%	7.50%	8.00%	7.00%	7.55%
Cost of Equity	%	13.00%	15.00%	12.00%	15.00%
WACC	%	10.67%	10.95%	11.95%	10.97%
Annual growth (operating inc.)	%	5.00%	5.00%	4.00%	4.80%
EVA	USD	5,161	6,210	(113,111)	20,052
Fair Value	USD	423,497	195,064	110,947	720,829

Comparative Consolidated Financial Statements and Financial Analysis (20X2)

Utilizing student inputs, the Excel spreadsheet generates consolidated financial statements (e.g., balance sheet, income statement, and statement of retained earnings), and a secondary worksheet which summarizes key financial ratios, including weighted average cost of capital (WACC), working capital, and economic value added (EVA). The financial analysis sheet presents the most common ratio analysis at two levels: the stand-alone level (i.e. Parent, subsidiary #1, and subsidiary #2) and the consolidated level. In this area, students are highly recommended to think about the difference in some ratios between the consolidated level and stand-alone level such as net profit margin. Figure 7 presents the consolidated financial statements and the financial analysis for the Year 20X2, baseline case results. Figure 8 and Figure 9 present key ratio analysis, including weighted average cost of capital (WACC) and economic value added (EVA) for the baseline case.

Figure 8: Comparative Consolidated Financial Statements (Year 20X2).

Comparative Consolidated Financial Statements
Year 20X2

Balance Sheet **USD**

	Baseline	Worst case scenario	Best case scenario
Cash and cash equivalents	1,001,752	1,436,451	960,169
Receivables	29,952	97,166	73,240
Inventory	27,040	6,076	15,528
Total Current Assets	**1,058,745**	**1,539,694**	**1,048,937**
Equipment	128,002	162,134	133,041
Investment in Sub #1	-	-	-
Investment in Sub #2	-	-	-
Goodwill	(941,261)	(941,261)	(941,261)
Total Assets	**245,485**	**760,566**	**240,716**
Accounts Payable	37,440	23,314	39,757
Accruals	4,160	12,821	4,514
Total Current Liabilities	**41,600**	**36,135**	**44,271**
LT debt	77,201	86,311	87,336
Total Liabilities	**118,801**	**122,446**	**131,607**
Common Stock	5,000	5,000	5,000
Paid-In Capital	15,000	15,000	15,000
Retained Earnings	98,510	122,717	105,373
Cumulative Translation Adjustment	8,173	495,404	(16,264)
Total Common Equity	**126,684**	**638,121**	**109,109**
Total Liabilities & Equity	**245,485**	**760,566**	**240,716**
	(0)	0	0

Income Statement

	Baseline	Worst case scenario	Best case scenario
Revenue	166,340	162,480	182,201
COGS	108,121	29,855	109,320
Gross Profit	**58,219**	**132,625**	**72,880**
Operating Expense	16,634	43,999	17,309
Income Sub #1	-	-	-
Income Sub #2	-	-	-
Operating Income (EBIT)	**41,585**	**88,627**	**55,571**
Interest expense	5,832	6,070	6,616
Income before tax (EBT)	**35,752**	**82,557**	**48,955**
Income tax	15,185	35,094	20,763
Income after tax	**20,567**	**47,463**	**28,192**

Statement of Retained Earnings

	Parent	Sub #1	Total
Beginning Retained Earnings	80,000	80,000	80,000
Net Income	20,567	47,463	28,192
Dividends	2,057	4,746	2,819
Ending Retained Earnings	**98,510**	**122,717**	**105,373**

Student Results and Lessons Learned

Student results reinforced key accounting and financial principles, such as how goodwill is generated on the financial statements and how tests of impairment have replaced systematic amortization. In addition, student results triggered discussions regarding how foreign exchange rates are used to "translate" the financial statements of foreign subsidiaries under generally accepted accounting principles.

The figures presented represent one student team's results involving the two subsidiary creations of a Fortune 500 company in the Cayman Islands and

Figure 9: Financial Analysis.

Financial Analysis
Comparative Analysis of Consolidated Financial Statements

Ratios	Unit	Baseline	Worst case scenario	Best case scenario
Liquidity Ratios				
Working Capital	USD	1,017,144	1,503,559	1,004,665
Cash Ratio	Times	24.08	39.75	21.69
Quick Ratio	Times	24.80	42.44	23.34
Current Ratio	Times	25.45	42.61	23.69
Profitability Ratios				
Net Profit Margin	%	12.4%	29.2%	15.5%
Return on Assets	%	8.4%	6.2%	11.7%
Operating Income	USD	42,409	93,940	56,789
Operating Income Margin	%	25.5%	57.8%	31.2%
Return on Investment	%	10.1%	6.6%	14.4%
Return on Equity	%	16.2%	7.4%	25.8%
Gross Profit Margin	%	35.0%	81.6%	40.0%
Financial Leverage Ratio				
Total Debts to Assets	%	48.4%	16.1%	54.7%
Capitalization Ratio	%	83.1%	95.2%	81.6%
Long-Term Debt to Equity	%	60.9%	13.5%	80.0%
Interest Coverage Ratio	Times	7.13	14.60	8.40

Efficiency Ratios	Unit	Baseline	Worst case scenario	Best case scenario
Total Asset Turnover	Times	0.68	0.21	0.76
Fixed Asset Turnover	Times	1.30	1.00	1.37
Accounts Receivable Turnover	Times	5.55	1.67	2.49
Days' Sales in Receivables	Days	65.72	218.28	146.72
Inventory Turnover	Times	4.00	4.91	7.04
Days' Sales in Inventory	Days	91.28	74.29	51.84
Payables Turnover	Times	2.89	1.28	2.75
Payables Turnover in Days	Days	126.39	285.03	132.74
Cash Conversion Cycle	Days	30.62	7.53	65.82
Altman Z-Score	Number	7.76	7.63	7.89
Valuation				
Operating Capital	USD	203,884	724,432	196,445
Cost of Debt	%	7.55%	7.03%	7.58%
Cost of Equity	%	15.00%	15.00%	15.00%
WACC	%	10.97%	13.69%	10.27%
Annual growth (operating income)	%	4.80%	3.38%	8.27%
EVA	USD	20,052	(5,268)	36,612
Fair Value	USD	720,829	941,466	3,067,022

Luxembourg. The "affordability" of locating a subsidiary in the Cayman Islands (exchange rate of $1.22, effective tax rate of 0%) and Luxembourg (exchange rate of $1.12, effective tax rate of 29.22%) was surprising to students. Students noted the increases in accounts receivable, current assets, and retained earnings. The creation of subsidiaries appeared to be associated with higher profit margins and improved earnings per share (Khan, Srinivasan, & Tan, 2017).

In the worst case scenario, student teams discovered that the subsidiary did not improve profitability for the parent corporation. After reviewing the financial items, gross profits, operating income (EBIT), EBT, income after tax, and retained earnings all decreased from the baseline. Looking at the ratios the gross profit margin decreased from 35% to 30% showing that in the worst case scenario they are not able to better control their costs. And the net profit margin, also decreased from 12.4% to 9.3 % showing that profits earned by the subsidiary are declining. Lastly, the students surmised that the subsidiary was less efficient at converting revenue to profit (comparative analysis sheet).

In the best case scenario, the Cayman Islands offers the highest amount of profit and the least amount of risk. Also, while having a slightly lower effective tax rate, Luxembourg contributes a large percentage of the revenue gained by the parent company. According to the student team, the best case scenario, with both subsidiaries, results in higher revenue and higher profit margins. They also commented on lower common equity, and increased liabilities as a result of increased financial leveraging, confirming the idea that companies have a motivation to raise leverage above the optimal level without taxation due to the deductibility of interest on debt from the tax base whereas the return on equity does not allow that deductibility, overall growth is nearly double that of the baseline (Egger, et al., 2010).

Lastly, the student team assumed that the parent corporation had a client in the USA and you can sell this client specific products for an amount of $1,000 from the Cayman Island subsidiary. When considering the impact of this client on the consolidated financial statements, student teams discovered that the parent corporation's after-tax income increased due to the strategy. Although a very simple

application of transfer pricing, the student team confirmed concepts presented by Contractor (2016), companies "pay higher amounts" to affiliates where taxes are lower and utilize international supply chains to ship goods and services, taking advantage of tax avoidance policies.

For some student teams, there was a supposed ethical issue of whether or not subsidiaries are moral because they capitalize on tax avoidance policies. However, many student teams were quick to point out that, according to the US government, subsidiaries are not illegal as long as a firm discloses all the information. For that reason, many student teams believed that while some might consider it unethical, a firm's priority was to maximize shareholder wealth and there is a difference between tax avoidance and policy abuse.

In Fall 2017, finance students used the simulation and additional research to examine the implications of the TCJA on a firm's financials. Adjusting the simulation's tax rate yielded significant increases in free cash flow and reduced weighted average cost of capital; however, the question remains as to how firms will utilize that free cash flow. From 2008 to 2016, Fortune 500 corporations paid an average effective federal tax rate of 23.4% from 2008 to 2016 (Institute of Taxation and Economic Policy, 2017). The simulation suggests that the tax cut depends upon many financial aspects, such as the firm's capital structure, cash position, and working capital management. Moody's suggests that leverage and private equity financing may become more expensive (Linnane, 2018). In addition, countries like the Bahamas may be less impacted because taxpayers may be losing state and local tax (SALT) deductions and may experience higher taxes to offset road maintenance and other public work projects. Lastly, a teachable moment of the simulation could involve a comparison of the 2004 tax holiday on the repatriation of foreign profits of U.S. companies, which revealed earnings per share increases via the reduction of this important ratio's denominator, the outstanding number of shares.

Conclusion: The Tax Cuts and Jobs Act & Future Recommendations

While medical mistakes can be spotted very quickly, poor corporate governance in the finance and accounting professions are slow to unravel (Lakshmi, 2016). The direction of the university finance and accounting educational systems appears to be supported by quantitative and econometric analysis and student support in preparation for professional certifications; yet, university professors spend so much time focusing on the techniques and tools in assessing risk management practices, options and derivatives, and modern portfolio theory that they may be providing a disservice to finance and accounting students preparing for positions where value judgments are necessary. Team projects integrating technology and quantitative techniques which can yield multiple solutions may help create student "sustainable

networks" which help prepare students for realistic solutions for issues they may face in real world settings (Capra, 2005). This is particularly true when managers are not present and an accounting and finance professional must make the decision for a client rather quickly.

The accounting and finance disciplines are as much a science as they are an art (Vollmer, Mennicken, & Preda, 2009). If university professors can begin to create more stylistic assignments and projects based upon world events and controversial topics, such as tax avoidance and transfer pricing, students preparing for careers in the profession may develop the critical thinking skills necessary to learn how to use their finance and accounting background responsibly when working with clients (Gendron & Smith-Lacroix, 2013). Capra (2005) and Taleb (2010) suggest that diversity is the gatekeeper which provides foundational interactions in the classroom necessary to discuss controversial issues in a global context. Diversity also provides the foundation necessary to combat fragility and disruption within networks. While this project in some small way attempts to leverage technology to create individual, team-based projects surrounding a controversial tax issue in accounting and finance, the importance of rewarding university faculty for creating mission-based assignments may lead to more research in this area. Tax avoidance may be a sustainability problem (Bird & Davis-Nozemack, 2016). While some may argue that tax avoidance stems from a need to increase shareholder wealth and transfer pricing and the TCJA will lead to higher intrinsic corporate values, its question on earnings and key financial statement items remains to be seen (Bernstein, 2017). As Ostrom (2010) suggests, developing finance and accounting curricula which serve the purpose of preparing students to create, assess, and use quantitative models surrounding controversial, ethical issues with no singular solution may lead to student contributions which are less socially destructive in the long run.

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Equity Auction Exercise

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A topic receiving limited attention in most finance courses is multi-winner auctions. Students are often familiar with the typical, single winner, E-bay type of auction. In this type of auction, the winner pays the price of their bid and the auction is over. Equity auctions are conducted in a much different manner as there are multiple winners which all receive the same price regardless of the individual bid price. In this paper we facilitate the learning of auctions by simulating equity auctions in which students compete with one another. Students are able to learn about how auctions work, auction bidding strategy, and the calculation of profits and losses on both types of auctions. We find that comprehension and retention increases significantly when the auction process is performed directly by the students as an in-class simulation. This auction method is also compared to the more traditional book building method commonly used in the United States.

Introduction

Auctions provide a means of finding the true market value of an asset. Although auctions provide interesting information, the topic usually is limited to cursory discussion with little to no application within traditional finance courses. In this paper, we provide an interesting interactive application of such auctions. The goal is to provide students with a framework for understanding auctions and provide interactive exercises to help facilitate the learning process. Weil et al (2001) studied student perceptions of cases and simulations used in accounting and finance and concluded that the major perceived benefit is in the way in which they expose students to real-world complexity, particularly with respect to decision-making. We believe that the use of a simulation exercise is a more effective pedagogical tool for student understanding and retention of the IPO market and auctions in general.

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Equity auctions are covered to a lesser degree in most Finance courses as the understanding of an auction is not a vital component in understanding the United States initial public offering (IPO) process. The United States IPO market principally uses the process of book building. In book building, the investment firms determine the price and allocation of IPO shares by their own discretion and not directly on the bids of individuals. The auction IPO process is much different and a more common event in other countries. One notable example of an IPO auction in the United States is Google.

Students are more familiar with an E-bay type auction process where the top bidder wins the auction and pays the price in which they bid. This is unlike an equity auction. Equity auctions differ in that numerous shares are offered, so multiple bidders will be successful within a single auction. Unlike other auction winners, the winners of equity auctions do not necessarily pay the price they bid, although they are guaranteed to not pay more than their bid price. For these types of auctions, all parties submit bids of various quantity and price. The bids are then sorted in order of price. The quantities of the bids at the highest price levels determine the final auction price. The quantity of highest bid price is subtracted from the total amount offered, followed by the next highest bid and so on until the final bid used to completely fill the entire supply is reached, this bid price becomes the final price for all of the bidders at that price level or higher. So, the price bid that covers the total amount of stock issued represents a ceiling but winners of the auction that bid above this amount receive a better price than their initial bid. This bidding process represents a much new prospective on auctions and strategic bidding within auctions. This simulation is suited for both graduate and undergraduate courses in finance, most notably investments and financial markets and institutions. Large or small class sizes would apply as it can be done individually or in a group setting.

The motivation of this exercise is three fold. One is to have students apply a real life application of equity valuation. A second is to have students better understand the auction process by participating within a simulated one. By the end of the exercise the students find out what strategies work and which do not and learn by doing. The third component is to have students consider the implications of other group actions upon their decisions, viewing the exercise from a game theory prospective. Although much of the attention is on the mechanics of the auction process, there is also an underlying dynamic relating to strategies behind the bidding process. Students must contemplate about how other groups will bid in order to have more success within the auction. Students' successes or failures within the equity auction exercise are directly related to what other students in the class decide as well. Many papers have been published relating game theory to the auction process including; McAfee and McMillan (1987), Weber [2003], and Reny and Zamir [2004]. These papers provide another link for students to connect game theory with the Auction Exercise.

The paper proceeds as follows, section two discusses the literature of book building and auction based IPOs, section three discusses the learning objectives, section four explains the equity auction exercise, section five concludes, and section six provides note for the instructor of the course.

Literature

Researchers of IPOs, generally attribute the underpricing of IPOs to the existence of informational asymmetries between initial shareholders (of the private firm) and first-day investors. They view the abnormal initial (first-day) return or underpricing as a discount to investors who are, on average, less informed about the firm's quality than insiders (Rock, 1986). Benveniste and Spindt [1989] explain how book building better reduces the information frictions between investors and private firms.

In this section we discuss the two typical ways IPOs are sold, which are book building and auction. By far the most common choice within the United States is through book building. This method dominates the U.S. equity market as it gives the power of choice to the investment bank chosen by the private firm which may then select which investors will receive allocation of shares from the offer. Some companies have selected alternative auction methods such as "Dutch" auctions or "dirty" auctions. Most of the firms using auction methods have been small until the IPO of well known internet search engine Google decided to go public using an auction versus the traditional book-building method.

The book building format has unique characteristics, one of which is the close and personal interaction between a few key players on both sides of the transaction. These cozy relationships often lead to preferential allocations of more attractively priced IPOs. Naturally there is the chance that investment banks and buy-side clients collude to set the offer price low and share the profits of underpriced shares. Even though instances of suspect allocations of underpriced shares have been made, the book-building mechanism has survived and is the number one choice of private firms going public in the United States.

In fact, there are several reasons book building is favored over auctions. The most prevalent being information flow and higher quality investors accessed through investment banks. Control of allocation by investment banks leads to better subscription of the IPO and elimination of the Winner's Curse. Sherman and Titman [2002] point out that underpricing of an IPO is a reward for information, whereas informed investors reveal their price information about IPOs in turn for favorable allocations. Cornelli and Goldreich [2001] confirm this point as they show that informed investors request more shares on average and receive better allocations. Sherman (2005) introduces several reasons why book building might be better addressing the issuer's needs. Sherman explains how investors are forced

to be more truthful with information as investment banks control the allocation of shares furthering the above information for shares tradeoff idea. Pukthuanthong, Varaiya and Walker [2007] find under subscription (offer not fully sold) of IPOs using the auction framework.

Some potential problems of book building include significant underpricing of offers by investment banks, which leads to money left on the table costing the offering firm and original investors. Highly underpriced IPOs become valuable currency for investment banks especially during the Bubble Period in 1999-2000, and during the Internet bubble from 1996-2000. Investment banks would make quid-pro-quo agreements with both the CEOs of private firms going public and venture capitalists. Examples of spinning (quid-pro-quo agreements) have been discussed in several popular press articles with empirical evidence shown by Flagg and Margetis [2008] and Liu and Ritter [2010].

An obvious alternative to book building is to use the auction method. Due to its fair and transparent nature, the auction mechanism has been used in several countries, including the United Kingdom and France. It is fair as it allows all investors to have equal access to IPO shares unlike book building where investment banks control the allocation. While in theory the auction process seems fair, the evidence of the efficiency of auctions has left something to be desired. Auctions have been shown to be less effective in achieving full subscription and creating a liquid aftermarket than book building. Jagannathan, Jirnyi, and Sherman [2010] discuss why issuers do not choose Dutch auctions even given some of the clear advantages of auctions. They propose the difficulty of participating by investors as a primary reason for this. Binay, Gatchev, and Pirinsky [2007] discuss the ability of regular investors to benefit more than casual investors, supporting the book building process.

One big advantage of an auction relates to lower underpricing and fees as an investment bank is not committed to sell all shares of the offer; this typically leads to less underpricing but sometimes at the stake of under subscription. Pucthuanthong, Varaiya and Walker [2005] note that IPO auctions are open to everyone, issuers can sell their new shares to a greater number of investors at a price which more accurately reflects the market demand for the shares. This allows the issuer to maximize proceeds received, thus eliminating or at least significantly reducing the initial return the day the IPO takes place. Klemperer [2002] points out that with a uniform price auction, the lowest winning bid is not much different than the highest losing bid. The issue becomes one of a reduction in information flow, which prevents selling efficiency and could hurt the selling of the IPO. As information flow is reduced, informed investors receive no benefit from providing information, as they are not rewarded with favorable allocations as in the book building method.

Perhaps the best-known U.S. IPO auction was Google's auction in August of 2004**.** Google announced the price of their equity offering would be determined by

a competitive Dutch type or "dirty" auction in which everybody could participate on equal terms, thus eliminating the favoritism of a typical U.S. style book-building auction. The price of the offering was set at the point where 19.6 million shares could be sold. The results of their IPO was not as impressive as Google had hoped for as the stock which was offered at $85, quickly increased to over $200 soon after. The lack of information flow and hyping of the deal by an investment bank to clients caused the price to be weaker than expected and subscription to the stock during the auction was lower than what was seen in the after-market. Robicheaux and Herrington [2007] discus the history of Google and their decision to use a Dutch auction for their IPO in detail. Adams, Baker, and Thornton (2008) discus the thought process of Net Suites when deciding to use a Dutch Auction for their IPO and draw similarities between Net Suites IPO and Google. Hensel [2005] discusses the Google Dutch auction IPO and how it worked verse the traditional allocation method in the US.

Previous studies support the idea that using an experiential approach to presenting the topic of equity auctions is a much more effective method than relying solely on a traditional lecture. Lumpkin, Achen and Dodd (2015) find both qualitative and quantitative evidence that active, applied learning activities had a greater positive impact on student engagement and student learning than passive, lecture-based approaches. These findings are consistent with those of Hawtrey (2007), who also found that there was a clear student preference toward these types of experiential and applied learning activities as well. While Michel, Cater and Vaerla (2009) argue that this approach did not significantly improve the general mastery of the subject, it did improve cognitive outcomes of class-specific materials. The evidence in the literature in favor of experiential, simulation-based classroom activities validates our choice to use this method to present information on this topic and increase the understanding equity auctions.

Equity Auction Exercise

Prior to the exercise, a lecture should be given on equity offerings. Information included in the literature review of this paper could be explained within the lecture to better inform students about the different methods of selling shares of an IPO. This would depend on how deeply the instructor of the course wanted to go into the IPO process and information discovery within the IPO process. A lecture and review provide the base level of understanding for students before the exercise is undertaken. Some information that should be discussed before the equity auction exercise includes the current IPO process used in the United States, the idea of an auction process for a company such as Google, and how to value equity. The students are expected to understand equity valuation using the Gordon growth model with non-constant growth. The H-model can also be used as a better measure

for a level decline in growth versus a dramatic sudden drop in growth as used in the Gordon model. A free cash flow model or a detailed DCF model may be utilized, as well as several other valuation models if desired. Before the auction process begins, a short sample problem on the equity valuation method desired should be conducted.

After going over an equity valuation problem, the instructions for the assignment are passed out to the groups of students as shown in Table 1. After giving students a few minutes to read over the information page, students will then need to use the information on the stock coming up for auction to calculate a fair value. Students calculate the present value of the stock using the constant dividend model of Gordon ($V_0 = D_1 / r_s - g$) and then modify this model to account

Table 1 – Equity Auction Information.

This table provides the information utilized by the students for the Equity portion of the auction exercise.

Equity Valuation Information
Current Dividend: $2.00 Super Growth Period: 8 years @ 35% Constant Growth Rate: 7.5% Required Rate of Return: 17%
Goals
1. Fill as best as possible the following demand schedule. **<u>Customer Demand Schedule for shares:</u>** 1.5 million at $85 1 million at $90 0.5 million at $95 2.5 million at any price 2. Earn the largest profit on shares you keep for yourself and the lowest possible price for clients. If you get shares that do not meet the price requirements than you must keep than at a gain or a loss whatever that may be. The worst thing for the exercise is to get shares at a loss. The correct intrinsic value will represent the final closing price and be used to determine profits.
Submitting Bids
There are 15 million total shares available. 1. Submit your bid to include both price and quantity. 2. You may submit up to 4 bids with a maximum of 1 million shares per bid.

for abnormal (or non-constant) growth. A suitable valuation is needed before the students can bid intelligently on the equity offering, demonstrating the importance of understanding how to value a firm before bidding or purchasing shares.

After calculating the value for the equity, the groups then turn their focus on the goals of the exercise. The goals for the exercise provide the student groups with information on what they hope to accomplish during the auction. Each group should attempt to maximize customer demand while obtaining the best possible return on shares. These goals often contradict each other as the equity offering is designed to be oversold. In order to obtain shares, the groups may have to bid close to the intrinsic value of the stock, thus increasing the price of the offering and lowering initial return.

The information is designed for six groups with anywhere from 2-6 members per group. As more groups are needed to handle the size of the class the information may be easily scaled. The idea is to have the equity auction oversold (more demand than available shares), so students compete for shares compelling them to make a difficult decision between filling all demand and maintaining an acceptable price for the stock.

After estimating the stock's value and examining the goals of the exercise, students are instructed to submit bids for the equity auction. During this process students are instructed that they can make up to four bids at any price they desire for a maximum of one million shares per bid. Each group is given about twenty to thirty minutes to submit their bids to the instructor. Students submit bids to the instructor once they reach a decision. In some classes, a timer may be a good option to limit the amount of time students have to submit their initial bids. For example a time clock could be put into place after the second to last bid is submitted. The clock places pressure on the final group to submit their bid quickly and prevents the students that have finished from becoming restless. After all bids are received the instructor records all bids on the board and selects those that are accepted including the highest priced bids first until all supply is eliminated. The final IPO offer price will be determined after the auction closes and is based on the lowest priced bid filled. After seeing the results students are given a set of follow-up questions.

How the Bidding for Equity Auctions Works

For equity auctions, participants must submit their bids for both the desired quantity of stock and the price which they are willing to pay. Students are allowed to submit up to four bids for shares. Multiple bidding allows the students to use a tiered pricing strategy if they desire to do so. Gathering all the bids and calculating the cutoff point, at or above which all the shares available are sold, determines the price of the offer. For example, if the company settles on an allocation of ten million shares, and it receives bids for thirty million shares at different price

ranges, than only the highest bids adding up to ten million shares offered will count as winning bids. The IPO price will equal the lowest priced bid accepted. In this exercise we have potential bids for 24 million shares but only 15 million shares available.

Thus, the price all bidders pay will be the same, equal to the lowest accepted bid price even if someone bid higher than that price. Ideally, the auction process enables sellers to price the issue "correctly". That is, the price should reflect the reasoning and expectations of thousands of investors who will determine for themselves how much they are willing to pay for a share of the firm. One popular example of an equity firm in the United States using this type of auction is the Google IPO as discussed in the literature review above. An example of bids received and accepted is shown in Table 2. The table shows 24 million bids made by students and the 15 million that were accepted in order of highest bid amount first. The table also reveals the clearing price of the IPO, which is $91. This is price that the company will receive for shares and the price that the winning groups pay for the stock. This simulation provides an example to show how the Equity Auction will work during the exercise.

Student Expectations

In accordance with assurance of learning we use the questions to test one of the school objectives. Appendix 1 shows the objective along with the five questions (or traits) used to measure the students learning from the exercise. Student performance on the questions following the exercise is shown in Appendix 1 as well. We also found student performance on the exam following exercise improved for the Equity Auction component in semesters when the exercise given versus those where only a lecture was given. The results provide further support of the importance of interactive exercises to help the learning process. After completing the exercise the students are expected to answer a set of five questions shown in Appendix 1. A successful completion of the questions by a student group is shown in Appendix 2.

Suggestions, Pitfalls, and Additional Topics

We have conducted this exercise six times in different classes. Over that time we have noticed some potential items that may make the case run more smoothly and avoid some potential mistakes in the delivery.

Suggestion 1: To add an additional real world component, financial information on a recently held or upcoming IPO may be used. Students can then determine a bid on the IPO and see how the price determined by bidding compares to the offer price of the IPO and the first day close of the IPO. Alibaba (BABA) has been used in

Table 2 - Example Of Bids Received & Filled.
This table provides an example of bids made by students and those bids that were accepted.

GROUP	PRICE	SHARES	FILLED	SHARES FILLED
Group 6	$111	1,000,000	YES	1,000,000
Group 5	$108	1,000,000	YES	1,000,000
Group 3	$108	1,000,000	YES	1,000,000
Group 1	$108	1,000,000	YES	1,000,000
Group 5	$106	1,000,000	YES	1,000,000
Group 5	$105	1,000,000	YES	1,000,000
Group 4	$105	1,000,000	YES	1,000,000
Group 6	$98	1,000,000	YES	1,000,000
Group 4	$97	1,000,000	YES	1,000,000
Group 3	$97	1,000,000	YES	1,000,000
Group 4	$95	1,000,000	YES	1,000,000
Group 3	$93	1,000,000	YES	1,000,000
Group 1	$92	1,000,000	YES	1,000,000
Group 2	$92	1,000,000	YES	1,000,000
Group 5	$91	1,000,000	YES	1,000,000
Group 2	$89	1,000,000	NO	0
Group 6	$89	1,000,000	NO	0
Group 1	$89	1,000,000	NO	0
Group 4	$88	1,000,000	NO	0
Group 3	$87	1,000,000	NO	0
Group 6	$86	1,000,000	NO	0
Group 1	$85	1,000,000	NO	0
Group 2	$85	1,000,000	NO	0
Group 2	$85	1,000,000	NO	0
TOTAL		**24,000,000**		**15,000,000**

class examples for this part and was very effective to allow students to think about a real company and real IPO value after conducting the Dutch auction. Students are provided three years of financials on BABA before the IPO and expected to use the information to calculate value of the company before the IPO. This forces students to think about valuation from a real life setting and then they must use this valuation to bid for shares of the IPO. We have used BABA to implement this in our recent trails and students tend to ask several questions during this part of the auction exercise as they have typically not valued companies in this manner before. Typically students are given all the inputs and ask to valuate a company which forces students to use company financials and think about things such as relevant cash flows and proper growth rates. The standard procedure is to wait to tell students what the company is until after the bidding process. Students are often surprised to find out that the company used was BABA. The example provides an opportunity to discuss the actual offer price of BABA at the time of its IPO. Adding this real world example enhances the value of the exercise in terms of retention and comprehension.

Suggestion 2: Make sure to go over dividend discount model with extended growth carefully before starting the exercise or students will be confused during this part. Perhaps even greater emphasis should be provided for undergraduate students.

Suggestion 3: The end of the exercise has become a great opportunity to open a discussion of valuation as well as a discussion of book building verse auction IPOS. After completing the exercise the students' interest level is peaked on valuating stocks and why the most private firms in the United States use the book building method. The first few times completing the exercise these opportunities were overlooked, missing out on a great learning opportunity. So, leave some class time to revisit these ideas.

Suggestion 4: It helps to go over an example of how an Auction will work, such as illustrated in Table 2 before conducting the Equity Auction. We have executed this before the exercise which assists in the understanding of how the auction will play out.

Potential Pitfall 1: The level of demand for shares sometimes confuses students. We find it acceptable to leave in, but one must be careful to describe what is meant by the demand included. Perhaps this topic may be taken out or simplified to make for an easier delivery of the exercise.

Potential Pitfall 2: Go over the questions before having students complete them on their own. After finishing the students are sometimes distracted and do not fully understand what the questions are asking them. In one case a student group not even realize they had to answer the questions.

Potential Pitfall 3: The stock information can be the symmetric or asymmetric based upon the instructor's goal for the exercise. If stock information is asymmetric than correct valuations must be close or groups with lower valuations may be receive zero shares during the auction. Giving different valuations does provide the opportunity after the exercise to discuss how various investment firms and analysts have divergent estimates on the intrinsic value of equities. Differing valuations of the same firm is commonplace within the market as varied analysts may have conflicting opinions on future cash flows and risk of a firm. Giving the symmetric stock information provides each group of students with a level playfield for the auction and provides one correct answer for stock valuation. We have performed the exercise under both of these scenarios and, in practice, symmetric information allows for a much smoother class period.

Additional Topic 1: Discuss strategies of bidding to find out what worked and what did not work. This could also lead into a discussion about game theory. A common winning strategy is to overprice shares and if no other groups follows this strategy than it is a very successful one. The group will receive a large allocation and if the other groups bid conservatively than they will do so at a low (under-valued) price. The problem with this strategy can be pointed out to the class. If all groups follow this strategy and bid high to win than everyone receives a high (over-valued) price and returns to all would be negative or extremely low. Of course, another potential result is that each group jointed decides to bid together and all bid low (collusion or working-together strategy). Collusion benefits all as each group receives under-valued shares, but of course the desire for one group to deviate from this strategy and bid high is very possible, which takes brings it back to the original scenario. Game theory demonstrates how the behaviors of others will impact each group's returns. Thus, the success or failure in the auction depends on not only their actions, but the actions of others. We have done this after the exercise a few times and this leads to a good discussion on game theory in a graduate course setting.

Additional Topic 2: Perhaps a design including the simulation of a book building IPO as may be a very interesting complement. If the instructor wishes to spend more time on the subject, the addition of a book building component should be strongly considered.

Additional Topic 3: An additional option might include the Adams, Baker, and Thornton (2008) case on Net Suites as a starting part and hold an auction based upon the information given within the case. Their case takes the students a step further, allowing them to conduct an auction based case. Learning the auction process not only through the case but also through an experiential learning exercise. We have not tried this in our course to date, given time constraints.

Conclusion

In this paper we examine equity auctions. Many finance courses overlook or spend little time on the auction processes utilized to raise capital. This exercise provides students with a hands-on approach to help understand how the actual auction process works in a real world setting. This equity auction exercise is much different from the typical E-bay type auction that many students are accustomed to. The paper also provides an interesting way students may apply game theory as students are required to think about what other groups will bid in order to determine their own decisions. We find that student understanding and retention of the material increases significantly when delivered in an in-class simulation as opposed to a traditional lecture. The understanding of an equity auction helps students to better understand the book building method typically used in the United States and the auction process to raise capital in general.

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Appendix Part 1 – Testing of Learning Objective and Traits

OBJECTIVE: Analyze and evaluate complex financial situations

Traits / Questions

1. 1. List the shares received and calculate the profit or loss and your rate of return on the stock.
2. 2. How did the trading go, discuss your strategy? How well did you fill your customers and your own demand for treasuries in terms of amount and rate?
3. 3. What would be the implications if most IPOs in the United States were conducted by auction instead of book building?
4. 4. What did you learn from the exercise and what you would do different if you conducted the exercise again?
5. 5. What would you change about the exercise to make it better?

Scoring Guidelines

3 = 9 − 10 points out of 5 (90-100%) exceeds expectations
2 = 8 − 8.99 points out of 5 (80-90%) meets expectations
1 = less than 8 points out of 10 (les than 80%) fails to meet expectations

Scoring of Traits for Auction Exercise **Trait**	**3**	**2**	**1**
List the shares received and calculate the profit or loss and your rate of return on the stock.	90%	10%	0.00%
Trait	**3**	**2**	**1**
How did the trading go, discuss your strategy?	100%	0.00%	0.00%
Trait	**3**	**2**	**1**
What would be the implications if most IPOs in the United States were conducted by auction instead of book building?	85%	15%	0.00%
Trait	**3**	**2**	**1**
What did you learn from the exercise and what you would do different if you conducted the exercise again?	80%	10%	10%
Trait	**3**	**2**	**1**
What would you change about the exercise to make it better?	85%	5%	10%

Appendix Part 2 – Example of Student Answer to Equity Exercise

Questions:

1. *List the stock received and calculate the profit or loss and your rate of return on the stock.*

   We received $3 million worth of stock. The filled orders were as follows:

   1. $1 million for our $59.68 bid
   2. $1 million for our $57.50 bid
   3. $1 million for our $48.00 bid

   However, in the end, profits are calculated based on the last bid price of $46. Therefore, our profit is as follows:

   Cost = 3,000,000 shares *$46/share = $138,000,000

   Proceeds = 3,000,000 shares*$59.68 = $179,040,000

   Profit = $179,040,000 − $138,000,000 = $41,040,000

   Underpricing = $59.68 − $46/ $46 = 29.74%

   Stock return = 29.74%

   Even though we did not meet our clients' demand of $44/share, they still have the choice of purchasing the shares at $46 and make a 29.74% return (assuming the stock trades at its intrinsic value of $59.68 on the first trading day).

2. *How did trading go, discuss your strategy? How well did you fill your customers and your own demand for equities in terms of amount and rate?*

   Part of our strategy involved the possibility of long-term investing for our own accounts. On our first bid we had a long term view in mind. We bid at a price exactly matching the intrinsic value of $59.68 to try to guarantee ourselves at least 1 million shares. We think the company has upside potential and its share price will eventually go up. Even though we have the choice of flipping the shares to obtain a quick profit of the difference between $46 and $59.68 on the shares we received, we may prefer to hold on to a portion of the three million shares for the long term.

   Unfortunately, we were not able to meet our client's demand of 2 million shares at $44/share. Since most of the other participants placed bids that were on the higher end, we were not able to receive our last bid of one

million shares at $43.50, which would've been an ideal price for our customers. However, we believe our clients may still be willing to buy the shares for $46.00, which is not too far above their desired $44.00/share. If they choose to do so, they would earn a 29.74% return and their total profit would amount to $27,360,000 (2 million shares x $59.68 selling price minus a total cost of 2 million shares x $46). In turn we would have 1 million shares remaining for own accounts, and if we decided to sell them right away we would profit by $13,680,000.

We think that being able to get 3 out of the 4 million possible shares was a pretty good outcome. There were a total of six groups bidding including ours. When pro-rating each group's share of the auction, it turns out we got a higher share (15,000,000 across six bidders = 2,500,000 shares each. Taking 2,500,000/4,000,000 = 62.5%. With the 3 million shares we received, we actually ended up meeting 75% of our demand). In addition, getting almost a 30% return is also very positive news both for us and for those clients who decide to invest in the IPO.

3. *What would the implications be if most IPOs in the US were conducted by auction instead of book building?*

   If most IPOs in the US were conducted by auctions instead of book building, this would essentially mean handing more of the control and decision making to investors. Since investors usually do not have the best understanding or knowledge about the markets these new companies would be operating in, it would be more difficult for them to perform a proper valuation. On the other hand, through book building the main role is given to the underwriter, who usually has information about the firm and can effectively disclose that information to potential investors. They have the best understanding of the market as well as the desire to place the shares in good hands.

   Unlike Treasury auctions which are held frequently, making valuation easier and more accurate, IPOs occur less frequently and at random times, therefore their value is much more difficult to determine. Also, each issue is different and may attract too much of a wide variation in the number of participants. For example there may be instances in which an auction attracts too many unsophisticated investors who are just out to chase high returns, so they may keep bidding higher in order to get the issue, making the auction price very volatile. Also, this artificially high price would not represent accurate information about the real value of the firm. So in essence, we think that IPO auctions would only work if all participants are highly knowledgeable and sophisticated. But with the nature of IPOs,

which occur sporadically and every issuer being so different, it makes it hard for investors to obtain the information and skills needed for a proper valuation.

Lastly, the mere fact that the issuer is usually willing to give up higher profits in order to have an underwriter deliver their shares may be enough to make auctions unpopular. With an auction, more of the bad firms who do not want their financial information disclosed would start participating in IPO auctions and this may affect the prestigious nature of IPO offerings.

4. *What you learned and what you would do different if you conducted the exercise again?*

   By conducting the equity auction we learned that at the end, everyone gets the same price, and that what other investors bid really does matter. If we conducted the exercise again, we would be better off staggering the prices so that they're more spread apart - that way if everyone else gets greedy and bids high (which will end up driving the last bid price up), we don't end up with such a high price. Also, this may give us have a better chance of obtaining a lower price for our clients.

5. *What would you change about the exercise to make better?*

   More information should be available on the other bidders (competitors). Also, how does our firm compare in size, volume?

Valuation Workbook: a Spreadsheet Framework for Security Analysis

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This paper introduces the valuation workbook (VWB), a spreadsheet framework that for security analysis, investment, portfolio management, or student managed investment fund classes. Consistent with the CFA methodology, we identify five methods of company valuation: free cash flow to the firm (FCFF), free cash flow to equity (FCFE), dividend discount model (DDM), residual income (RIM), and multiples. In addition to enhancing student knowledge of financial analysis, the standard format facilitates security evaluation and grading of student analyses.
Keywords: *Security analysis, spreadsheet application, valuation, investments, student funds*

Introduction

A key element in common stock selection is fundamental security analysis. Graham, Dodd, and Cottle in their seminal text, *Security Analysis* (1962), provide the foundation for investment analysis. Warren Buffett was a student of Benjamin Graham at Columbia University and continues to apply the Graham and Dodd techniques though his company, Berkshire Hathaway. This analysis begins with macro-economic analysis, followed by an industry analysis. This top down approach is further supported by Bodie, Kane, & Marcus in their *Investments* textbook (2014). Consistent with Graham, Dodd, & Cottle (1962) and Bodie, Kane, & Marcus (2014), Stowe, Robinson, Pinto, & McLeavey (2007), hereafter SRPM, provide their text, *Equity Asset Valuation*, for the CFA Investment Series. We use SRPM as the foundation for our Valuation Workbook. Investopedia is a quick and reliable source of financial definitions. Once the fundamental analysis is completed one should look at stock trends and buy if the stock is headed up and avoid a downward trending stock. Will Rogers expresses this "Don't gamble: take all your savings and buy some good stock and hold it till it goes up and then sell it. If it don't go up, don't buy it" (Brainy Quotes, 2018). Pring (2002) provides technical analysis techniques.

This paper introduces the Valuation Workbook (VWB), a spreadsheet framework that can be used in security analysis, investment, portfolio management, or student managed investment fund (SMIF) classes. To implement a top-down approach in our classes, we divide students into sector teams based on the S&P 500 sectors. The Sector SPDRs reflect the sectors. After a detailed sector analysis, we allocate class portfolios based on the sector analysis. Students then evaluate companies in their sector for potential addition to or subtraction from the class portfolio. The portfolio can be either actual funds in a SMIF or simulated portfolio.

We provide three examples of company valuations 3M, an industrial company; Apple, a technology company; and Edwards Lifesciences, a healthcare company. Consistent with SRPM we examine five methods of company valuation: free cash flow to the firm (FCFF), free cash flow to equity (FCFE), dividend discount model (DDM), residual income (RIM), and multiples. Since we provide a standard format in the Valuation Workbook, the major challenge for student analysts is to evaluate companies where growth rate is greater than cost of capital. This confounds the FCFF, FCFE, and DDM models. The VWB assists students in meeting several teaching objectives with a spreadsheet:

Calculate the cost of equity with capital asset pricing model

$$k_e = r_f + B\,(r_m - r_f) \tag{1}$$

where k_e is cost of equity, r_f is the risk free rate (normally the 10-year treasury rate), B is the company beta, and r_m is the market return from which the beta is measured.

Calculate the after tax cost of debt

$$k_d\,(1-T) \tag{2}$$

where k_d is the cost of debt (yield to maturity) and T is the corporate income tax rate

Calculate the weighted average cost of capital

$$WACC = w_d * k_d\,(1-T) + w_e * k_e \tag{3}$$

where w_d is weight of debt, w_e is weight of equity and the other terms are defined in equations 1 and 2.

Once these costs of capital are calculated the student can proceed to equity valuation models and their associated teaching objectives:

- Calculate the value of a share of stock with the free cash flow to the firm model
- Calculate the value of a share of stock with the free cash flow to equity model
- Calculate the value of a share of stock with the Gordon dividend discount model
- Calculate the value of a share of stock with the residual income model
- Calculate the value of a share of stock with multiples
- Apply technical analysis to determine the stock price trend

In addition to enhancing student knowledge of financial analysis as witnessed in Payne and Tanner (2011) and McNeill (2015), the standard format facilitates security evaluation and grading of student analyses. The VWB provides a concise way to examine each of these valuation methods. Also, with Apple, Inc. as an example, the VWB links four spreadsheets: a free cash flow sheet (Figure 1), a company valuation sheet (Figure 2), a Buy-Sell sheet (Figure 5), and an enterprise value worksheet (EV) (Figure 8). Based on criteria in SRPM students designed the company valuation worksheet, the cash flow calculation worksheet, and linked the worksheets with the Buy-Sell sheet to create the Valuation Workbook. In addition to the company's annual report (which can be found in EDGAR), data sources can be Value Line, Morningstar, S&P Net Advantage, Yahoo Finance, or other financial data sources. If one uses more than one data source, the analyst must ensure that the sources' orders of magnitude are consistent. For example, if one source is in millions and another in thousands, the analyst must convert the thousands to millions (or vice versa) to ensure consistency. (Some students add zeros to data reported in millions. In many cases this confounds a potential error.) It is more accurate to mirror the report as thousands or millions without the zeros. We indicate cells to be input in yellow. The intent is to minimize student mistaken input into cells with algorithms.

Free Cash Flow Calculation Sheet

With Apple Inc. as an example, in Figure 1, the Free Cash Flow Calculation Sheet provides free cash flow to the firm (FCFF) and free cash flow to equity (FCFE). We obtain gross property, plant and equipment (or gross fixed assets) for the most recent reported period and the year prior. (If capital expenditures are reported, one posts the information to the cash flow calculator.) In addition, we obtain the long-term debt for the same periods.

Figure 1. Apple FCFF-FCFE.

	A	B	C	D	E	F	G
1	Free Cash Flow to the Firm (FCFF)						
2	CFO	Stmt of CF		65417			
3	Interest	Inc Stmt		3500			
4	Tax Rate	Valueline		0.256		Gross PP&E or Gross Fixed Assets (recent)	Gross PP&E or Gross Fixed Assets (previous)
5	Int*(1-T)			2604			
6	Fixed Cap Investment	Balance Sheet		12962		Fixed capital investment provided on balance sheet	
7	FCFF			55059			
8							
9	Free Cash Flow to Equity (FCFE)					Long-Term Debt (recent)	Long-Term Debt (previous)
10	CFO			65417		75427	53463
11	FCInv			12962			
12	Net Borrowing	Balance Sheet		21964			
13	FCFE			74419			
14							
15							

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$$FCFF = CFO + Int\,(1-T) \quad (4)$$

where FCFF is free cash flow to the firm, CFO is cash flow from operations, Int is interest expense, T is the corporate tax rate, and FCINV is fixed capital investment.

To calculate FCFF with a spreadsheet we begin with cash flow from operations (CFO), add interest expense from the income statement, obtain the tax rate from sources such as S&P Net Advantage, Morningstar, or others. Also, we calculate the fixed capital investment as the difference between recent and previous year's gross plant and equipment (or gross fixed assets) (SRPM, 2007).

The FCFE calculation uses the CFO and fixed capital investment from the FCFF worksheet. We add net borrowing as the difference between recent and the previously reported long term debt.

From FCFF we can calculate FCFE as:

$$FCFE = FCFF - Int\,(1-T) + Net\ Borrowing \quad (5)$$

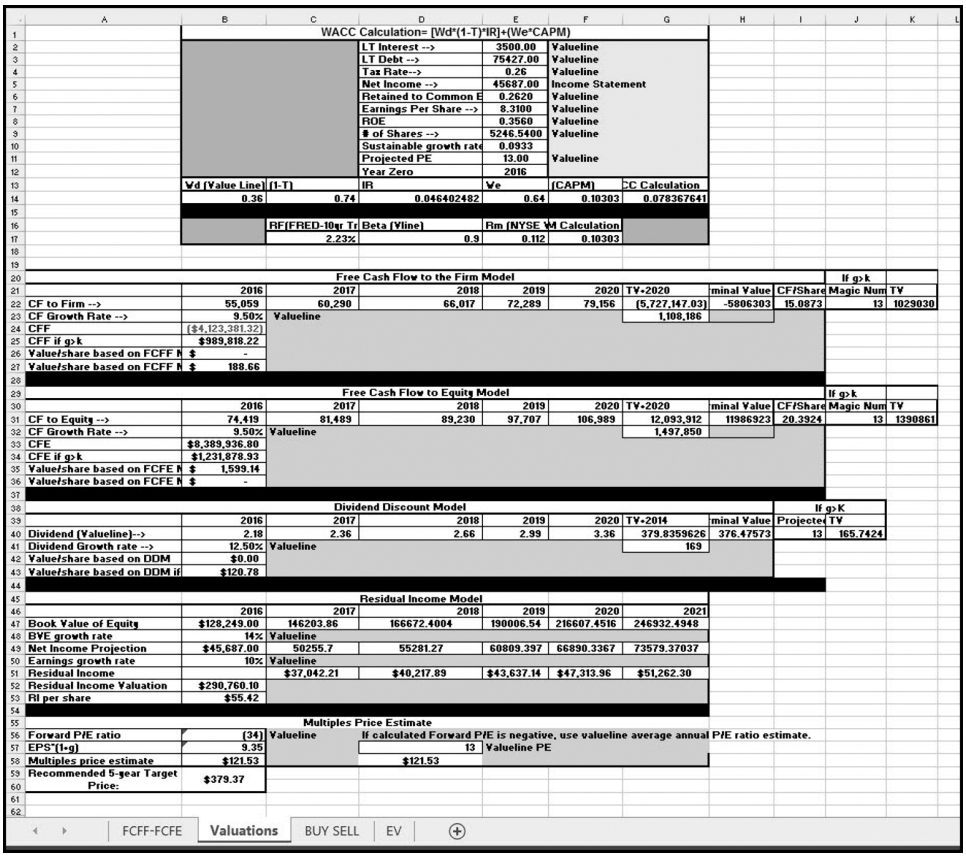
where FCFE is free cash flow to equity, FCFF is free cash flow to the firm, Int is interest expense, T is the corporate tax rate, and Net Borrowing is net debt issued less debt repayments over the period for which cash flow is calculated.

Company Valuation Worksheet

The Apple Inc. Company Valuation Worksheet example (Figure 2) provides five methods of security valuation: FCFF, FCFE, dividend discount model (DDM), residual income model (RIM), and multiples. First we enter several input cells: long term interest (LT int), long term debt (LT debt), tax rate, percentage retained to equity, earnings per share, ROE, number of shares, and projected PE. The spreadsheet calculates the sustainable growth rate (retention rate times ROE). Source information can be found in S&P Net Advantage, Morningstar, Value Line, or the company's annual report. The year zero is the last year of reported annual data. Once year zero is input, the spreadsheet adjusts other years.

The weight of debt (W_d) is provided by one of the sources previously mentioned. The inputs are the tax rate, interest rate (IR), weight of equity (W_e). The weighted average cost of capital (WACC) is calculated from these inputs. The CAPM calculation is based on the 10-year treasury rate from FRED, the St Louis Federal Reserve Bank data. Next we input the company beta. The market return is the New York Stock Exchange Index return if the beta is based on Value Line (S&P 500 return if the beta is based on Morningstar) for the past year.

Figure 2. Apple Valuation.



WACC Calculation= [Wd*(1-T)*IR]+(We*CAPM)						
		LT Interest -->	3500.00	Valueline		
		LT Debt -->	75427.00	Valueline		
		Tax Rate-->	0.26	Valueline		
		Net Income -->	45687.00	Income Statement		
		Retained to Common E	0.2620	Valueline		
		Earnings Per Share -->	8.3100	Valueline		
		ROE	0.3560	Valueline		
		# of Shares -->	5246.5400	Valueline		
		Sustainable growth rate	0.0933			
		Projected PE	13.00	Valueline		
		Year Zero	2016			
Wd (Value Line)	(1-T)	IR	We	(CAPM)	WC Calculation	
0.36	0.74	0.046402482	0.64	0.10303	0.078367641	
	RF(FRED-10yr Tr	Beta (Vline)	Rm (NYSE W	M Calculation		
	2.23%	0.9	0.112	0.10303		

Free Cash Flow to the Firm Model									If g>k	
	2016	2017	2018	2019	2020	TV+2020	minal Value	CF/Share	Magic Num	TV
CF to Firm -->	55,059	60,290	66,017	72,289	79,156	(5,727,147.03)	-5806303	15.0873	13	1029030
CF Growth Rate -->	9.50%	Valueline				1,108,186				
CFF	($4,123,381.32)									
CFF if g>k	$989,818.22									
Value/share based on FCFF N	$ -									
Value/share based on FCFF N	$ 188.66									

Free Cash Flow to Equity Model									If g>k	
	2016	2017	2018	2019	2020	TV+2020	minal Value	CF/Share	Magic Num	TV
CF to Equity -->	74,419	81,489	89,230	97,707	106,989	12,093,912	11986923	20.3924	13	1390861
CF Growth Rate -->	9.50%	Valueline				1,497,850				
CFE	$8,389,936.80									
CFE if g>k	$1,231,878.93									
Value/share based on FCFE N	$ 1,599.14									
Value/share based on FCFE N	$ -									

Dividend Discount Model								If g>K	
	2016	2017	2018	2019	2020	TV+2014	minal Value	Projecte	TV
Dividend (Valueline)-->	2.18	2.36	2.66	2.99	3.36	379.8359626	376.47573	13	165.7424
Dividend Growth rate -->	12.50%	Valueline				169			
Value/share based on DDM	$0.00								
Value/share based on DDM if	$120.78								

Residual Income Model						
	2016	2017	2018	2019	2020	2021
Book Value of Equity	$128,249.00	146203.86	166672.4004	190006.54	216607.4516	246932.4948
BVE growth rate	14%	Valueline				
Net Income Projection	$45,687.00	50255.7	55281.27	60809.397	66890.3367	73579.37037
Earnings growth rate	10%	Valueline				
Residual Income		$37,042.21	$40,217.89	$43,637.14	$47,313.96	$51,262.30
Residual Income Valuation	$290,760.10					
RI per share	$55.42					

Multiples Price Estimate				
Forward P/E ratio	(34)	Valueline	If calculated Forward P/E is negative, use valueline average annual P/E ratio estimate.	
EPS*(1+g)	9.35		13	Valueline PE
Multiples price estimate	$121.53		$121.53	
Recommended 5-year Target Price:	$379.37			

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We input year zero FCFF and FCFE from the cash flow calculation sheet (Figure 1) into the company valuation worksheet in cells B23 and B33, respectively. (Value Line provides projected growth rates for BVE, cash flow, and earnings. Morningstar provides historical growth rates.) Analysts input the cash flow growth rates from one of the sources mentioned earlier in cells B24 for FCFF and B34 for FCFE. We calculate the present value of cash flows as follows:

$$V_0 = \Sigma [PV (CF_t + TV_n)] \quad (6)$$

where V_0 is the present value, CF_t is the cash flow at time t, and TV_n is the terminal value where

$$TV = CF_n / (k - g) \text{ if } k > g \quad (7)$$

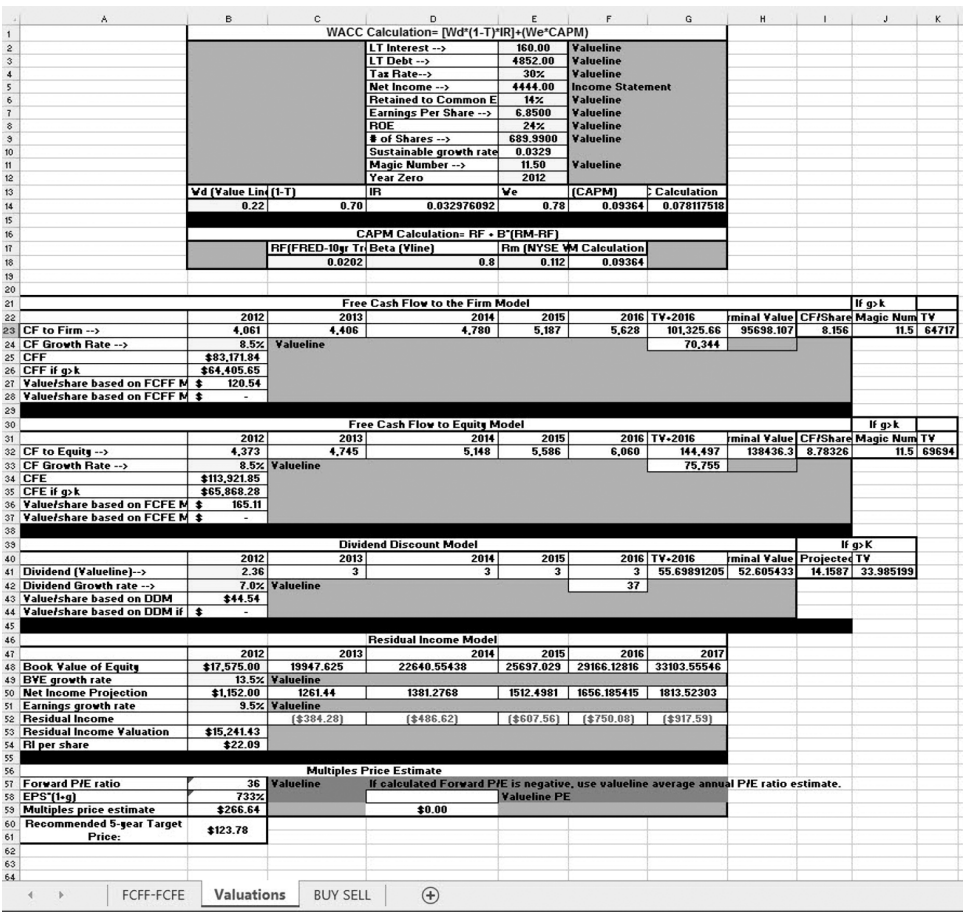
FCFF is discounted with the WACC and FCFE is discounted with the cost of equity (k_e).

Cash flows are grown at the cash flow growth rate. The algorithms for FCFF and FCFE are based on two situations: the cost of capital (k) is greater than the growth rate (g) and g > k. If k > g the terminal value for FCFF posts to cell H23. 3M Corp (Figure 3) provides an example when k > g for FCFF.

In cases such as Apple Inc. (Figure 2) and Edwards Lifesciences (Figure 4) where g > k then the analyst must adjust the terminal value. First, the analyst must input the cash flow multiplier from Value Line (or the forward PE from Morningstar). The spreadsheet multiplies this value by the fourth-year cash flow to obtain the terminal value (TV). The result posts to cell K23. The FCFF cash flows plus TV are discounted at the WACC. FCFF present values are calculated in cell B25 if k > g and in cell B26 if g > k.

$$\text{If } g > k\text{: } TV = (FCFF_n)^* \text{ (cash flow multiplier)} \quad (8)$$

Figure 3. 3M Valuation.



	A	B	C	D	E	F	G	H	I	J	K
1		WACC Calculation= [Wd*(1-T)*IR]+(We*CAPM)									
2				LT Interest -->	160.00	Valueline					
3				LT Debt -->	4852.00	Valueline					
4				Tax Rate-->	30%	Valueline					
5				Net Income -->	4444.00	Income Statement					
6				Retained to Common E	14%	Valueline					
7				Earnings Per Share -->	6.8500	Valueline					
8				ROE	24%	Valueline					
9				# of Shares -->	689.9900	Valueline					
10				Sustainable growth rate	0.0329						
11				Magic Number -->	11.50	Valueline					
12				Year Zero	2012						
13		Wd (Value Line	(1-T)	IR	We	(CAPM)	Calculation				
14		0.22	0.70	0.032976092	0.78	0.09364	0.078117518				
15											
16		CAPM Calculation= RF + B*(RM-RF)									
17			RF(FRED-10yr Tr	Beta (Vline)	Rm (NYSE WM	Calculation					
18			0.0202	0.8	0.112	0.09364					
19											
20											
21		Free Cash Flow to the Firm Model								If g>k	
22		2012	2013	2014	2015	2016	TV=2016	rminal Value	CF/Share	Magic Num	TV
23	CF to Firm -->	4,061	4,406	4,780	5,187	5,628	101,325.66	95698.107	8.156	11.5	64717
24	CF Growth Rate -->	8.5%	Valueline				70,344				
25	CFF	$83,171.84									
26	CFF if g>k	$64,405.65									
27	Value/share based on FCFF M	$ 120.54									
28	Value/share based on FCFF M	$ -									
29											
30		Free Cash Flow to Equity Model								If g>k	
31		2012	2013	2014	2015	2016	TV=2016	rminal Value	CF/Share	Magic Num	TV
32	CF to Equity -->	4,373	4,745	5,148	5,586	6,060	144,497	138436.3	8.78326	11.5	69694
33	CF Growth Rate -->	8.5%	Valueline				75,755				
34	CFE	$113,921.85									
35	CFE if g>k	$65,868.28									
36	Value/share based on FCFE M	$ 165.11									
37	Value/share based on FCFE M	$ -									
38											
39		Dividend Discount Model							If g>K		
40		2012	2013	2014	2015	2016	TV=2016	rminal Value	Projected	TV	
41	Dividend (Valueline)-->	2.36	3	3	3	3	55.69891205	52.605433	14.1587	33.985199	
42	Dividend Growth rate -->	7.0%	Valueline			37					
43	Value/share based on DDM	$44.54									
44	Value/share based on DDM if	$ -									
45											
46				Residual Income Model							
47		2012	2013	2014	2015	2016	2017				
48	Book Value of Equity	$17,575.00	19947.625	22640.55438	25697.029	29166.12816	33103.55546				
49	BVE growth rate	13.5%	Valueline								
50	Net Income Projection	$1,152.00	1261.44	1381.2768	1512.4981	1656.185415	1813.52303				
51	Earnings growth rate	9.5%	Valueline								
52	Residual Income		($384.28)	($486.62)	($607.56)	($750.08)	($917.59)				
53	Residual Income Valuation	$15,241.43									
54	RI per share	$22.09									
55											
56		Multiples Price Estimate									
57	Forward P/E ratio	36	Valueline	If calculated Forward P/E is negative, use valueline average annual P/E ratio estimate.							
58	EPS*(1+g)	733%			Valueline PE						
59	Multiples price estimate	$266.64		$0.00							
60	Recommended 5-year Target Price:	$123.78									
61											
62											
63											
64											

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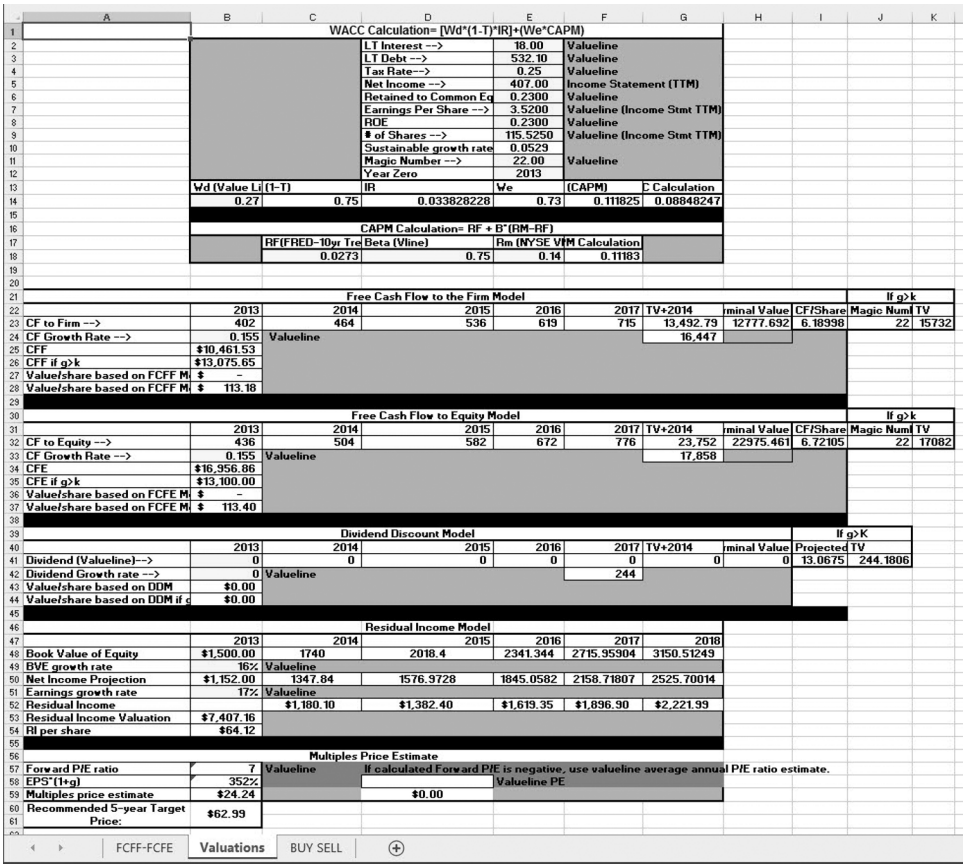
The FCFE cash flows plus TV are discounted at the cost of equity. The TV posts to cell H32 if k > g. Cash flow 4 is posted in cell F32. The sum of CF4 (Cell F32) and TV (Cell H32) is posted to cell G32. The sum of TV and cash flow four is reported in cell G32.FCFE present values are calculated in cell B34 if k > g.

Similar to the FCFF procedure, in cases such as Edwards Lifesciences where g > k (see Figure 4), the terminal value is calculated as the product of the cash flow multiplier from Value Line (or projected PE from Morningstar) in cell J32 and cash flow 4 (cell F32). The result is posted to cell K32. The sum of TV and cash flow four is reported in cell G32. FCFE present values are calculated in cell B35 if g > k.

Figure 4. Edwards Lifesciences Valuation



	A	B	C	D	E	F	G	H	I	J	K
1	WACC Calculation= [Wd*(1-T)*IR]+(We*CAPM)										
2				LT Interest -->	18.00	Valueline					
3				LT Debt -->	532.10	Valueline					
4				Tax Rate-->	0.25	Valueline					
5				Net Income -->	407.00	Income Statement (TTM)					
6				Retained to Common Eq	0.2300	Valueline					
7				Earnings Per Share -->	3.5200	Valueline (Income Stmt TTM)					
8				ROE	0.2300	Valueline					
9				# of Shares -->	115.5250	Valueline (Income Stmt TTM)					
10				Sustainable growth rate	0.0529						
11				Magic Number -->	22.00	Valueline					
12				Year Zero	2013						
13		Wd (Value Li	(1-T)	IR	We	(CAPM)	C Calculation				
14		0.27	0.75	0.033828228	0.73	0.111825	0.08848247				
15											
16	CAPM Calculation= RF + B*(RM-RF)										
17			RF(FRED-10yr Tre	Beta (Vline)		Rm (NYSE VLM Calculation					
18			0.0273	0.75	0.14	0.11183					
19											
20											
21	Free Cash Flow to the Firm Model									If g>k	
22		2013	2014	2015	2016	2017	TV+2014	minal Value	CF/Share	Magic Num	TV
23	CF to Firm -->	402	464	536	619	715	13,492.79	12777.692	6.18998	22	15732
24	CF Growth Rate -->	0.155	Valueline				16,447				
25	CFF	$10,461.53									
26	CFF if g>k	$13,075.65									
27	Value/share based on FCFF M	$ -									
28	Value/share based on FCFF M	$ 113.18									
29											
30	Free Cash Flow to Equity Model									If g>k	
31		2013	2014	2015	2016	2017	TV+2014	minal Value	CF/Share	Magic Num	TV
32	CF to Equity -->	436	504	582	672	776	23,752	22375.461	6.72105	22	17082
33	CF Growth Rate -->	0.155	Valueline				17,858				
34	CFE	$16,956.86									
35	CFE if g>k	$13,100.00									
36	Value/share based on FCFE M	$ -									
37	Value/share based on FCFE M	$ 113.40									
38											
39	Dividend Discount Model								If g>K		
40		2013	2014	2015	2016	2017	TV+2014	minal Value	Projected	TV	
41	Dividend (Valueline)-->	0	0	0	0	0	0	0	13.0675	244.1806	
42	Dividend Growth rate -->	0	Valueline			244					
43	Value/share based on DDM	$0.00									
44	Value/share based on DDM if g	$0.00									
45											
46	Residual Income Model										
47		2013	2014	2015	2016	2017	2018				
48	Book Value of Equity	$1,500.00	1740	2018.4	2341.344	2715.95904	3150.51249				
49	BVE growth rate	16%	Valueline								
50	Net Income Projection	$1,152.00	1347.84	1576.9728	1845.0582	2158.71807	2525.70014				
51	Earnings growth rate	17%	Valueline								
52	Residual Income		$1,180.10	$1,382.40	$1,619.35	$1,896.90	$2,221.99				
53	Residual Income Valuation	$7,407.16									
54	RI per share	$64.12									
55											
56	Multiples Price Estimate										
57	Forward P/E ratio	7	Valueline	If calculated Forward P/E is negative, use valueline average annual P/E ratio estimate.							
58	EPS*(1+g)	352%			Valueline PE						
59	Multiples price estimate	$24.24		$0.00							
60	Recommended 5-year Target Price:	$62.99									
61											

FCFF-FCFE | Valuations | BUY SELL

$$\text{If } g > k\text{: } TV = (FCFE)^* \text{ (cash flow multiplier)} \tag{9}$$

The DDM multi-year model is calculated as

$$V = \Sigma\, PV\,(D_1 : Dn) + PV\,(D_n + 1)/(k - g) \tag{10}$$

$$D_n = (D_{n-1})*(1+g) \quad (11)$$

where D_n is the dividend at time n and g is the dividend growth rate

For the DDM, year zero dividend is posted to cell B41 and dividend growth rate is placed in cell B42. Dividends are grown by the growth rate for years 1-4. Similar to the cash flow models, the TV is calculated by equation 2 and posted to cell H41 if $k > g$. The year 4 dividend is added to the TV in cell G41. If $g > k$, TV is the product of the forecasted PE and the year 4 dividend and is posted to cell J41.The terminal value is added to the year 4 dividend (cell F41) in in cell G42. DDM present values are calculated in cell B43 if $k > g$ and in cell B44 if $g > k$. For companies such as Edwards Lifesciences that do not pay dividends, the DDM is excluded from valuation.

The residual income model (RIM) is:

$$V_0 = B_0 + \Sigma (E_t - k_e * B_{t-1})/ (1+ k_e)^t \quad (10)$$

where V_0 = value of a share, B_0 is current book value of equity per share, E_t expected earnings per share at time t, k_e is the cost of equity, B_t is the expected book value per share at time t.

For the residual income model (RIM) one inputs year zero book value of equity (BVE) in cell B48 and the BVE growth rate in cell B49. Year zero net income is placed in cell B50 and the earnings per share growth rate is placed in cell B51. BVE and net income are grown at their respective growth rates. Residual income per year is the difference between projected BVE and projected net income. The residual income value is the sum of the present values of the residual income per year discounted at the cost of equity (cell F18). The result is calculated in cell B53. The value of residual income per share is calculated in cell B54 (Cell B53/ Cell E10).

For the multiples price estimate and if $k > g$, we calculate the forward PE as:

$$P_0/E_1 = (1-b)/ (k-g) \quad (11)$$

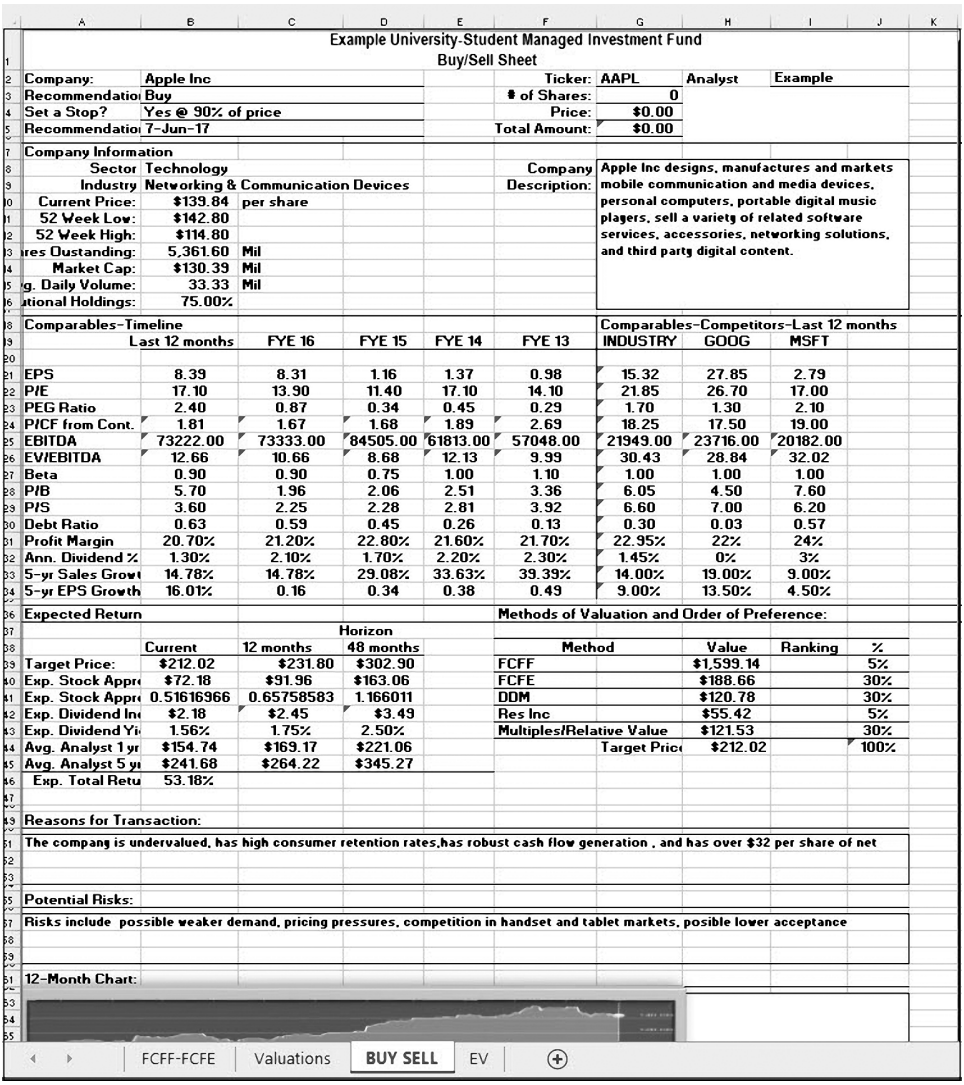
where P_0/E_1 is the forward PE, (1-b) is the dividend payout (1- cell E6), k is the cost of equity (cell F18), and g is the dividend growth rate (cell B42). The result is calculated in cell B57. The multiples price is the forward PE times the eps (cell E7) and is reported in cell B59. If $g > k$ we provide a forward PE from one of the sources mentioned earlier and multiply the value by the eps. The result is calculated in cell D59.The mean price estimate reported in cell B60 is the average of the five estimates.

Buy-Sell Sheet

The Buy-Sell Sheet is based on the operations manual for Rice University's Wright Fund, a student managed investment fund, (2008). The Buy-Sell sheet

provides corporate history and data compared with major competitors. We provide Buy-Sell sheets for Apple (Figure 5), 3M (Figure 6), and Edwards Lifesciences (Figure 7). First, we report basic company information and a brief company description.

Figure 5. Apple Buy-Sell.



Example University-Student Managed Investment Fund
Buy/Sell Sheet

Company:	Apple Inc			Ticker:	AAPL	Analyst	Example	
Recommendation:	Buy			# of Shares:	0			
Set a Stop?	Yes @ 90% of price			Price:	$0.00			
Recommendation:	7-Jun-17			Total Amount:	$0.00			

Company Information

Sector	Technology	Company Description:	Apple Inc designs, manufactures and markets mobile communication and media devices, personal computers, portable digital music players, sell a variety of related software services, accessories, networking solutions, and third party digital content.
Industry	Networking & Communication Devices		
Current Price:	$139.84 per share		
52 Week Low:	$142.80		
52 Week High:	$114.80		
ıres Oustanding:	5,361.60 Mil		
Market Cap:	$130.39 Mil		
g. Daily Volume:	33.33 Mil		
ational Holdings:	75.00%		

Comparables-Timeline

	Last 12 months	FYE 16	FYE 15	FYE 14	FYE 13	Comparables-Competitors-Last 12 months INDUSTRY	GOOG	MSFT
EPS	8.39	8.31	1.16	1.37	0.98	15.32	27.85	2.79
P/E	17.10	13.90	11.40	17.10	14.10	21.85	26.70	17.00
PEG Ratio	2.40	0.87	0.34	0.45	0.29	1.70	1.30	2.10
P/CF from Cont.	1.81	1.67	1.68	1.89	2.69	18.25	17.50	19.00
EBITDA	73222.00	73333.00	84505.00	61813.00	57048.00	21949.00	23716.00	20182.00
EV/EBITDA	12.66	10.66	8.68	12.13	9.99	30.43	28.84	32.02
Beta	0.90	0.90	0.75	1.00	1.10	1.00	1.00	1.00
P/B	5.70	1.96	2.06	2.51	3.36	6.05	4.50	7.60
P/S	3.60	2.25	2.28	2.81	3.92	6.60	7.00	6.20
Debt Ratio	0.63	0.59	0.45	0.26	0.13	0.30	0.03	0.57
Profit Margin	20.70%	21.20%	22.80%	21.60%	21.70%	22.95%	22%	24%
Ann. Dividend %	1.30%	2.10%	1.70%	2.20%	2.30%	1.45%	0%	3%
5-yr Sales Growt	14.78%	14.78%	29.08%	33.63%	39.39%	14.00%	19.00%	9.00%
5-yr EPS Growth	16.01%	0.16	0.34	0.38	0.49	9.00%	13.50%	4.50%

Expected Return

	Current	Horizon 12 months	48 months
Target Price:	$212.02	$231.80	$302.90
Exp. Stock Appre	$72.18	$91.96	$163.06
Exp. Stock Appre	0.51616966	0.65758583	1.166011
Exp. Dividend Inc	$2.18	$2.45	$3.49
Exp. Dividend Yi	1.56%	1.75%	2.50%
Avg. Analyst 1 yr	$154.74	$169.17	$221.06
Avg. Analyst 5 yr	$241.68	$264.22	$345.27
Exp. Total Retu	53.18%		

Methods of Valuation and Order of Preference:

Method	Value	Ranking	%
FCFF	$1,599.14		5%
FCFE	$188.66		30%
DDM	$120.78		30%
Res Inc	$55.42		5%
Multiples/Relative Value	$121.53		30%
Target Price	$212.02		100%

Reasons for Transaction:

The company is undervalued, has high consumer retention rates,has robust cash flow generation , and has over $32 per share of net

Potential Risks:

Risks include possible weaker demand, pricing pressures, competition in handset and tablet markets, posible lower acceptance

12-Month Chart:

FCFF-FCFE | Valuations | BUY SELL | EV

Figure 6. 3M Buy-Sell.

Company:	3M Corporation			Ticker:	MMM	Analyst	Kelsey Kern
Recommendation:	Hold			# of Shares:	0		
Set a Stop?				Price:	$0.00		
Recommendation Da	21-Feb-13			Total Amount:	$0.00		

Company Information

Sector	Industrials		Company Description:
Industry	Diversified Co.		
Current Price:	$102.72	per share	
52 Week Low:	$81.98		
52 Week High:	$104.40		
Shares Oustanding:	689.99	Mil	
Market Cap:	$71,883.15	Mil	
Avg. Daily Volume:	2.85	Mil	
stitutional Holdings:	68.00%		

3M Co. is a global manufacturer operating a broadly diversified business. The company classifies its business into six reportable segments -- Industrial & Transportation, Health Care, Display & Graphics, Consumer & Office, Electro & Communications, and Safety, Security and Protection. Most 3M products involve expertise in product development, manufacturing and marketing, with many of the company's products involving some form of coating, sealant, adhesive, film, or chemical additive that increases the product's overall functionality and

Comparables-Timeline

	Last 12 months	FYE 12	FYE 11	FYE 10	FYE 09
EPS	6.85	6.33	5.96	5.75	4.52
P/E	14.60	14.70	13.70	15.30	18.30
PEG Ratio	2.69	2.43	3.75	6.20	3.47
P/CF from Cont. Ops.	13.50	12.30	11.20	12.10	11.80
EBITDA	7771	7810	7453	7076	6008
EV/EBITDA	9.23	8.47	8.77	9.15	7.95
Beta	0.80	0.86	0.87	0.87	0.88
P/B	3.94	3.56	3.33	3.85	4.40
P/S	2.42	2.19	2.02	2.35	2.52
Debt Ratio	0.34	0.34	0.33	0.35	0.44
Profit Margin	0.15	0.15	0.15	0.16	0.14
Ann. Dividend %	0.02	0.03	0.03	0.03	0.03
5-yr Sales Growth	0.96	0.96	0.95	0.95	0.97
5-yr EPS Growth	0.93	0.98	0.97	0.94	0.96

Comparables-Competitors-Last 12 months

	INDUSTRY	GE	HON	SI
EPS	4.51	1.29	3.69	6.21
P/E	20.20	18.04	18.89	16.41
PEG Ratio	1.77	3.69	0.46	0.23
P/CF from Cont. Ops.	11.10	7.80	15.70	10.40
EBITDA	11773	19458	5152	14710
EV/EBITDA	9.55	12.57	11.18	6.93
Beta	1.07	1.64	1.37	1.06
P/B	7.60	45.19	4.19	2.17
P/S	1.40	1.67	1.46	0.88
Debt Ratio	0.48	0.14	0.57	0.67
Profit Margin	0.10	0.10	0.03	0.07
Ann. Dividend %	0.02	0.03	0.02	0.03
5-yr Sales Growth	1.00	1.04	0.99	1.01
5-yr EPS Growth	0.92	1.01	0.95	0.80

Expected Return

	Current	Horizon 12 mont	48 months
Target Price:	$156.64	######	######
Exp. Stock Appreciat	$53.92	$59.07	$75.57
Exp. Stock Appreciat	0.524884328	0.5751	0.7357
Exp. Dividend Incom	$3.16	$3.38	$4.43
Exp. Dividend Yield	3.08%	3.29%	4.31%
Avg. Analyst 1 yr. est	$112.79	$116.50	######
Avg. Analyst 5 yr. est	$112.82	$116.53	$128.41
Exp. Total Return	55.56%		

Methods of Valuation and Order of Preference:

Method	Value	Ranking	%
FCFF	$120.54	1	35%
FCFE	$165.11	2	35%
DDM	$44.54	4	5%
Res Inc	$22.09	5	5%
Multiples/Relative V	$266.64	3	20%
Target Pric	$156.64		100%

Reasons for Transaction:

3M is rated as undervalued and is expected to continue growing with steady dividends, but isn't growing at such a rate that we should buy more at the sake of other stocks.

Potential Risks:

3M relies heavily on raw materials, especially chemicals and natural gas, so fluctuations in those markets can influence 3M's earnings.

12-Month Chart:

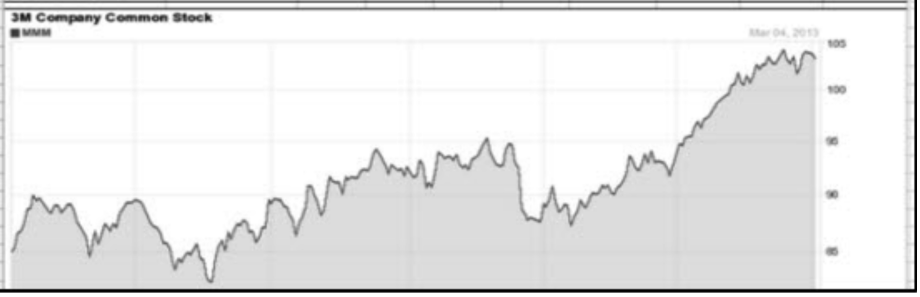
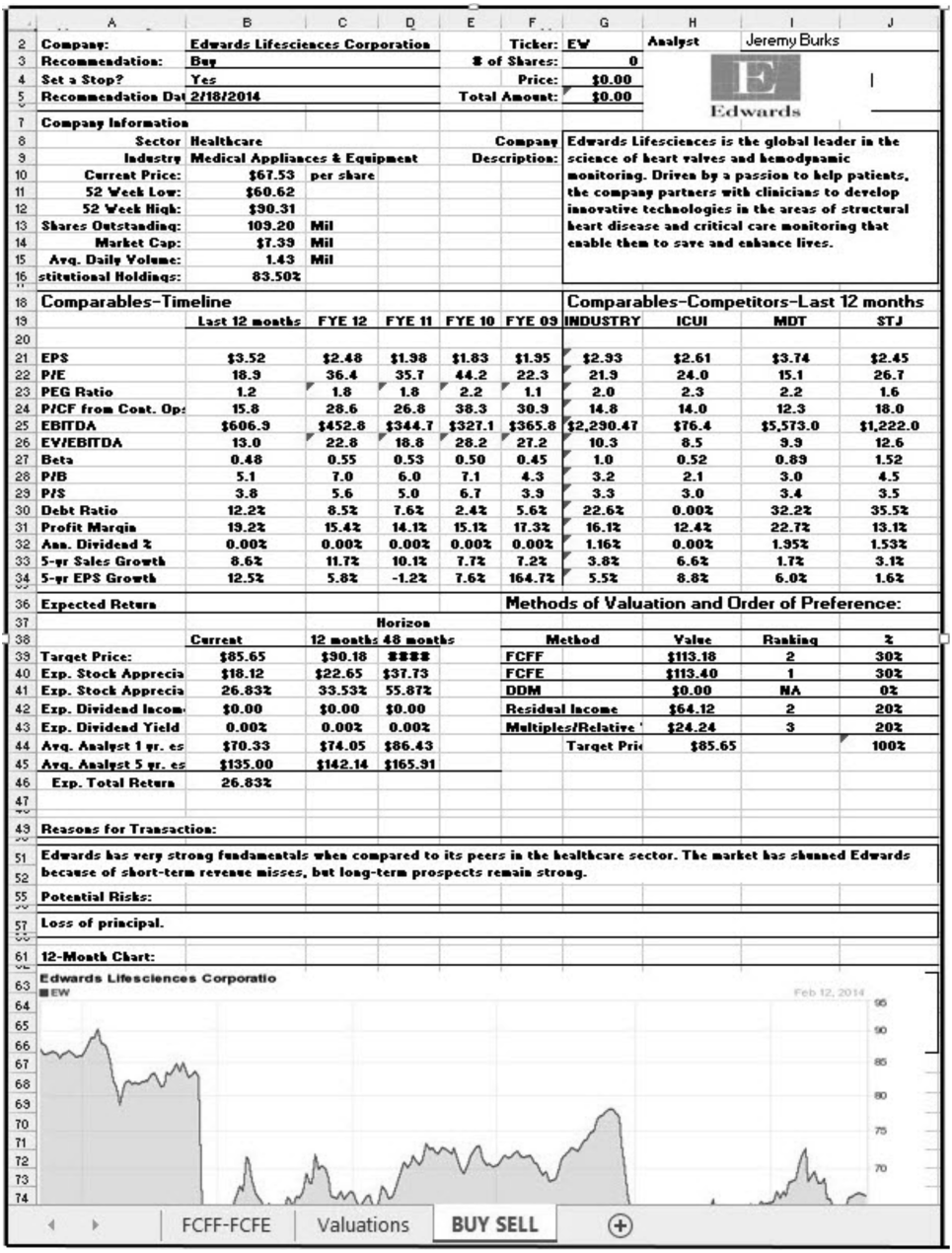


Figure 7. Edwards Lifesciences Buy-Sell Lamar University Student Investment Fund.



Company:	Edwards Lifesciences Corporation				Ticker:	EW	Analyst	Jeremy Burks	
Recommendation:	Buy				# of Shares:	0			
Set a Stop?	Yes				Price:	$0.00			
Recommendation Dat	2/18/2014				Total Amount:	$0.00			

Edwards

Company Information									
Sector	Healthcare				Company	Edwards Lifesciences is the global leader in the science of heart valves and hemodynamic monitoring. Driven by a passion to help patients, the company partners with clinicians to develop innovative technologies in the areas of structural heart disease and critical care monitoring that enable them to save and enhance lives.			
Industry	Medical Appliances & Equipment				Description:				
Current Price:	$67.53	per share							
52 Week Low:	$60.62								
52 Week High:	$90.31								
Shares Outstanding:	109.20	Mil							
Market Cap:	$7.39	Mil							
Avg. Daily Volume:	1.43	Mil							
stitutional Holdings:	83.50%								

Comparables–Timeline						Comparables–Competitors–Last 12 months			
	Last 12 months	FYE 12	FYE 11	FYE 10	FYE 09	INDUSTRY	ICUI	MDT	STJ
EPS	$3.52	$2.48	$1.98	$1.83	$1.95	$2.93	$2.61	$3.74	$2.45
P/E	18.9	36.4	35.7	44.2	22.3	21.9	24.0	15.1	26.7
PEG Ratio	1.2	1.8	1.8	2.2	1.1	2.0	2.3	2.2	1.6
P/CF from Cont. Ops	15.8	28.6	26.8	38.3	30.9	14.8	14.0	12.3	18.0
EBITDA	$606.9	$452.8	$344.7	$327.1	$365.8	$2,290.47	$76.4	$5,573.0	$1,222.0
EV/EBITDA	13.0	22.8	18.8	28.2	27.2	10.3	8.5	9.9	12.6
Beta	0.48	0.55	0.53	0.50	0.45	1.0	0.52	0.89	1.52
P/B	5.1	7.0	6.0	7.1	4.3	3.2	2.1	3.0	4.5
P/S	3.8	5.6	5.0	6.7	3.9	3.3	3.0	3.4	3.5
Debt Ratio	12.2%	8.5%	7.6%	2.4%	5.6%	22.6%	0.00%	32.2%	35.5%
Profit Margin	19.2%	15.4%	14.1%	15.1%	17.3%	16.1%	12.4%	22.7%	13.1%
Ann. Dividend %	0.00%	0.00%	0.00%	0.00%	0.00%	1.16%	0.00%	1.95%	1.53%
5-yr Sales Growth	8.6%	11.7%	10.1%	7.7%	7.2%	3.8%	6.6%	1.7%	3.1%
5-yr EPS Growth	12.5%	5.8%	-1.2%	7.6%	164.7%	5.5%	8.8%	6.0%	1.6%

Expected Return				Methods of Valuation and Order of Preference:			
	Horizon						
	Current	12 months	48 months	Method	Value	Ranking	%
Target Price:	$85.65	$90.18	####	FCFF	$113.18	2	30%
Exp. Stock Appreci	$18.12	$22.65	$37.73	FCFE	$113.40	1	30%
Exp. Stock Appreci	26.83%	33.53%	55.87%	DDM	$0.00	NA	0%
Exp. Dividend Incom	$0.00	$0.00	$0.00	Residual Income	$64.12	2	20%
Exp. Dividend Yield	0.00%	0.00%	0.00%	Multiples/Relative '	$24.24	3	20%
Avg. Analyst 1 yr. es	$70.33	$74.05	$86.43	Target Pric	$85.65		100%
Avg. Analyst 5 yr. es	$135.00	$142.14	$165.91				
Exp. Total Return	26.83%						

Reasons for Transaction:

Edwards has very strong fundamentals when compared to its peers in the healthcare sector. The market has shunned Edwards because of short-term revenue misses, but long-term prospects remain strong.

Potential Risks:

Loss of principal.

12-Month Chart:

Next, we provide the last 12-month data and comparables for the industry and major competitors. In addition, we provide company data for the four previous years. (Past five years' enterprise value (market cap plus debt, interest, and

preferred minus cash and cash equivalents), and EBITDA can be acquired from company annual reports. If available, FACTSET provides enterprise value (EV) and the EV/EBITDA ratio.) If enterprise value (EV) and EBITDA are not available in local data sources, EV and EV/EBITDA are calculated in the EV spreadsheet (Figure 8). Results are posted to the Buy-Sell Sheet. Since Edwards Lifesciences does not pay dividends, we weight their DDM value as zero.

Figure 8. Apple EV.

	A	B	C	D	E	F	G	H	I	J
1	**Enterprise Value**		Last 12 mo	2016	2015	2014	2013	GOOG	MSFT	
2	Mkt Cap		753,718	608,960	583,613	643,120	500,741	668,402	530,940	
3	Debt		193,437	193,437	171,124	120,292	83,451	28,461	121,697	
4	Min Int		0	0	0	0	0	0	0	
5	Preferred		0	0	0	0	0	0	0	
6	Cash& Eq		20484	20484	21,120	13,844	14,259	12,918	6,510	
7	Enterprise Value		926,671	781,913	733,617	749,568	569,933	683,945	646,127	
8	EBITDA		73,222	73,333	84,505	61,813	57,048	23,716	20,182	
9	EV/EBITDA		12.65564	10.6625	8.681344	12.12638	9.990412	28.83897	32.01501	
10										

These evaluation results are linked from the Company Valuation Worksheet (Figure 2). If a value is missing from the list of values in cells H39 to H43, one must change the cell reference in the company valuation sheet. For example, if the DDM value is blank one must change the cell reference from B43 to B44. Similar changes may need to be made for the FCFF and FCFE models. We report example EV for Apple, Inc. The procedure is similar for other companies.

Thirdly, we calculate the target price. In many cases one can use an average of the five estimates. It is up to the analyst to carefully weigh the estimates to obtain the target price. In some cases, the analyst may choose to delete extremely high or low estimates. In our example, we use a 5% weight for extreme results and the balance is divided among the other estimates. The target price is calculated in cell H44 as a weighted average of the estimates. Fourthly, we examine expected returns. The target price from cell H44 posts to cell B39. The price is grown at the sustainable growth rate from the Valuation Sheet (cell E10).

Analysts review stock trends before making a recommendation. Analysts can examine price movements versus a moving average where a move from below the moving average through the average would indicate a positive trend. A similar observation can be found for a moving average convergence divergence (MACD) chart. However, a parabolic spike pattern may indicate an overextension of the stock price SRPM. See Pring (2002) for technical analysis techniques.

Lastly, we report reasons for the transaction, potential risks, and provide a twelve-month chart. These items assist in the buy, sell, or hold decision making process.

Conclusion

The Valuation Workbook provides a method to capture pertinent elements of security valuation. Users can modify the VWB to meet their own criteria or style. The author's students find the VWB to be a useful tool in common stock analysis. The process encourages student analysts to seek investments with positive returns. Based on criteria in SRPM students designed the company valuation worksheet, the cash flow calculation worksheet, and linked the worksheets with the Buy-Sell sheet to create the Valuation Workbook.

Teaching Note

Synopsis: This workbook provides a hands-on spreadsheet valuation of a publicly traded company. Students apply five valuation methods: FCFF, FCFE, dividend discount model (DDM), residual income model (RIM), and multiples. Once the valuation is completed, the student can make a recommendation to buy, sell, or hold. In many student managed investment funds, the class or portfolio management group votes on the recommendation.

Intended courses: The intended courses are graduate or advanced undergraduate courses such as investments, portfolio management, or intermediate or advanced financial management.

Suggested teaching approaches: The Valuation Workbook (VWB) has been used in graduate and undergraduate student managed investment fund classes. The VWB can be used as an initial buy/sell recommendation or as the basis for a detailed security analysis.

Assignment question: Based on your analysis, should you buy, sell, or hold the evaluated company?

Epilogue: The example Valuation Workbooks for 3M and Edwards Lifesciences are student products from the Lamar University Student Managed Investment Fund. The Lamar SMIF earned recognition as a top graduate level value or growth fund based on annual performance for each year from 2010 through 2014 at the Global Asset Management Education (GAME) Conference. Student names are removed for privacy reasons. The Apple VWB is instructor created.

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Vector Autoregression-Informed Monte Carlo Simulation

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Vector Autoregression (VAR) modeling of financial planning variables can provide key insights into the accumulation and spending policies of a range of investment portfolios at both an individual and institutional level, if coupled with Monte Carlo simulation. A standard-form VAR may be used to characterize the joint probability distribution of a range of variables that potentially interact dynamically, and can do so using simple least-squares techniques available in common spreadsheet programs.

This article demonstrates how VAR-informed Monte Carlo simulation may be introduced to students in a simple, straightforward manner, using no more than commonplace spreadsheet tools. The use of VAR-informed Monte Carlo simulation substantially increases the range of variables financial practitioners can consider, and so can be a valuable addition to a business school graduate's set of skills. VAR-informed Monte Carlo simulation, while simple in implementation, may shed light on complicated dynamics between variables—dynamics that are missed by traditional Monte Carlo simulations.
Keywords: *Monte Carlo simulation, Vector Autoregression, Joint Distributions, Pedagogy, Risk*

Introduction

An understanding of the risk/reward profile of a portfolio is key to virtually any investment planning. Too often in presenting to students, we distill such understanding to the simple parameters of expected return and variance (or covariance). A model of the *probability distribution* of future asset values and future economic conditions is often critical. Further, the solutions to many financial problems requires knowledge of the joint probability distribution of asset values not just at a particular point in time, but of the probability distribution describing the paths of assets in reaching that future value. Once this distribution has been

recovered, it is possible to perform useful analyses via Monte Carlo simulation to understand the evolution in the value or behavior of financial variables, such as portfolio values.

Our goal in this paper is to demonstrate that the use of vector autoregression (VAR) to establish the joint distribution of variables, and the subsequent use of that information in a Monte Carlo simulation, is well within the grasp of many undergraduate students. This procedure is surprisingly simple—it distills to a small set of linear regressions followed by simulation. Once the regressions are estimated, students have in hand the joint distribution of the relevant variables—as well as how that distribution may change through time. Once estimated, the VAR allows a potentially very rich set of Monte Carlo simulations to be performed, simulations that simply aren't possible to conduct without an in-hand description of the joint distribution of the variables. Monte Carlo simulation has been used pedagogically for quite a while to reduce complexity for undergraduate students (see, for example, Fink and Fink (2006)). Our experience is that students respond quite favorably to this combination of intuition, feasibility, and real-world relevance.

To illustrate the use of VAR-informed Monte Carlo simulation in the classroom, there are many possible examples. A natural one, in the modern era of retirement planning in which retirees face the joint risks of outliving their retirement savings or under-utilizing their retirement resources, is the spending policy decisions of retirees. Many studies have attempted to characterize an "optimal" withdrawal rate from a retirement portfolio, jointly determined with a given portfolio allocation (see Cooley et al (1999) for an older example, and Frank and Brayman (2016) for an excellent review of more recent literature). Because of the complexity of forecasting future retirement portfolio asset values and the economic environment in which those values will be manifest, these studies are well suited for simulation. Further, with over 200,000 practicing personal financial advisors in the United States, this is an example of significant professional (not to mention virtually universal personal) relevance to many finance undergraduates (Bureau of Labor Statistics (2016)).

The most influential of the retirement portfolio withdrawal papers is Bengen (1994), which established the "4% rule" used by so many financial planners. Bengen (1994) collects historical data, and examines the effect of portfolio decisions (asset allocation, withdrawal rates, etc…) on portfolio values as if they had been exposed to the economic fluctuations present in a series of overlapping historical periods. This approach has several benefits. Most notably, what is observed is a single sample path of economic and financial variables as realized from their true historical joint distribution. There is no need to articulate a model of the joint distribution of the variables—by working with realizations, these distributions are implicit. This is especially valuable if you are working with variables that do not have a clear theoretical link—but are demonstrated

to have a link nonetheless. For example, Kitces and Pfau (2015) examine the incorporation of the implications of the market-wide Cyclically Adjusted PE Ratio (CAPE) on retiree portfolio allocations. The dynamic path of the CAPE variable, while it has been shown to exhibit a relationship with future equity returns, does not have a well-defined theoretical link to those returns. A significant benefit of using historical data is that it eliminates the need to articulate such a theoretical link. There are many variables that are potentially of interest in understanding retiree portfolios, but that interact with stock and bond returns in theoretically uncertain ways. For example, examinations of the interaction between the risk/reward profile of stocks with consumer confidence and political uncertainty may be found, respectively, in Fisher and Statman (2003) and Baker et al (2016). The absence of clear theoretical relationships among the studied variables poses significant challenges to the standard Monte Carlo approach, which uses theory to generate potential realizations of future financial variables. In a classroom setting, an instructor may find it pedagogically valuable to review the Bengen (1994) historical-data approach prior to introducing the VAR-informed Monte Carlo simulation, to provide contrast.

The usefulness of the contrast, of course, is in the illustration that there are significant drawbacks to using the method of historical overlapping periods. Most notably, historical data provides a relatively limited number of possible scenarios against which to test the hypothetical outcomes of a given portfolio structure. Further, generally very long histories of all relevant variables are necessary to provide sufficient observations for meaningful results. For example, between 1926 (the typical starting point for reliable data in Bengen (1994) style studies) and 2017, there are only 61 overlapping 30-year windows—and because they are overlapping, they are strongly correlated with one another, reducing our confidence in conclusions derived from them.

Monte Carlo simulation is often used by financial planners to recover a relevant joint probability distribution, and this process can be replicated in the classroom. See Cooley et al (2003) for a detailed comparison of differing results yielded by overlapping historical periods and Monte Carlo simulation, for the time period 1946–2001. The advantage of this approach is that an arbitrary number of simulations may be performed, giving rise to an arbitrarily large number of possible scenarios that may be considered in the evaluation of a portfolio strategy. Monte Carlo simulations may bring to light combinations of variable values that are not observed in the historical data, but are possible nonetheless. Assuming the joint distribution of the variables involved in the simulation is appropriately described, it is possible to uncover complex interrelationships between financial variables that may not be immediately apparent given the limited number of historical observations present. Demonstrating these kinds of insights can be key to generating engagement with students in the subject matter. The implications of these interrelationships may then be explored.

Perhaps the biggest difficulty in using the Monte Carlo method is the establishment of the joint distribution of the variables. For example, how does the student write down the joint distribution of inflation and portfolio returns though time? The relationship of these two variables is complicated since inflation changes likely affect future stock and bond returns, but past stock and bond returns may well affect inflation. To construct a Monte Carlo simulation such as this, it is necessary to have a model of this interaction, and it is particularly difficult to model this distribution if the relationships among the variables are not just contemporaneously correlated, but autocorrelated as well. Nawrocki (2001) criticizes Monte Carlo simulation for financial planning use on precisely this point.

It is here that the use of VAR-informed Monte Carlo simulation is useful in the classroom. The simple linear regressions necessary to estimate the VAR allow students to comprehend complex relationships using simplifying OLS concepts typically introduced early in business school education. These OLS models can be estimated using simple spreadsheet programs such as Microsoft Excel. With these VAR results (which provide the joint distribution of the variables) in hand, simple Monte Carlo simulations that accommodate autocorrelated variables can be performed. Real-world problems can then be approached that simply weren't accessible previously.

Vector Autoregression—An Overview

VAR has been part of the economist's toolbox for a few decades now (notably, see Sims (1980)). However, the goals of economists and the goals of finance practitioners involved in financial planning are quite different, and those differences in goals allow a dramatic simplification of the methodology. This simplification can be exploited by instructors, to their students' benefit. While economists use VARs ideally to understand the inter-relationships and even cause/effect among economic variables, as finance instructors we can be agnostic on those points. So long as there is agreement on what variables are relevant, the particulars of how and why those variables interact are not of paramount importance—so long as those interactions are correctly modeled. The sacrifice of that level of detail is exactly the simplifying point for VAR analysis, and what allows a relatively simple recovery of the joint distribution of key financial variables.

Let's develop a simple financial planning example to illustrate the process—exactly the kind of example an instructor would develop for students. Consider a model of two variables relevant to a retirement planning decision. Reflecting a simple portfolio of interest, let the two variables be the returns to an equity fund and the returns to a bond fund. A vector autoregressive system such as this may be written as:

$$\begin{aligned} S_t &= \alpha_1 + \gamma_{11} S_{t-1} + \gamma_{12} B_{t-1} + e_{St} \\ B_t &= \alpha_2 + \gamma_{21} S_{t-1} + \gamma_{22} B_{t-1} + e_{Bt} \end{aligned} \tag{1}$$

Where S_t and B_t are the returns to the stock and bond funds at time t, γ_{ij} are the system parameters, and the e's are normally-distributed error terms. Throughout the paper, it is assumed that the "error" terms in the VAR are normally distributed, which needn't necessarily be the case. This is in keeping with OLS assumptions, provides simple, effective solutions, and employs a distribution with which undergraduate students are likely familiar. This simple system just models stock and bond returns as functions of previous-period stock and bond returns, and random "shocks" to the system (the uncertain returns to stocks and bonds). Subject to the conditioning information, this model gives us the joint distribution of the stock and bond returns through time. This type of VAR is referred to as a "standard" or "reduced form" VAR. What makes this setup useful is its simplicity—it can be estimated using ordinary least squares regression, tools for which are widely available, such as in the Data Analysis Toolpak Add-In shipped with Microsoft Excel.

To provide concreteness, estimate the system above using monthly data from January 1995 to March 2017. Arbitrarily, let the stock fund be the S&P 500 Index, and the Bond Fund be the Bloomberg Barclays US Aggregate Bond Index. Both series are collected from the Bloomberg system, using ticker symbols of SPX and LBUSTRUU for the stock and bond indices, respectively. Since the goal is ultimately to use the estimated system to provide the joint probability distribution to be used in a Monte Carlo simulation, it is convenient to set the frequency of the data to the simulation frequency that will eventually be employed. Monthly data, for example, is a reasonable choice if we ultimately wish to simulate retirement withdrawals taken by a retiree on a monthly basis. Using this data the resulting model, estimated via ordinary least squares, is:

$$\begin{aligned} S_t &= 0.31 + 0.24S_{t-1} + 0.46B_{t-1} + e_{St} \\ B_t &= 0.46 + 0.49S_{t-1} + 0.10B_{t-1} + e_{Bt} \end{aligned} \tag{2}$$

This model is interesting both for what it tells us, and what it does not. Most importantly, it gives a method for generating future paths for stock and bond returns that conforms to their joint probability distribution. This will be key when we turn our attention to simulation. But also important, it does *not* tell us the direct effects of the lags of stock and bond returns on contemporaneous stock and bond returns the way a properly specified OLS regression would. So for example, $\frac{\partial S_t}{\partial B_{t-1}}$ does not necessarily equal 0.46, as one would expect under usual OLS assumptions. The reason for this has to do with the particulars of VAR modeling, but distills to the notion that contemporaneous effects of stock and bond returns affect each other, and these effects are embedded in the parameter estimates in ways that are difficult to disentangle. For this kind of analysis, however, there is no need to disentangle them. A detailed but readable treatment of the differences between structural and reduced-form VAR models, however, may be found in Enders (2003, p. 264—266). A discussion of this may be added to advanced econometrics classes. For

typical finance classes, a warning about the interpretation of the coefficients is likely sufficient.

In addition to estimating the two OLS regressions, it is also necessary to collect the covariance matrix of the *e*'s. This covariance matrix will complete our understanding of the joint distribution of the variables in the system, the stock and bond returns. Estimation of this covariance matrix can be readily accomplished by students in Microsoft Excel. An optional output of most OLS tools, such as the "regression" procedure in Microsoft's Data Analysis Toolpak, is the export of the estimated residuals of the OLS regression. Calculating the variances and covariances of these residuals will yield the covariance matrix of the e's.

Denote the covariance matrix for the e_S and e_b terms *S*. For our example above,

$$\Sigma = \begin{bmatrix} 12.62 & -0.13 \\ -0.13 & 0.99 \end{bmatrix}.$$

The variance of the stock index residual e_S is 12.62, the variance of the bond index residual e_B is 0.99, and their covariance is -0.13. This covariance is a crucial ingredient in defining the joint distribution of stock and bond returns in this system.

The VAR system as estimated doesn't provide a great deal of economic intuition—but it doesn't need to. The purpose of estimating the VAR system is to establish the joint probability distribution of the variables in question. There already exist upper-division classes in which many undergraduate students are comfortable estimating the contemporaneous correlation between stock and bond returns and implementing standard Monte Carlo techniques from there (see, for example, Evans (2000) and Cheung and Powell (2012)). However, this process breaks down if the student needs to simulate variables whose values are not well represented by such a simple model. For example, what if the student also needs to simulate inflation rates (as virtually any real-world retirement planning would require)? Simply estimating the contemporaneous correlation between inflation rates, stock returns and bond returns does not provide an adequate basis for the simulation. Why? Because these three series *affect each other in dynamic ways.* These dynamic interactions are completely missed in standard Monte Carlo simulations that only capture *contemporaneous* correlations. If, say, a spike in inflation rates today increases bond returns in the future, standard Monte Carlo analysis would miss this potentially important feature of portfolio evolution. The simulation would be wrong.

But dynamic relationships are easily addressed in the VAR system. To add inflation to the example above, it is necessary only to estimate a third OLS equation, retain the coefficients, and compute the resultant 3x3 covariance matrix of the error terms. The resulting dynamic system then describes the joint probability

distribution of all three relevant variables. An example of this will be presented in Section 4.

Once the VAR system has been estimated, the instructor can then straightforwardly have students simulate from this VAR system, which is explained in detail in Section 3.

Vector Autoregression and Simulation

With the estimated parameters of the VAR system in hand, it is relatively easy to construct a simulation of the relevant variables. This can be quite useful, as our example involving the potential future values of a retiree portfolio will demonstrate. Using the parameters estimated in the previous section, the simulation of the stock and bond returns through time is easy:

1. Randomly draw two numbers, which will be the first period e_S and e_b. These numbers should be drawn from a joint normal distribution with a mean of zero and covariance matrix S above. Appendix 1 discusses in greater detail how this may be accomplished, but it can be achieved using readily available tools such as Microsoft Excel.
2. Let the new period's stock and bond returns be S_t and B_t, respectively. Then, our forecasts for these new period stock and bond returns are given by:

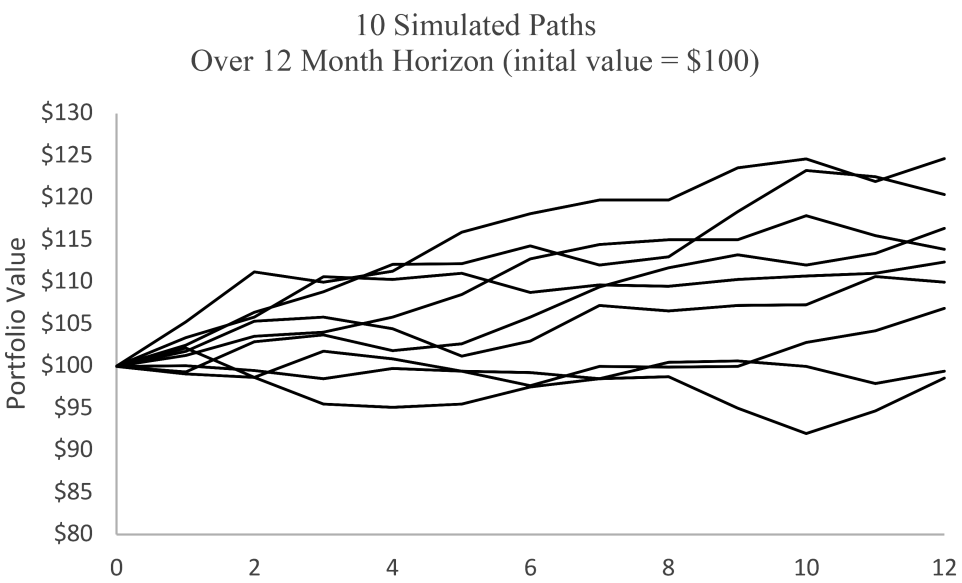
$$\begin{aligned} S_t &= 0.31 + 0.24S_{t-1} + 0.46B_{t-1} + e_S \\ B_t &= 0.46 + 0.49S_{t-1} + 0.10B_{t-1} + e_B \end{aligned} \tag{3}$$

   S_t and B_t will then become "next period's" stock and bond returns, as the system rolls forward.
3. Given the stock and bond returns (and any other modifications, such as reducing the portfolio value by the amount of retiree spending), update the value of the portfolio. Incorporate into the simulation any planned portfolio rebalancing.
4. Repeat steps 1 through 3 until the number of desired periods have been simulated.
5. Retain the information from steps 1 – 4, and repeat until the desired number of simulations have been conducted.

What makes this procedure so effective is that complex relationships between variables can be relatively easily simulated. Once the returns from the simulation above are generated by this VAR-informed Monte Carlo simulation, appropriate analysis can be undertaken—the same kind of analysis frequently undertaken using standard Monte Carlo simulation. For example, for an initial hypothetical portfolio,

the returns generated from the simulation can show the probability distribution of the value of the portfolio. Figure 1 illustrates a simple hypothetical portfolio simulation with 10 simulations over 12 months. It is simple to incorporate into this kind of simulation different spending patterns and how those patterns would subsequently affect portfolio value.

Figure 1.



Completing the Example—Incorporating Inflation into a Retiree Portfolio Simulation

For a couple of decades, it has been standard practice for financial planners to use Monte Carlo simulation to cast client future portfolio values into a probabilistic setting. These simulations have a common structure—usually positing a normal distribution for asset and other variable changes, accounting for their contemporaneous correlations, and allowing random evolutions from there—much in the vein of our discussion so far, but without the benefit of the VAR component.

To extend our example, consider a standard financial planning problem. Assume a simple retiree portfolio consisting of 60% investment in a stock fund and 40% investment in a bond fund, rebalanced each month. Assume that the problem of interest is to understand the potential effects on the retiree portfolio of a given spending policy. Let that policy be a baseline one—in the first month the client will

withdraw 1/12 of 4% of the portfolio value, and will take withdrawals monthly, adjusting the withdrawal amount by inflation (for simplicity of the example, we'll ignore transaction costs, taxes, and required minimum distributions—but it would be straightforward to incorporate them into this setup). At the end of a 10-year period, what is the distribution of the real value of the portfolio in today's dollars?

By way of comparison, it is useful to ask students to first consider the standard Monte Carlo approach. Three variables must be simulated—the stock return, the bond return, and inflation. Continuing with the variables introduced in Section 2, let the stock portfolio be modeled by the S&P 500, and assume the bond portfolio is represented by the Bloomberg Barclays US Aggregate Bond Index. Assume that the inflation rate is given by the Consumer Price Index (CPI), and that historical values for all three variables are collected at a monthly frequency back to 1995. As in Section 2, stock and bond series are collected from the Bloomberg system, using ticker symbols of SPX and LBUSTRUU. Monthly CPI data is collected from Robert Shiller's website found at: http://www.econ.yale.edu/~shiller/data.htm.

Assuming returns to the variables follow the standard lognormal model, the evolution of the three series follows this system:

$$\begin{aligned} S_t &= \exp\left((\mu_s - \frac{\sigma_S^2}{2})\Delta t\ 1\ e_{St}\right) - 1 \\ B_t &= \exp\left((\mu_B - \frac{\sigma_B^2}{2})\Delta t\ 1\ e_{Bt}\right) - 1 \\ CPI_t &= \exp\left((\mu_{CPI} - \frac{\sigma_{CPI}^2}{2})\Delta t\ 1\ e_{CPIt}\right) - 1 \end{aligned} \tag{4}$$

where S and B continue to be the monthly stock and bond returns, and CPI is the percentage change in inflation over the month. Note that it is also reasonable to use the Euler discretization here, for added simplicity. This is particularly helpful if students are encountering these kinds of simulations for the first time. The parameters for this model are estimated from the historical data, and are given in the top panel of Table 1—we simply collect the mean and standard deviation for each series, plus their covariances. Because we have monthly data, our estimates of the μ parameters will be the means multiplied by 12 (since they are annual parameters). Similarly, our estimates for the parameters in equation 4 will be determined by

$$\sigma^2 = \left(\frac{S}{\sqrt{1/12}}\right)^2,$$

where s is the estimated standard deviation of the series.

Table 1. Parameter Estimates for Stock Returns, Bond Returns, and Inflation Changes for a Standard Monte Carlo Simulation.

	Parameter Estimates		
	Stock	Bond	Inflation
μ	7.41%	5.59%	2.19%
σ	12.99%	3.52%	1.23%

	Covariance Matrix		
	Stock	Bond	Inflation
Stock	14.06	−0.23	0.18
Bond	−0.23	1.03	−0.04
Inflation	0.12	−0.04	0.13

The diagonal elements in the second panel of Table 1 provide the variance of each variable, and the off-diagonal elements provide the covariances (these are estimated directly from the data series, and are not adjusted—we provide these for comparison with the VAR-informed Monte Carlo results to be presented shortly). As can be seen by the relative magnitudes of the off-diagonal elements, these three variables are not very highly correlated, at least contemporaneously. The low covariance between stock and bond returns, of course, is unsurprising and one of the fundamental benefits of asset diversification. This model essentially fits into step 2 of the simulation sequence presented in section 3, replacing the VAR equations with the simpler standard Monte Carlo setup.

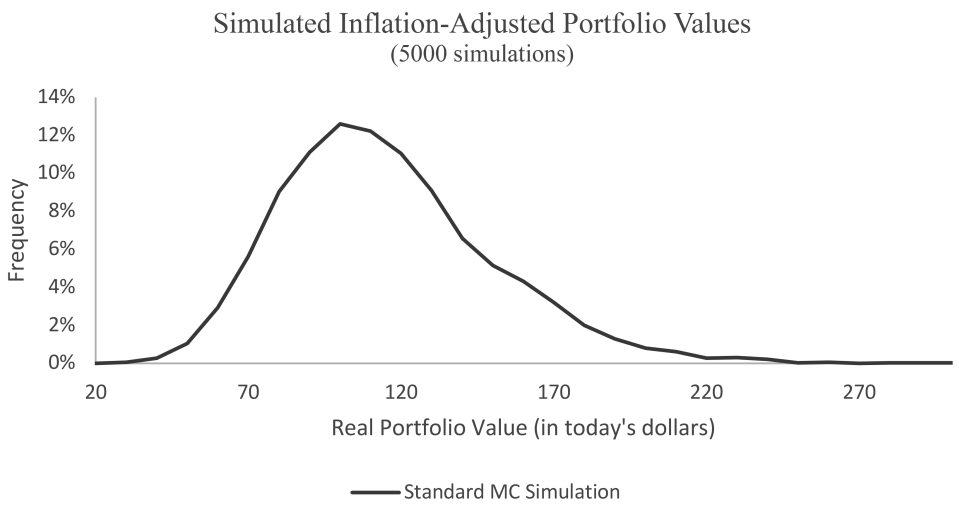
Figure 2 illustrates the distribution of the real value of the resulting client portfolio in 10 years, given 5,000 simulations, and an assumed initial value of $100. The distribution has the expected lognormal shape, and consistent with the literature has a very low probability of being exhausted in this timeframe (in 5,000 simulations, the lowest simulated real portfolio value was $23.27).

Now, consider the simple modifications necessary to include in the Monte Carlo simulation a VAR model. There are only 2 modifications that must be made. The first is to replace the three-equation model (collectively referred to as equation 4) above with three OLS regressions that utilize the historical data available. These three regressions have the following form:

$$\begin{aligned} S_t &= \alpha_1 + \gamma_{11}S_{t-1} + \gamma_{12}B_{t-1} + \gamma_{13}CPI_{t-1} + \varepsilon_{St} \\ B_t &= \alpha_2 + \gamma_{21}S_{t-1} + \gamma_{22}B_{t-1} + \gamma_{23}CPI_{t-1} + \varepsilon_{Bt} \\ CPI_t &= \alpha_3 + \gamma_{31}S_{t-1} + \gamma_{32}B_{t-1} + \gamma_{33}CPI_{t-1} + \varepsilon_{CPIt} \end{aligned} \tag{5}$$

where S, B and CPI continue to be the percentage changes in the stock, bond and inflation variables, respectively. The α and γ are parameters to be estimated by OLS, and the covariance terms of the ε's will need to be estimated as well. The ε's

Figure 2.



are assumed to have a normal distribution. Estimates of these parameters given our data set are provided in Table 2. Throughout this article, it is assumed that the VAR regressions use only 1-period lags to describe the dependent variables. Certainly, longer lags could be included if desired by the instructor.

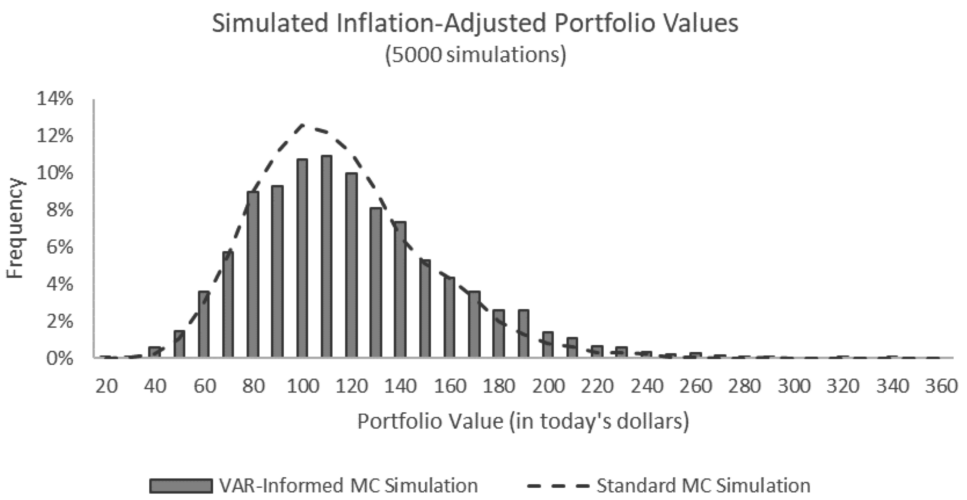
Table 2. Parameter Estimates for Stock Returns, Bond Returns, and Inflation Changes for a VAR-Informed Monte Carlo Simulation.

	VAR Coefficients			
	Intercept	S_{t-1}	B_{t-1}	CPI_{t-1}
Equation 1, S_t =	0.32	0.24	0.46	−0.04
Equation 2, B_t =	0.52	−0.05	0.08	−0.29
Equation 3, CPI_t =	0.07	0.02	0.02	0.47

	Covariance Matrix of the ε's		
	Stock	**Bond**	**Inflation**
Stock	12.62	−0.13	0.04
Bond	−0.13	0.98	−0.02
Inflation	0.04	−0.02	0.09

The second modification is to estimate the covariance matrix of the ε's. This can be done by collecting the residuals from the OLS regressions, and computing the appropriate variances and covariances.

Figure 3.



Again it should be noted that it is difficult extract meaningful information from the coefficients of a standard form VAR such as this. However, the dynamic lead-lag relationships of the system are embedded in the combination of parameter estimates and covariance structure of the error terms.

A 5,000 simulation experiment drawn from this system gives rise to a similar distribution for potential future portfolio values that we saw in the standard Monte Carlo simulation. However, as can be seen in Figure 3, the distribution changes a bit. In this particular example, the distribution appears a bit "flatter" than in the standard simulation, implying the range of client outcomes is more varied than the standard simulation suggests. There are several reasons this result may arise, stemming from the dynamic relationships present among the three variables. Just as an example, suppose high stock returns are estimated to follow from low inflation changes—which can happen even though *contemporaneously* the correlation between stock returns and CPI changes is close to zero. A low CPI "today" indicates that the hypothetical retiree would not need to take large withdrawals, and so more of the portfolio would be available for growth when the subsequent higher returns are experienced—leading to a higher real portfolio value. The flexible VAR specification allows the opportunity for the model to capture these kinds of effects if they are present, and in this example it appears that the result of this increased realism of the model is a greater variability of outcomes than the standard model was able to capture. As such, this example provides an important illustration to students of why modeling the system correctly allows greater understanding of the risk/reward tradeoff of this portfolio.

Interestingly, the correlation between the nominal portfolio value at the end of the 10 year simulation period and the level of inflation in the VAR-informed

simulation was about 17.4% (this is not reported directly in the tables). This is surprising, since the raw data indicated that the contemporaneous monthly correlation between CPI changes and S&P 500 returns was about 8%, while the contemporaneous monthly correlation between CPI changes and bond returns was around -12%,. By contrast, the standard Monte Carlo simulation only indicated a correlation between the nominal portfolio value and the inflation level of about 4%. The VAR model was able to capture dynamics in the data beyond what simple contemporaneous measurements were able to reveal. The result is a more accurate picture of the risk/reward environment.

Our simple example here, however, is just that—a simple example. An almost limitless number of possibilities arise once this simple method for including historical relationships into the Monte Carlo is mastered. To extend our example, it would be possible to add the price of health insurance to our simulation (which is likely correlated with general inflation) by using the VAR method. All that would be necessary is an appropriate index of health insurance costs. It would then be possible to incorporate these expenditures into the model.

Implications for Instructors

We have illustrated how instructors may use standard-form vector autoregression (VAR) to significantly expand the range of simulations that they may feasibly approach with their students. Simulation is a flexible tool that allows both students and the financial practitioners they hope to become to examine the risks and rewards of a great many decisions, and to do so without the significant constraints that are present when simulating only from historical data. While this research has presented a financial planning example from the realm of retirement planning, clearly other common financial planning problems can be tackled with the combination of VAR and Monte Carlo simulation, and the basic simplicity and intuition should flow through. For example, this kind of procedure could help inform charitable foundations as they establish their spending policies.

The challenge with Monte Carlo simulation is the estimation of the joint probability distribution of the relevant variables. It is often not clear to students what this distribution should be, or how to construct it to allow the distribution to change through time. Worse, many students do not realize the importance of determining this distribution. VAR provides a framework to estimate this joint distribution. Further, since VAR can be distilled to a small number of OLS regressions, it becomes possible for the instructor to explicitly discuss the joint distribution and its subsequent role in simulation. While the VAR distributional assumption in our simple examples effectively distills to the normal distribution of the errors to which most upper division undergraduates have been exposed, it is the linkages through time among the variables of interest that is of particular value. This simple specification is very robust. This then provides a framework

for students to recover a probability distribution that may be difficult or impossible to recover otherwise in a relatively simple way, using techniques no more advanced than simple OLS.

This article presents a very simple example—that of the asset components of a retiree portfolio evolving through time along with the inflation rate, and the client spending some of the value of the portfolio according to a prespecified rule. It is a worthy example in a time when virtually all students will eventually have to solve this problem for themselves, and many will do so professionally for others. Even in such a simple framework, there are notable realism gains to be had relative to the standard Monte Carlo setup, because of the dynamic linkages among the variables. This added realism can be used to help students understand the importance of the dynamic linkages, and the benefit of more realistic modeling.

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Appendix 1

If there are only two random variables in the simulation, such as stock and bond returns, it is easy to generate correlated normally-distributed residuals, such as e_S and e_B. Assume that the covariance matrix of e_S and e_B is:

$$\sum = \begin{bmatrix} \sigma_S^2 & \sigma_{SB} \\ \sigma_{SB} & \sigma_B^2 \end{bmatrix}$$

implying the standard deviation of e_S is σ_S, and the standard deviation of e_B is σ_B. The correlation of e_S and e_B is $\frac{\sigma_{SB}}{\sigma_S \sigma_S}$. Denote this correlation ρ. The first step is to generate mean zero, normally distributed residuals. In Excel, this can be accomplished with the functions:

$$X_S = \text{Norm.S.Inv(Rand())}$$

$$X_B = \text{Norm.S.Inv(Rand())}$$

The function Rand() generates a uniformly distributed random number between 0 and 1, and Norm.S.Inv then maps this number back into a normally distributed number, with a mean of 0 and a standard deviation of 1.[1] To recover correlated variables e_S and e_B, the student can then modify X_S and X_B by:

$$e_S = (X_S)\,\sigma_S$$

$$e_B = (\rho X_S + \sqrt{1-\rho^2} X_B)\sigma_B$$

This is a specific example of a procedure known as a Cholesky decomposition. If more variables are needed in the simulation, a Cholesky decomposition with a greater number of transformations is necessary. See Hull (2015), p. 473 for a simple generalization.

[1] It should be noted that in some versions of Microsoft Excel, the Rand() function has been criticized for generating inadequate sequences of random numbers, and so instructors may wish to replace the built-in function with an alternative one if very large numbers of simulations are necessary. However, recent Excel versions appear better on this score, particularly if the numbers of simulated values are not in the millions. See Mélard (2014).

Creating a Series of Capital Budgeting Cases Based on the Buy vs. Build Decision

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The purpose of this paper is to encourage finance faculty teaching in the area of capital budgeting to develop their own series of cases based on a local firm's consideration of an investment in new technology. Investing in technology provides a setting to consider the buy vs. build decision: Should the firm buy the technology from an outside firm or should they develop the technology in-house? We present, as an example, a series of three cases used over the past ten years in which we highlight learning objectives, common student errors, and personal insights into the analytical issues arising from the buy vs. build decision. These cases provide students with the opportunity to apply a wide range of financial tools commonly used to evaluate capital investments with an emphasis on adjusting the models for the unique risks of developing the technology in-house.
Keyword: *Capital Budgeting, Case Writing, Local Firms, Buy vs. Build, Systematic vs. Unsystematic Risk*

Introduction

The purpose of this paper is not to simply provide finance faculty with yet another capital budgeting case, but rather to explain how to develop their own series of unique cases that provide a rich environment to discuss and apply the most common financial tools used to evaluate capital investments. The process we present for developing a series of capital budgeting cases initially requires identifying a local firm considering an investment in new technology. In addition to the actual cases we have developed, we also provide a discussion of the learning objectives, common student errors, and personal insights into best practices necessary to complete a detailed logical analysis of the buy vs. build decision to aid interested faculty in developing and introducing their own cases into the courses they teach.

The financial tools and methodologies which students are required to apply in order to evaluate capital investments in the series of cases include: estimation of

the incremental after-tax operating cash flows, calculation of four key performance measures, consideration of utilizing risk adjusted discount rates, and application of various risk assessment tools including Monte Carlo Simulation. The cases also require students to consider non-quantifiable value relevant factors that should be included in the decision to buy or build the new technology, thus creating a discussion of the objective vs. subjective nature of evaluating capital investments. The most important learning outcome of the series of cases is a better understanding of the differences between systematic and unsystematic risk. It is our experience that being able to determine whether a specific risk is systematic or unsystematic, and how the analysis should reflect these risks, are very difficult concepts for students and are skills that are quickly forgotten as students leave the academic environment and enter the work force. The series of cases presented in this paper is based on an actual investment decision faced by PACCAR, Inc. a global leader in the design and manufacture of high-quality premium trucks, headquartered in the Seattle area. In 2005, PACCAR was considering upgrading the technological capabilities of its two major lines of trucks: PeterBilt™ and Kenworth™. Applications of this technology include email, vehicle diagnostic and maintenance, as well as other vehicle information. The decision to invest in this new technology involves two mutually exclusive alternatives. PACCAR could buy the technology from an outside firm or it could attempt to develop the technology in-house. The buy vs. build decision is a key aspect of the case because developing the technology in-house is a riskier alternative and, therefore, creates the need to understand whether the additional risk is systematic or unsystematic and how the analysis should be adjusted for the additional risks associated with in-house development.

Pedagogical research suggests that reality-based projects are effective learning tools (Baker and Schomburg, 2003; Hruby, Kahl, and Newman, 2003; Rich, 2005; and Seiver, 2014) yet they are underutilized (Clarke, 2005). Clarke reports results from student surveys suggesting that real-life case projects, though time consuming, are engaging, enjoyable, useful for synthesizing course material, and helpful in recognizing and analyzing complex business situations. The benefits of reality based assignments, requiring students to interact with finance professionals, are impactful for many reasons but primarily because students perceive that interacting with the business community increases the relevance of assignments and thereby, their overall learning experience (Brous, 2007). Paulson (2011), citing the work by Carrithers, Ling, and Bean (2008), describes how using a reality-based project encourages students to develop communication and critical thinking skills.

Our experience suggests that the pedagogical advantages of basing cases on a real world investment decision faced by a local firm can vary dramatically based on the faculty's efforts. At minimum, it provides a familiar context – students likely have some prior knowledge of the firm, making the exercise more real to them. If the instructor develops a relationship with a representative of the local firm, there is the

potential to create opportunities for face-to-face meetings between students and firm representatives. Onsite visits by students afford them the opportunity to observe the decision-making process in a real world situation. Classroom presentations by firm employees give students a chance to gain direction and clarification of issues involved in the project directly from the source. Ancillary benefits include the possibility of additional research and/or consulting opportunities for faculty or faculty/student teams, the potential for students to gain employment with the firm, and the creation of a long term relationship between the firm and the academic institution.

For business schools involved in assessment, this approach to case development creates extremely rich opportunities for Assurance of Learning (AOL). If the instructor/firm relationship is strong, the opportunity to utilize firm employees involved in the capital budgeting decision process to evaluate students' work is a profound way to analyze whether they have achieved the level of competence required to perform similar tasks in a real world setting.

Identifying the Investment Decision of a Local Firm

In 2005, we examined PACCAR's press releases provided in their annual report and observed one describing PACCAR's consideration of upgrading the technological capabilities of its two major lines of trucks: PeterBilt™ and Kenworth™. Applications of this technology upgrade would be the inclusion of email, vehicle diagnostic and maintenance, as well as other vehicle information for these two lines of trucks. What was particularly interesting about this investment decision was that PACCAR was considering two alternative means of obtaining the new technology. The press release suggested that PACCAR was considering purchasing the new technology from another firm (the buy alternative) or developing the technology in-house, (the build alternative). The choice between buying the software and building it is a common decision, requiring analysts to consider the unique risks associated with developing the technology in-house. As previously mentioned, determining the appropriate methods for adjusting the analysis of these unique risks creates the potential for several key learning opportunities from these cases. In the first case, the unique risks are only considered as a relevant qualitative factor. In the second case, the issue of increasing the discount rate for the build alternative is considered, and in the third case, various risk assessment tools are applied to quantify the unique risks and to understand potential consequences associated with developing the technology in-house.

Case Learning Objectives

The authors created a series of three cases designed to apply commonly used financial tools and methods for evaluating capital projects. For each case, students

are expected to complete a two to three page write up describing their analysis along with all Excel spreadsheets (exhibits) necessary to complete the required analysis. The learning objectives for each case contain both technical and conceptual hurdles. Students are required to demonstrate their technical skills by creating Excel exhibits which requires the application of various tools necessary for the analysis. Students are also required to demonstrate conceptual understanding in their write ups through explaining their analysis, presenting their results, and discussing the implications of the results for the buy vs. build decision. The expectation is that the write up is easy to understand and well organized with properly structured sentences and paragraphs. Essential components of a well written report are: An introductory paragraph which describes the purpose of the analysis, the main body which describes the analysis, the results and the implications for the decision, and a concluding paragraph which summarizes the results and provides a well-supported recommendation. Excel exhibits must look professional, have an informative title, clearly present the underlying assumptions and the analysis (with calculations referencing the assumptions cells), and provide a clear presentation of the results. The case instructions stress that the decision maker reviewing the analysis should be able to understand how all of the numbers were derived.

The remainder of this paper provides a detailed description of the analysis expected from students and a discussion of the common errors that students make for each case. We also provide a discussion of the conceptual issues students are expected to grapple with including our opinion of the appropriate way to think about these conceptual issues. The three case assignments are presented in Appendices A, B, and C.

Case One: Cash Flow Estimation and the Calculation of Key Performance Indicators

The student's first task is to estimate the incremental after-tax operating cash flows for both the buy and build alternatives based on detailed assumptions provided in the case description (see Appendix A for Case One). Additionally, an estimate of PACCAR's weighted average cost of capital (WACC) is provided. The case suggests that this estimate be used as the required return for both the buy and build alternatives. Given their estimation of each alternative's cash flows and the discount rate provided to them, students are asked to calculate the commonly used performance indicators: net present value (NPV), internal rate of return (IRR), payback period (PP), as well as modified internal rate of return (MIRR), a performance measure that PACCAR's decision makers are not familiar with. Based on their forecasts of the key performance indicators for both alternatives, students are asked to make a recommendation to buy, build, or pass on the new technology. Finally, students are asked to consider non-quantifiable factors and

discuss how these factors may affect their original recommendation based solely on the quantifiable results.

The process of estimating the incremental after-tax operating cash flows over the life of the investment opportunity for both alternatives creates significant challenges for most students. Common student errors associated with estimating after-tax operating cash flows are improper consideration of the annual **change** in the firm's working capital and incorrect calculations of the after-tax salvage value of the operating assets in the projects' final year. Even though prior class discussions focus on the calculation of both of these aspects of cash flow estimation, students tend to consider the level of working capital needed rather than the annual change in the level, and often ignore the recapture of the annual increases in working capital at the end of the project's life. Additionally, since the case states that the expected salvage value of the operating equipment purchased will be zero, students often ignore the tax consequence associated with selling a depreciable asset for less than its book value. Given the asset's book value is positive at the time of sale and the expected salvage value is zero, the firm earns a tax credit at the end of the project's useful life because the asset was under depreciated over its useful life.

An additional technical hurdle that students encounter is how to manage the unusual timing of the cash flows associated with the build alternative. Although the buy alternative creates typical cash flows over the project's five year useful life, that is; an outflow (purchase price and operating equipment), at time 0 followed by five annual cash inflows, the build alternative requires one year to develop the software. The development costs are incurred throughout the first time period. Thus the cash flows at time 0 are zero. The outflows, (development costs and investment in operating equipment), occur during year 1 when the technology is being built, with the first year of operation in year 2, and the fifth and final year of operation occurring in year 6. The following table provides the forecasted incremental after-tax cash flows:

Table 1. After-Tax Cash Flows.

Buy Cash Flows:						
	Time 0	Year 1	Year 2	Year 3	Year 4	Year 5
After-Tax Cash Flow ($M)	−$175.00	#27.48	$51.07	$49.07	$49.20	$86.33

Build Cash Flows:							
	Time 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
After-Tax Cash Flow ($M)	$0.00	−$155.00	$25.82	$48.95	$46.76	$46.87	$81.30

The unusual timing of the cash flows for the build alternative requires students to figure out how to adjust the estimation of the four key performance measures.

For example, when estimating the NPV of the build alternative, students typically will use Excel's NPV function without adjusting for the delayed cash flows. This leads to an estimate of the NPV in year 1. Students need to understand that to compare it to the NPV of the buy alternative, the NPV of the build alternative must be discounted an additional year to time 0. Additional issues raised by the unusual timing of the cash flows of the build alternative are: (1) determining the starting point for estimating the project's payback period, and (2) whether or not to include the time 0 cash flow of zero dollars into the estimation of IRR and MIRR. In our opinion, the payback period for the build alternative should start after the initial investment is made in year 1. The IRR function in Excel for the build alternative is not affected by the inclusion of the zero cash flow at time 0, however to be correct, the MIRR function in Excel should not include the zero cash flow at time 0.

There are two conceptual issues raised in the case which students need to address in the write up describing their analysis. First, since the case description clearly states that PACCAR's financial management is not familiar with MIRR, students must explain the difference between IRR and MIRR, and why MIRR is a better performance measure. Most students can explain that IRR assumes that the annual cash inflows from the investment are reinvested at the investment's IRR while MIRR allows the analyst to determine the reinvestment rate, and that it is common to use the same reinvestment rate as NPV, the investment's required rate of return (typically the firm's WACC). Explaining why MIRR is a better performance measure of the project's return tends to be difficult for students. Their explanation should include the notion that reinvesting at the investment's required return is a value-neutral reinvestment assumption, while assuming reinvestment at the project's IRR will inflate the return for value enhancing projects and likewise deflate the return for value destroying investments.

The second conceptual issue associated with Case One involves the non-quantified factors that may influence students' recommendations whether to buy or build the new technology. The assumptions provided in the case should lead students to find that all four performance measures favor the build alternative compared to the buy alternative as illustrated in the following table:

Table 2. Various Performance Measures.

	Buy	**Build**
NPV ($ millions)	$28.09	$34.98
IRR	13.07%	15.57%
MIRR	11.26%	12.82%
Payback Period (years)	**3.66**	**3.71**

The case description clearly suggests that student reports should make a recommendation based on the quantitative analysis before they consider how non-quantified factors might alter their recommendation. Our hope is that students can identify at least one non-quantifiable factor that favors and one non-quantifiable factor that opposes the build alternative. In our opinion, a significant non-quantifiable benefit of developing the technology in-house is the creation of intellectual capital. Owning the rights to this intellectual capital gives the firm the option to either use this technology for PACCAR's other lines of trucks, or to sell the technology to other truck manufacturers. Importantly, having this intellectual capital would certainly make the potential reinvestment in the technology at the end of its useful life significantly cheaper.

The obvious significant non-quantifiable factor against developing the technology in-house is the added risk. There is the risk of complete failure to develop the technology, or of developing relatively inefficient technology thereby reducing forecasted increases in revenues. Moreover, cost overruns and time delays are also common concerns when developing new technology. Another non-quantified risk of the build alternative occurs because of the one-year delay in entering the product market due to the time required to develop the technology. This delay to market increases the probability that competition will beat Paccar to the market and thereby reduce forecasted increases in revenue from the addition of the technology.

It is imperative for students to understand that capital allocation decisions between alternative investment opportunities are not all about the numbers. Simply because the quantitative analysis suggests an investment is value enhancing or is better than a mutually exclusive alternative, non-quantifiable or qualitative issues may be just as, or even more important than the numbers. In this first case, we want students to learn that the decision to build or buy is potentially more subjective than objective. Yes, the quantitative analysis suggests recommending developing the technology in-house but the added non-quantified risks associated with the build alternative are significant and therefore, this is not a clear choice. Student recommendations are fairly easy to predict. Undergraduates almost always choose the build decision, essentially ignoring the non-quantifiable factors. Graduate students usually will split 50/50; half will ignore the added risk and half will argue that this factor alone suggests PACCAR should buy the technology. Executive MBA students will almost unanimously choose the buy decision based on their concerns about the additional risks associated with developing the technology in-house.

In summary, the first case requires students to apply the basic tools necessary to evaluate capital investments. They must estimate incremental after-tax cash flows and the key performance indicators for both the buy and build alternatives. The unusual timing of the cash flows associated with the build alternative, the

conceptual issues of the benefits of MIRR, and the importance of identifying and incorporating non-quantifiable factors into their ultimate recommendation create many rich learning opportunities.

Case Two: Determining the Appropriate Risk Adjusted Discount Rate (Required Return)

The second case initially requires students to correct any errors they may have made in Case One because they will be using the same incremental after-tax operating cash flows and performance measures as they proceed. The case description (see Appendix B for Case Two) acknowledges that the alternative to develop the technology in-house is more risky than buying the technology from a third party vendor. The key issue addressed in this case is whether or not the discount rate (the required return) used in Case One should be adjusted for the differences in risk and, if so, how. Case Two requires students to estimate a risk adjusted discount rate using the *Pure Play* approach, based on two software development firms, and to ultimately decide whether it is more appropriate to use the risk adjusted discount rate based on their pure play analysis or to use PACCAR's WACC as applied in Case One. Given their determination of which discount rate is appropriate for each alternative and the possibility of revised key performance indicators based on their selected discount rates, students must provide an updated recommendation for the buy or build decision that considers both their quantitative results and any remaining non-quantifiable factors.

Technical hurdles in Case Two arise from applying the pure play approach to estimate the potential discount rate (required return). The pure play approach presented in class suggests that there are two ways to use data from pure play firms to estimate the required return on an investment into a new product market. The first approach requires unleveraging each pure play firm's equity beta to determine their asset betas, then plugging the average of the firms' asset betas into the CAPM to get an estimate of the required return. The second approach simply finds the WACC of each pure play firm and then averages their WACCs. This average WACC, then, is an estimate of the required return. Ultimately, Case Two suggests that an average of the required returns from each approach should be considered as a point estimate of the required return on a firm's investment into a new product market.

The specific technical learning objectives are twofold: First, students must collect the appropriate inputs from the online sources and estimate a pure play firm's asset beta by applying the Hamada equation:

$$B_a = \frac{Be + Bd*(1-t)*D/E}{(1 + (1-t)*D/E)}$$

The second technical learning objective is that students should be able to identify the appropriate inputs and estimate each pure play firm's WACC. The procedures presented in class are consistent with Brotherson, Eades, Harris, and Higgins (2013) article entitled "Best Practices in Estimating the Cost of Capital: An Update". One problem students have is in identifying the appropriate dates on which to measure the value of debt and equity. The book value of interest-bearing liabilities is used to proxy for the firm's market value of debt and the source is the most recent quarterly balance sheet available for the firm. In order to estimate the firm's debt ratios, it is important to measure the values of debt and equity at the same point in time. This requires that students examine historical stock prices to estimate the market value of equity **on the same date** as the most recent quarterly balance sheet as opposed to using the most current market capitalization. Another difficulty for students is estimating the firm's cost of raising debt. Brotherson, et al. (2013) suggests using the current yield to maturity on the firm's bonds that mature in ten years. Given the surfeit of bond data, this task may not be so simple.

Conceptually, one major issue students must address is the logic underlying their reasoning for their selection of the required returns for both the buy and build alternatives. Should there be a higher discount rate (required return) for the build alternative given the unique risks associated with developing the software in-house? This issue requires students to consider whether the risks associated with the build alternative are systematic or unsystematic. If the risks are systematic in nature then the discount rate should be increased to compensate for the higher systematic risk. However, if the additional risks are project specific or unsystematic in nature then the discount rate should not be increased, rather the expected cash flows should be adjusted to reflect these risks. In our opinion, the risks associated with the build alternative (failure to develop the technology, cost overruns, time delays, increased competition from a delay to market, etc.) are project specific or unsystematic in nature and, therefore, the discount rate should not be adjusted. Since both the buy and build alternatives generate cash inflows from the same product market - trucks with enhanced technology - the systematic risk of both alternatives is the same. As the economy (stock market) goes up and down, sales and ultimately the incremental after-tax cash inflows will go up and down equally for both alternatives because the product being sold is the same and, therefore, so are the correlations with the overall market.

Another conceptual issue facing students is whether the risk adjusted discount rate used for both the buy and build analysis should be estimated by PACCAR's WACC (used in Case One) or the required return estimated from the pure play approach. The issue is whether the systematic risk of the incremental after-tax operating cash flows from these two alternatives is more similar to the truck manufacturing industry or the software development industry? Are the incremental cash flows generated from the sales of trucks or the sales of software? The answer,

we believe, is a bit of both. Nevertheless, we would suggest that the increases and decreases in these cash inflows as the economy goes up and down is more consistent with the changes in the trucking industry than the software industry. If PACCAR was considering selling the software they developed, then the discount rate generated from the software developing firms (pure play approach) would be appropriate but not for the increase in truck sales due to adding the software to their trucks.

Case Three: Applying Various Risk Assessment Tools

Case Three focuses on evaluating the additional unsystematic risks associated with developing the technology in-house. The additional unsystematic risk is a significant non-quantifiable factor discussed in Cases One and Two but it is not incorporated into the quantitative analysis of either case. Students are required to apply various risk assessment tools (Breakeven Analysis, Sensitivity Analysis, Scenario Analysis, and Monte Carlos Simulation) to address management concerns about the additional risks associated with attempting to develop the technology in-house (See Appendix C for the description of Case Three). Students are then required to submit a three page report describing the results from the risk assessments and the implications of each for the buy or build decision. Finally, students must provide a well-supported recommendation to the CFO, as to whether PACCAR should buy or build the technology based on their risk assessment results and any other non-quantifiable factors they believe should be considered.

The technical hurdles include appropriately applying the various risk assessment tools required by the case. For example, the case asks students to determine the cost of developing the technology at which PACCAR would be indifferent between the buy and build alternatives. Many students solve for the development cost that makes the NPV for the development option zero because examples in class were structured that way. However, they are expected to solve for the level of the development cost that would create a NPV for the development alternative equal to the NPV for the buy alternative. We believe this analysis is more useful in deciding whether the added risk of developing the technology is manageable.

Another technical hurdle faced by students is to properly adjust the incremental cash flows and the performance measures for the specific scenario provided in the case description. The scenario is one in which the development of the technology will be delayed an additional six months (culminating after 18 months vs. one year as in Case One), the costs to develop the technology increase by 20%, and the incremental revenue in the first year from adding the technology is 10% less than originally expected. The assumption of an additional six months to develop the technology requires students, once again, to adjust their NPV calculation for cash

outflows that occur at the end of 18 months with five annual cash inflows starting 30 months from time zero.

The final technical hurdle associated with Case Three is for students to apply Monte Carlo Simulation. For many students this is their first experience with Monte Carlo Simulation which can represent a significant challenge. The case description explicitly requests specific outputs for each alternative including the project's mean NPV, standard deviation of NPV, the Value at Risk (5% level of significance), the probability that the project's NPV will be less than zero, and a sensitivity analysis for each assumption/input necessary to estimate the project's cash flows. The mean NPV is considered a revised estimate of the NPV derived from point estimates of the assumptions, while the standard deviation of NPV, the Value at Risk, and the probability that (NPV $<$ 0) are all risk assessment measures.

The conceptual hurdle students face in Case Three is to craft a well-articulated description of the implications of the results from each risk assessment tool applied, requiring students to present a logical discussion of their assessment of the risk return tradeoff. We have observed students often have a difficult time interpreting the results from the break-even analysis and the two-way sensitivity analysis. Additionally, if the Monte Carlo Simulation finds that the mean NPV is greater for the build than the buy alternative but the build alternative's standard deviation of NPV is greater, its Value at Risk is significantly more negative, and the probability of NPV $<$ 0 is greater, then students have to logically discuss this classic risk/return tradeoff facing decision makers.

Conclusion

Our hope in writing this paper is to encourage finance faculty teaching in the capital budgeting area to create their own series of cases based around a local firm's investment opportunity in technology. The series of cases covers all of the fundamental tools used to evaluate capital investments: estimating after-tax cash flows, calculating key performance measures, considering the use of risk-adjusted discount rates, and applying various risk assessment tools including Monte Carlo Simulation. Identifying a capital budgeting decision facing a local firm creates many excellent learning opportunities for students and the possibility of a long term relationship between the local firm and the university. A very important aspect of the case design is that the decision involves a technological investment because there are two ways of obtaining the technology; build versus buy. This is important because it requires the analyst to consider how to incorporate the additional risks associated with developing the technology in-house compared to buying existing technology from another firm. To properly incorporate the additional risks into the analysis requires a determination of whether the risk is systematic or unsystematic. Based on this determination, the analyst must adjust the analysis accordingly. It is

our belief, based on our teaching of capital budgeting for more than 20 years that understanding the difference between these two types of risks, and how to adjust the analysis for them is very difficult for most students. Moreover, it is a concept that practitioners seem to forget upon graduation.

We strongly believe that the benefits to the students, faculty, and the business school are significant enough to offset the time and effort (costs) required of a finance professor who chooses to develop their own series of cases. The real world learning experience is the key benefit for the students. Additionally, students will have a "product" that they can use as they embark on the process of interviewing for a job which demonstrates that they have obtained important financial analytical skills. Faculty who develop their own cases will benefit from the satisfaction of improving students' knowledge and employment opportunities. Additionally, anecdotal evidence suggests that faculty will benefit from an improvement in their course evaluations. In the eleven times that we have taught this course before the development of these cases, the average response to the question, "Would you recommend this course?" was 4.41 out of 5. However in the eighteen times we taught this course after the development of the cases, the average response increased to 4.66 out of 5. Finally, the business school benefits from increased student satisfaction and an increase in the satisfaction employers have with the school's graduates. The reputation of the business school will improve when its curriculum is seen to be connected to local businesses.

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Appendix A
Case 1: PACCAR's Buy or Build Decision

PACCAR, a local truck manufacturer, is considering upgrading the technological capabilities of their two major lines of trucks: PeterBilt and Kenworth. Applications of this technology may include email and vehicle diagnostic and maintenance as well as other vehicle information. The decision whether to invest in this new technology is complicated by the realization that PACCAR could buy the technology from an outside firm or could attempt to develop the technology in house.

If PACCAR chooses to buy the rights to the technology from an outside firm, it would cost them $25 million. Additionally, some new operating equipment would be required at a cost of $150 million (assume both costs occur at time 0). The technology rights have a depreciable life of 3 years but a useful life of 5 years. The new operating equipment has a depreciable life of 10 years but also a useful life of 5 years. Both assets will have no salvage value at the end of 5 years. Additionally, there will be an increase in maintenance expenses associated with this new technology of approximately $5 million in the first year of operation. The expected annual increase in maintenance expense is 3% per year over the five years of its use.

If PACCAR chooses to develop the software in-house, the expected development costs would equal $30 million and new operating equipment would be required at a cost of $125 million. The time to develop the technology is expected to take one year and the operating equipment would be purchased at the end of the year (assume both costs to occur at the end of year 1). The development costs would have a depreciable life of 3 years but a useful life of 5 years, while the new operating equipment would have a depreciable life of 10 years and a useful life of 5 years. Neither asset would have any salvage value at the end of 5 years of use. Additionally, there will be an increase in maintenance expenses associated with this new technology of approximately $7 million in the first year of operations. The expected annual increase in maintenance expense is 3% per year over the five years of its use.

The benefits from either method of providing the new technology would be an increase in sales generating additional revenue of approximately $300 million in the first year the new technology is available (we are assuming we will be first to market whether we buy the technology or develop it). The increase in sales revenue is expected to grow at 5% per year over the next two years (years 2 and 3) and at 3% per year in the following two years (years 4 and 5). PACCAR's cost of goods sold is typically 80% of revenue and their working capital needs are 6% of revenue. PACCAR's WACC is approximately 6.5% and their expected tax rate is 30%. PACCAR uses the MACRS method of depreciation and depreciation expense will start in the year the firm begins selling trucks with the new technology.

Your task: John Harquest, an assistant to the CFO, has asked you (a financial analyst at PACCAR) to analyze this new technology project and write a short report (maximum of 2 typed pages, double spaced, font size 12, one inch margins all around) describing the project, your procedures, your results, and your recommendation. John is expecting you to apply the traditional performance measures used at PACCAR (NPV, IRR, and the payback period) for each alternative to obtain the new technology (buy or build). Additionally, John recently has heard someone mention another performance measure called the modified internal rate of return (MIRR) and would like you to learn about it and apply it to this analysis realizing that the decision makers at PACCAR are not familiar with this measure. Based on your financial analysis, would you recommend: buy, build, or pass on the new technology? Additionally, Mr. Harquest would like you to identify any non-quantifiable issues that may be relevant to this decision and describe how they would affect your original recommendation based solely on the quantitative analysis. **He needs your report by the end of day on October 5th, 2016.**

MARCS: Recovery Allowance Percentages for Property.

Ownership Year	3-Year	5-Year	7-Year	10-Year
1	33%	20%	14%	10%
2	45%	32%	25%	18%
3	15%	19%	17%	14%
4	7%	12%	13%	12%
5		11%	9%	9%
6		6%	9%	7%
7			9%	7%
8			4%	7%
9				7%
10				6%
11				3%
	100%	100%	100%	100%

Depreciation Expense in year t = Initial Outlay * Recovery Allowance Percentage in year t.

Note: there is no adjustment for salvage value in the calculation of depreciation expense using the MACRS method of depreciation.

Also Note: This MACRS schedule assumed a June 30 acquisition of the asset and, therefore, year 1's allowance and the last year's allowance are already adjusted to reflect depreciation expense for the half year.

Appendix B

Case #2: PACCAR's Buy or Build Decision Revisited

As you already know, PACCAR is considering either purchasing (buying) or developing in-house (building) new technology for their two major lines of trucks. Your initial analysis suggested that the build option would have a higher expected NPV, IRR, MIRR and a lower payback period and, therefore, it appeared to be the better alternative based on your quantitative analysis. This initial analysis was completed using PACCAR's WACC (6.5%) as the required return (discount rate). Mr. Harquest would like you to revisit the analysis given the uncertainty regarding the appropriate required return given the agreed upon greater risk associated with the build option. Some analyst in your group believe that it is appropriate to use PACCAR's WACC as the required return for both alternatives, some argue that there is a need to apply the pure play approach based on firms in the software development industry to estimate the appropriate required return, while others argue that PACCAR's WACC should be used for one alternative, while the pure play RADR should be used for the other.

Mr. Harquest has asked you to apply the pure play approach (utilizing both the asset approach and the WACC approach) to determine the required return used by software development firms. More specifically, he suggests using Symantec Corp (SYMC) and Oracle Corp (ORCL) as your pure play firms. Given your estimate of the risk adjusted discount rate (RADR) from your pure play analysis, what do we learn about the difference in risk between the truck manufacturing industry and the software development industry? Ultimately, he is asking for your opinion regarding the appropriate required return for each alternative, buy and build. Should the required return be the same for the buy and build alternatives? If so, should the required return be estimated by PACCAR's WACC of 6.5% or should it be based on the results of the pure play approach. If you believe that a different required return should be applied then explain which required return should be applied to each alternative. Ultimately, based on your suggested required returns, recalculate (if necessary) the various performance measures and provide an updated recommendation on which alternative is best for PACCAR. In this recommendation do not forget any remaining non-quantifiable factors.

Mr. Harquest is expecting a well written two page summary (double spaced, font size of 12 with reasonable margins) describing your analysis, your procedures, your results, and the implication of these results. Feel free to attach as many self-explanatory exhibits as necessary. For the exhibit(s) used to estimate the alternative required return based on the pure play approach clearly define variables used, equations applied, and sources for all data. Mr. Harquest is expecting your report on his desk by late afternoon on Wednesday, October 12th.

Note: The following page provides helpful insights on the use of various websites to find the necessary data to do the pure play analysis.

Instructions to Access Necessary Data from Various Websites:

1. If you go to http://finance.yahoo.com/ you can get access to a wide range of firm specific data. On the right, near the top of the page there is a quote lookup box. Type in name or symbol of the company of interest. On the opening page, you will see an estimate of beta for this firm's stock. If you click on Financials, the firm's income statement appears and there is a tab for the cash flow statement and the balance sheet. First, hit balance sheet and then click on quarterly to get the most recent quarterly balance sheet necessary to be able to determine the level of debt (sum of Short/Current Long Term Debt figure plus the Long Term Debt figure reported on the most recent quarterly statement). If you click on Statistics tab (just above the balance sheet), under Trading Information and Share Statistics you can observe the Number of Shares Outstanding (please read footnote #5). If you click on Historical Data you will observe some historical stock prices, what you need is the close price on the same date of the quarterly balance sheet.

2. For corporate bond yields there are two sites, first try:
   http://www.morningstar.com
   Type the firm's ticker symbol in quote box and hit return. **Below** the Company's name hit bonds (far right) and scroll down to see Yield to Maturity data (hint: if you click on Maturity Date headline, the bonds will be sorted based on maturity). What you are looking for is the Yield to Maturity for the firm's bonds with a maturity closest to 10 years (9/2026).

3. The Treasury Bond yield curve is can easily be found:
   http://finance.yahoo.com/bonds
   http://www.federalreserve.gov/releases/h15/current/default.htm current rates and more maturities
   http://www.federalreserve.gov/releases/h15/data.htm historic yields

4. Value Line reports are available on line and are a good source to provide an estimate of a firm's expected future tax rate. To access Value Line online use the SU webpage, click LIBRARY (top bar), under Research Tools, click on Articles and Databases, click on Business, then click on Value Line, log in, click on Browse Research and then type the company name or ticker symbol in the Company name or symbol box and hit quote. At bottom right hand corner of the company screen is a list of the most recent value line reports, click on view for the most recent report.

5. Note: Forecasts of future tax rates (18-20 or 19-21) are located in the far right hand column by the Income Tax Rate variable. The range 18-20, are for years 2018 to 2020 and the range 19-21, are for years 2019 to 2021. The range provided depends on the firm's fiscal year end.

Appendix C

Case #3: PACCAR's Buy or Build Decision – Applying Risk Assessment Tools

As you already know, PACCAR is considering either purchasing (buy) or developing in-house (build) new technology for their two major lines of trucks. Based on your initial quantitative analysis, the build option is expected to have a higher NPV, IRR, MIRR and a lower payback period and, therefore, it appears to be the better alternative. Your initial analysis was completed using an estimate of PACCAR's WACC as the required return (discount rate) and point estimates for each of the various inputs. Mr. Harquest would like you to revisit the analysis focusing on the consequences associated with the greater risk exposure associated with developing (building) the new technology.

To assess the additional risk associated with the build alternative, Mr. Harquest would like you to apply several risk assessment tools using PACCAR's WACC (6.5%) as the discount rate. More specifically, he wants you to apply the following risk assessment tasks. First, Mr. Harquest would like you to determine the level of development costs that would make PACCAR indifferent between buying and building the new technology. Similarly, he wants to know what the level of increased revenue is in year one if we develop the technology that would make PACCAR indifferent between buying and developing the new technology Additionally, he would also like you apply two-way sensitivity analysis to the NPV of developing the new technology based on the expected increase in year 1 revenue, and growth in increased revenue in years 2 and 3. Furthermore, Mr. Harquest would also like you to apply scenario analysis by estimating all four performance measures for the build alternative assuming it takes 18 months to develop the technology, the cost of developing the new technology will be 20% greater than originally expected, and the increase in revenue in year 1 is 10% lower than originally expected (keep the growth rate the same). He suggests that you should assume that the probability of this scenario occurring is 40% while the probability of our original expectations occurring is 60%. Finally, Mr. Harquest would like you apply Monte Carlo Simulation Analysis (focusing only on our key performance measure: NPV) separately for both alternatives, buy and build, given the expected distribution of the inputs provided in exhibit 1.

Mr. Harquest is expecting a well written two to three page (double spaced, font size of 12 with reasonable margins) summary of your analysis. The introductory paragraph should let the reader know what is going to be analyzed, why we are doing this analysis, and should mention the tools to be applied. The body of this summary should contain a paragraph for each risk assessment task that describes the procedure, the results, **and the implication of the results for our decision to buy or build**. The concluding paragraph should summarize your key results

and provide a recommendation based on the entirety of your analysis and any remaining non-quantifiable factors. Feel free to attach as many self-explanatory exhibits as necessary. Mr. Harquest is expecting your report on his desk by late afternoon on Wednesday, October 26th.

Exhibit 1.

Input Ranges

($ millions)

Input Ranges for Buy Analysis

	Lowest Possible	Expected Outcome	Highest Possible
Cost of Technology		$25.0	
Cost of New Equipment	$140.0	$150.0	$160.0
Increase in Maintenance Exp. In Year 1	$4.0	$5.0	$6.0
Growth in Incr. in Maintenance Exp.	2.0%	3.0%	4.0%
Increase in Revenue in Year 1	$200.0	$300.0	$350.0
Growth in Incr. in Revenue (Years 2 & 3)	3.0%	5.0%	6.0%
Growth in Incr. in Revenue (Years 4 & 5)	1.0%	3.0%	4.0%
Cost of Goods Sold as a % of Revenue	78.0%	80.0%	82.0%
Working Capital as a % of Revenue	5.0%	6.0%	7.0%
Discount Rate	6.0%	6.5%	7.0%
Tax Rate	25.0%	30.0%	35.0%

Input Ranges for Build Analysis

	Lowest Possible	Expected Outcome	Highest Possible
Cost of Developing Technology	$25.0	$30.0	$50.0
Cost of New Equipment	$115.0	$125.0	$140.0
Increase in Maintenance Exp. In Year 1	$6.0	$7.0	$9.0
Growth in Incr. in Maintenance. Exp.	2.0%	3.0%	4.0%
Increase in Revenue in Year 1	$100.0	$300.0	$400.0
Growth in Incr. in Revenue (Years 2 & 3)	2.0%	5.0%	7.0%
Growth in Incr. in Revenue (Years 4 & 5)	1.0%	3.0%	5.0%
Cost of Goods Sold as a % of Revenue	78.0%	80.0%	82.0%
Working Capital as a % of Revenue	5.0%	6.0%	7.0%
Discount Rate	6.0%	6.5%	7.0%
Tax Rate	25.0%	30.0%	35.0%

True Returns: Adjusting Stock Prices for Cash Dividends and Stock Splits

James Felton
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Accurately calculated historical returns are critical inputs for investment decisions. We document that data vendors adjustments to historical prices for dividends and stock splits result in inaccurate estimations of historical returns. We demonstrate several techniques that can be used to correct the error and estimate the true returns. Our findings pose a challenge for the finance literature that derives conclusions based on the historical returns naively calculated using the adjusted closing prices provided by the data vendors'.
Keywords: *Adjusted close, historical price, stock split, cash dividend, split-adjusted*

Introduction

One of the important variables that impacts most of the finance literature is return. Returns are used as an explanatory variable (such as in deriving momentum and reversal trading strategies or estimating market risk factor, such as beta) or a dependent variable (as is the case with most of the asset pricing literature). Not only academics but also practitioners use historical stock prices and returns to derive their trading strategies. Historical stock prices, in general, are used as provided by the data vendors. In this paper we examine the adjustments for stock splits and cash dividends made by the data vendors. Closing stock prices prior to the payment of cash dividends are reduced in a method that is used by convention. The method is largely ignored in the literature and textbooks. While most of our demonstrations are derived using the historical prices from Yahoo! Finance, our findings can be extended to other providers of financial data. The adjusted closing prices are available in the "historical prices" section of Yahoo! Finance, and they are also used for graphs of historical stock prices. Yahoo!'s adjustments for stock splits are first examined, followed by their adjustments for cash dividends.

Adjusted Close for Stock Splits

Cisco Systems provides professors with a good example of Yahoo!'s adjustments for stock splits because they had nine splits in a ten-year period. Cisco had their Initial Public Offering (IPO) in 1990. Trading of Cisco's shares on the Nasdaq Stock Market with the ticker symbol "CSCO" began on March 26, 1990, and the stock closed at $24.25. Cisco split 2:1 just a year later, on March 18, 1991. During the period before the first split, the closing price for Cisco rose to $48 per share on March 15, 1991. After the 2:1 split, all previous stock prices were divided by two. The March 26, 1990 close of $24.25 became $12.13, the March 15, 1991 $48 close became $24.00, and so on. Each adjusted close is also known as a "split-adjusted price." Table 1 contains a description of Yahoo!'s adjustments for Cisco's nine stock splits from 1991 to 2000, and Appendix 1 has Yahoo!'s description of the adjustment process for both stock splits and cash dividends.

Cisco's second 2:1 stock split was on March 23, 1992. The adjusted closing prices were calculated again by taking all stock prices prior to that date and dividing them by two. The March 26, 1990 adjusted close fell from $12.13 to $6.06, the March 20, 1992 close of $82.87 fell to $41.44, and everything in between was also divided by two. The stock prices prior to the first split were therefore divided by a total of four after the two splits.

A third 2:1 split occurred on March 22, 1993 after Cisco rallied to $89.38 just before the split. All stock prices before the split were divided by two in order to calculate the adjusted close. The period before the first split was now divided in total by eight, the period before the second split was divided by a total of four, and the period before the third split was divided by two.

Splits four through nine took place from 1994 to 2000. They were 2:1, 2:1, 3:2, 3:2, 2:1, and 2:1. Previous stock prices were divided by 2, 2, 1.5, 1.5, 2, and 2, respectively. Sections of stock prices are now divided by 288, 144, 72, 36, 18, 9, 6, 4, and 2 in order to calculate the adjusted close. Appendix 2 contains Yahoo!'s Cisco graph from 1990 to September 2014.

An investor who bought 100 shares of Cisco on March 26, 1990 (and did not sell any shares) would now own 28,800 shares (288 times as many) worth $25 per share on September 5, 2014. The split-adjusted price for the shares purchased in 1990 is now $0.0842 ($24.25/288) after nine splits, and 28,800 shares are now worth $720,000. The return on 100 shares of Cisco purchased on March 26, 1990 for $24.25 per share can be calculated two ways:

$$\text{Return} = (\$720{,}000 - \$2{,}425) / \$2{,}425 = 29{,}591\%$$

$$\text{Return} = (\$25.00 - \$0.0842) / \$0.0842 = 29{,}591\%$$

The 29,591% return on Cisco Systems common stock is accurate. It can be calculated either using total dollar amounts ($2,425 to $720,000) or with the split-adjusted stock price ($0.0842 to $25.00), and the two answers are identical.

Table 1.

Closing stock prices and split-adjusted closing stock prices for Cisco Systems (CSCO) on selected dates from March 26, 1990 to March 22, 2000. Cisco Systems had the following nine stock splits during the period: 2:1, 2:1, 2:1, 2:1, 2:1, 3:2, 3:2, 2:1, and 2:1. Numbers in bold are the split-adjusted price for Cisco Systems (excluding adjustments for cash dividends) that are used to graph historical stock prices.

	Close	**2:1**	**2:1**	**2:1**	**2:1**	**2:1**	**3:2**	**3:2**	**2:1**	**2:1**
3/26/1990	24.25	12.13	6.06	3.03	1.52	0.76	0.51	0.34	0.17	**0.0842**
3/15/1991	48.00	24.00	12.00	6.00	3.00	1.50	1.00	0.67	0.33	**0.17**
2:1 stock split on 3/18/1991. Total divisor from 3/26/1990 to 3/15/1991 is 288 after nine stock splits.										
3/18/1991	25.50		12.75	6.38	3.19	1.59	1.06	0.71	0.35	**0.18**
3/20/1992	82.87		41.44	20.72	10.36	5.18	3.45	2.30	1.15	**0.58**
2:1 stock split on 3/23/1992. Total divisor from 3/18/1991 to 3/20/1992 is 144 after eight stock splits.										
3/23/1992	40.50			20.25	10.13	5.06	3.38	2.25	1.13	**0.56**
3/19/1993	89.38			44.69	22.35	11.17	7.45	4.97	2.48	**1.24**
2:1 stock split on 3/22/1993. Total divisor from 3/23/1992 to 3/19/1993 is 72 after seven stock splits.										
3/22/1993	43.00				21.50	10.75	7.17	4.78	2.39	**1.19**
3/18/1994	79.00				39.50	19.75	13.17	8.78	4.39	**2.19**
2:1 stock split on 3/21/1994. Total divisor from 3/22/1993 to 3/18/1994 is 36 after six stock splits.										
3/21/1994	38.75					19.38	12.92	8.61	4.31	**2.16**
2/16/1996	89.00					44.50	29.67	19.78	9.89	**4.94**
2:1 stock split on 2/20/1996. Total divisor from 3/21/1994 to 2/16/1996 is 18 after five stock splits.										
2/20/1996	45.62						30.41	20.28	10.14	**5.07**
12/16/1997	80.13						53.42	35.61	17.81	**8.90**
3:2 stock split on 12/17/1997. Total divisor from 2/20/1996 to 12/16/1997 is nine after four stock splits.										
12/17/1997	54.19							32.13	18.06	**9.03**
9/15/1998	96.63							64.42	32.21	**16.11**
3:2 stock split on 9/16/1998. Total divisor from 12/17/1997 to 9/15/1998 is six after three stock splits.										

Table 1. (Continued)

	Close	2:1	2:1	2:1	2:1	2:1	3:2	3:2	2:1	2:1
9/16/1998	64.62								32.31	**16.16**
6/21/1999	123.12								61.56	**30.78**
2:1 stock split on 6/22/1999. Total divisor from 9/16/1998 to 6/21/1999 is four after two stock splits.										
6/22/1999	59.50									29.75
3/22/2000	144.38									72.19
2:1 stock split on 3/23/2000. Total divisor from 6/22/1999 to 3/22/2000 is two after one stock split.										
3/23/2000	77.81									
9/5/2014	25.00									

Cisco's return became much more complicated to calculate in March 2011 when Cisco began paying a cash dividend. In a junior-level Principles of Investments class, we showed all of the calculations involved for finding the return after nine stock splits, but the split-adjusted price listed in Yahoo! Finance was no longer $0.0842. It was slightly lower, which is the motivation for this paper. We were left with the following choices. First, we could simply state in class "They also adjust for cash dividends. The stock price is lowered each time a cash dividend is paid." Second, we could find a different stock to use that has not yet paid any cash dividends. Third, we could start explaining in class the adjustments for dividends and the controversy it creates.

Adjusted Close for Cash Dividends

The following details of Yahoo's adjustments for AbbVie common stock demonstrates how Yahoo! adjusts for cash dividends. AbbVie Inc. pays a cash dividend and they have never had a stock split. They became independent of Abbott Laboratories on January 1, 2013. AbbVie's common stock began trading separately with the ticker symbol ABBV, and they quickly paid their first quarterly cash dividend of 40¢ per share on January 11, 2013. The dividend triggered Yahoo!'s first adjustment for dividends. Using AbbVie's closing stock price of $34.00 per share the day before the dividend, all closing stock prices before January 11 were adjusted as follows: Adjustment = 1 − (.40/34.00) = 0.9882353. Each closing stock price prior to January 11 is multiplied by 0.9882353. The January 10 closing price of $34.00 becomes $34.00(0.9882353) = $33.60, the January 9

closing price of $33.90 becomes $33.90(0.9882353) = $33.50, and so on. Table 2 contains these calculations. The adjusted closing stock prices subsequent to the first cash dividend are in the column entitled "Adj1" in Table 2.

AbbVie paid their second quarterly cash dividend of 40¢ per share on April 11, 2013, and the same adjustment for dividends was triggered by Yahoo! All stock

Table 2.

Closing stock prices, dividends, and the adjusted close for dividends for AbbVie Inc. (ABBV) on selected dates from January 9, 2013 to July 11, 2014. AbbVie paid five quarterly cash dividends of 40 cents per share followed by two quarterly dividends of 42 cents per share. Numbers in bold are the Adjusted Close for AbbVie from Yahoo! Finance following adjustments for quarterly dividends.

	Close	Adj1	Adj2	Adj3	Adj4	Adj5	Adj6	Adj7	Change	Percent
1/9/13	33.90	33.50	33.19	32.89	32.60	32.34	32.05	**31.81**	-2.09	6.17
1/10/13	34.00	33.60	33.29	32.99	32.70	32.44	32.15	**31.91**	-2.09	6.15
1/11/13	33.85		33.54	33.23	32.94	32.68	32.39	**32.14**	-1.71	5.05
Div.= 0.40, Adj. = 1 - (.40/34.00) = 0.9882353										
4/9/13	42.55		42.16	41.78	41.41	41.08	40.72	**40.41**	-2.14	5.03
4/10/13	43.62		43.22	42.83	42.45	42.11	41.74	**41.42**	-2.20	5.04
4/11/13	43.20			42.81	42.42	42.09	41.72	**41.40**	-1.80	4.17
Div. = 0.40, Adj. = 1 - (.40/43.62) = 0.9908299										
7/9/13	43.32			42.93	42.55	42.21	41.84	**41.52**	-1.80	4.16
7/10/13	43.91			43.51	43.12	42.78	42.40	**42.08**	-1.83	4.17
7/11/13	43.78				43.39	43.05	42.67	**42.35**	-1.43	3.27
Div. = 0.40, Adj. = 1 - (.40/43.91) = 0.9908905										
10/8/13	44.52				44.12	43.78	43.39	**43.06**	-1.46	3.23
10/9/13	44.81				44.41	44.06	43.67	**43.34**	-1.47	3.28
10/10/13	45.68					45.32	44.92	**44.58**	-1.10	2.41
Div. = 0.40, Adj. = 1 - (.40/44.81) = 0.9910734										
1/9/14	51.22					50.82	50.37	**49.99**	-1.23	2.40
1/10/14	50.90					50.50	50.05	**49.68**	-1.22	2.40
1/13/14	49.83						49.39	**49.02**	-0.81	1.63
Div. = 0.40, Adj. = 1 - (.40/50.90) = 0.9921415										

Table 2. (Continued

	Close	Adj1	Adj2	Adj3	Adj4	Adj5	Adj6	Adj7	Change	Percent
4/9/14	50.63						50.18	**49.80**	-0.83	1.64
4/10/14	47.35						46.93	**46.58**	-0.77	1.77
4/11/14	46.46							**46.11**	-0.35	0.75
Div. = 0.42, Adj. = 1 – (.42/47.35) = 0.9911299										
7/9/14	55.01							**54.60**	-0.41	0.75
7/10/14	55.79							**55.37**	-0.42	0.76
7/11/14	54.96								0.00	0.00
Div. = 0.42, Adj. = 1 – (.42/55.79) = 0.9924718										

prices before April 11 were adjusted using AbbVie's closing stock price of $43.62 on April 10: Adjustment = 1 − (.40/43.62) = 0.9908299. The April 10 close was reduced by 40¢ to $43.22 per share. Included in the adjustment is the January 9 close that was already lowered from $33.90 to $33.50 when the first cash dividend was paid. The January 9 adjusted close was lowered a second time, from $33.50 to $33.19, which is an additional 31¢ reduction. The column "Adj2" in Table 2 contains the adjusted closing prices following the April 11 dividend.

AbbVie paid 40¢ cash dividends again on July 11, 2013, October 10, 2013, and January 13, 2014. They then paid 42¢ quarterly cash dividends on April 11, 2014 and July 11, 2014. The January 9, 2013 adjusted close at the top of Table 2 was lowered again with each dividend. The adjusted close fell by 30¢ to $32.89 on the third adjustment (Adj3), by 29¢ to $32.60 on the fourth adjustment (Adj4), by 26¢ to $32.34 on the fifth adjustment (Adj5), by 29¢ to $32.05 on the sixth adjustment (Adj6), and by 24¢ to $31.81 on the seventh adjustment (Adj7). Abbvie's adjusted close on January 9, 2013 is now $31.81 in Yahoo! Finance. AbbVie has now paid $2.84 in cash dividends. After seven adjustments triggered by seven quarterly cash dividends, the January 9, 2013 closing stock price of $33.90 was reduced by $2.09 per share, 6.17%, to $31.81. Yahoo!'s graph of historical performance from January 9, 2013 to July 11, 2014 is now based on the stock price rising from $31.81 to $54.96 (+$23.15), even though investors received $2.84 in cash dividends as the stock price actually rose from $33.90 to $54.96 (+21.06). There are now several competing methods for calculating return.

AbbVie's return based on the adjusted close is calculated as follows:

$$\text{Return} = (\$54.96 - \$31.81) / \$31.81 = +72.78\%$$

This method, taking the dividend as a percentage of the stock price to find the adjusted close, is used by convention at Yahoo!. The initial stock price cannot be negative because it is based on a percentage each time a cash dividend is paid.

The initial stock price is reduced by $2.09 due to $2.84 in cash dividends, and the return is inaccurate, higher, due to the reduction in the denominator.

Yahoo! could alternatively simply deduct the amount of each cash dividend to find the adjusted close. AbbVie's initial stock price would then be reduced to $31.06. AbbVie's stock price would then rise from $31.06 to $54.96 during the period, and the return would be higher since the full $2.84 is deducted from the initial stock price:

$$\text{Return} = (\$54.96 - \$31.06) / \$31.06 = +76.95\%$$

However, an initial stock price could eventually become negative with this method, and the return is again artificially high because the initial stock price is reduced with each dividend.

AbbVie's return is also often calculated as follows:

$$\text{Return} = (\$54.96 - \$33.90 + \$2.84) / \$33.90 = 70.50\%$$

The return in this case is for a stock rising from $33.90 to $54.96, and the stock paid a one-time $2.84 cash dividend at the end of the period, which was July 11, 2014. The return is significantly lower than the first two methods because the divisor was not reduced to adjust for dividends. This method for calculating returns assumes, for simplicity, that any dividend is received at the end of the holding period. The correct method for calculating return is to add the cash dividend each time one is paid. More generally, the holding period return could be calculated based on reinvesting any dividend received during the holding period in additional shares on the date the dividend was received at the price then available. Continuing with our example of AbbVie, under this approach, the total return is calculated as follows:

Assume that an investor gets into a long position in one share of AbbVie on January 9, 2013 at the closing price of $33.90. Also assume that the stock is infinitely divisible, hence the investor can buy 0.012 additional shares for $0.40 dividends received on January 11, 2013 at the opening price of $33.59. Similarly the investor continues to reinvest the subsequent dividends received in additional AbbVie stock (Table 3) until he closes the position on July 11, 2014. The reinvestment of dividends increases the investor's overall holding in AbbVie to 1.0635 shares by the end of his holding period. The total return under this approach is:

$$\textit{Return} = \frac{(1.0635 * 54.96) - 33.90}{33.90} = 72.42\%$$

The return in this scenario is higher than the one we calculated assuming no reinvestment in dividends. This is consistent with the capital asset pricing model as by reinvesting the dividends in the common stock we increase the overall risk exposure resulting in higher returns. Alternatively, the dividends can be reinvested in a risk-free asset and earn a risk-free return. Table 4 summarizes the cash flows

Table 3.

This table presents the number of additional shares that can be purchased by reinvesting the dividends.

Ex-dividend date	Dividend per share	Opening price	# of additional shares purchased
1/11/2013	0.40	33.90	0.0118
4/11/2013	0.40	43.42	0.0092
7/11/2013	0.40	43.94	0.0091
10/10/2013	0.40	45.10	0.0089
01/13/2014	0.40	50.66	0.0079
04/11/2014	0.42	46.58	0.0090
07/11/2014	0.42	55.34	0.0076
Total	2.84		0.0635

Table 4.

This table summarizes the cash flows generated by reinvesting the dividends in a risk-free security. The interest rates used to calculate the future value at the Treasury bill (T-Bill) rates.

Ex-dividend date	Dividend per share	T-Bill rate (%)	Future value
1/11/2013	0.40	0.20	0.4012
4/11/2013	0.40	0.15	0.4008
7/11/2013	0.40	0.13	0.4005
10/10/2013	0.40	0.11	0.4003
01/13/2014	0.40	0.06	0.4001
04/11/2014	0.42	0.04	0.4200
07/11/2014	0.42	0.00	0.4200
Total	2.84		2.8430

generated by reinvesting dividends at the risk-free rate. The return under this strategy is calculated as follows:

$$Return = \frac{(54.96 + 2.8430) - 33.90}{33.90} = 70.51\%$$

As expected, we find a return lower than what would be generated by the risky strategy of reinvesting dividends in common equity.

Price adjustment for dividends

Yahoo! Finance adjusts the historical prices by reducing the stock prices by the amount of the dividend. The impact of dividends on shareholder wealth has been extensively debated in the finance literature. Miller, Merton, & Modigliani (1961) argue that, under perfect capital market assumptions with no taxes and transaction

costs, and no information asymmetry among all investors, a company's dividend policy should not impact shareholder wealth. Under such conditions stock price on ex-dividend date should adjust 1:1 for any dividends and hence, the past prices should be adjusted by the present value of the dividends. Under perfect capital markets, a stock's price would fall by the amount of the dividend on the ex-day. However, the markets are not perfect and the ratio of price drop to dividend has been consistently below one (Eades, Hess & Kim, 1994; Elton & Gruber, 1970; Michaely, 1991). and Literature provides the following reasons to explain the ex-day phenomenon: (1) differential taxation between dividends and capital gains, (2) transactions costs, and (3) bid-ask bounce (Litzenberger & Ramaswamy, 1979; Lakonishok & Vermaelen, 1986; Karpoff & Walkling, 1990; Michaely and Vila, 1995; Frank & Jagannathan, 1998; and Graham, Michaely, & Roberts, 2003). While there is no consensus on the reasons for price decline on ex-dividend day, the tax differential between dividends and capital gains is the most accepted explanation for the decline in the stock price of less than 100% of dividend on ex-dividend day.

Tax differential argument

If the tax rates applied to dividends and capital gains are the same, then (all else being equal) the expected price drop on the ex-dividend date is the amount of the dividend. This suggests that the stock price should be adjusted by the amount of the present value of the dividends.

In some countries, dividend income has traditionally been taxed at higher rates than capital gains. An argument could be made that in a country that taxes dividends at higher rates than capital gains, taxable investors should prefer companies that pay low dividends and reinvest earnings in profitable growth opportunities. A taxable investor in a dividend paying stock has the following two choices:

- *Sell just before the share goes ex-dividend*. By selling the share before the ex-dividend date the investor will *not* be entitled to the dividend. The resulting cash flow is the sale price P_w minus the capital gains tax owed on the sale:

$$P_w - (P_w - P_b)(T_{CG})$$

- *Sell just after the share goes ex-dividend*. In this case the investor will receive the dividend. The resulting cash flow is the sale price P_x minus the capital gains tax owed on the sale plus the after-tax amount of the dividend:

$$P_x - (P_x - P_b)(T_{CG}) + D(1 - T_D)$$

For arbitrage-free pricing, the above two cash flows given must be equal:

$$P_w - (P_w - P_b)(T_{CG}) = P_x - (P_x - P_b)(T_{CG}) + D(1 - T_D)$$

This equation can be solved for the amount of the price decrease when the share goes ex-dividend (See Elton and Gruber (1970), pp. 68–74), $P_w - P_x$:

$$P_w - P_x = D\,\frac{1 - T_D}{1 - T_{CG}}$$

where P_W is the stock price right before the ex-dividend day, P_X is the ex-dividend day stock price, P_D is the purchase price for the stock, D is the amount of the dividend paid, and T_{GC} and T_D are the marginal tax rates on capital gains and dividends. So, if the marginal tax rate on dividends (T_D) is 35% and the marginal tax rate on capital gains (T_{GC}) is 15%, the expected price decline for every dollar in dividend is given by:

$$P_w - P_x = 1 * \frac{1 - 0.35}{1 - 0.15} = 0.765$$

Hence, under this method the stock prices should be adjusted by the present value of 0.765 per $1 in dividends. The above expression does not account for the time value of money and assumes investors are risk neutral. It also does not account for information asymmetry. All of these issues further complicate the stock price adjustment process for future dividends.

Conclusion

A sound investment decision depends critically on the accuracy of the calculated historical returns. In this study we show how data vendors adjust historical prices for dividends and stock splits and the resulting inaccurate estimations of historical returns. We also demonstrate several techniques that can be used to estimate the true returns. Our findings raise concerns for most of the finance literature that derives conclusions based on the historical returns calculated using the adjusted closing prices provided by the data vendors.

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Appendix 1

(What is the Adjusted Close?, 2014)

Adjusted Close provides the closing price for the requested day, week, or month, adjusted for all applicable splits and dividend distributions. Data is adjusted using appropriate split and dividend multipliers, adhering to Center for Research in Security Prices (CRSP) standards.

- **Split multipliers** are determined by the split ratio.
  - For example, in a 2 for 1 split, the pre-split data is multiplied by 0.5.
- **Dividend multipliers** are calculated based on dividend as a percentage of the price, primarily to avoid negative historical pricing.
  - For example, when a $0.08 cash dividend is distributed on Feb 19 (ex-date), and the Feb 18 closing price is $24.96, the pre-dividend data is multiplied by (1-0.08/24.96) = 0.9968.

Here's an example

Let's take a look at how split and dividend multipliers are calculated and applied to determine adjusted close prices. We'll start with this table of historical prices, a split, and a dividend:

Date	Close, Dividend, or Split
2/13/03	Close = 46.99
2/14/03	Close = 48.30
2/18/03	Split = 2:1
2/18/03	Close = 24.96
2/19/03	Cash Dividend = 0.08 (ex-date)
2/19/03	Close = 24.53

The multipliers we'll use are determined from the split and dividend:

- Split Multiplier = 0.5
- Dividend Multiplier = 1 - (0.08/24.96) = 0.9968

Using these split and dividend multipliers, the adjusted close prices are calculated for those dates prior to the split:

Date	Adjusted close calculation
2/13/03	0.5 * 0.9968 * 46.99 = 23.42
2/14/03	0.5 * 0.9968 * 48.30 = 24.07
2/18/03	0.9968 * 24.96 = 24.88
2/19/03	24.53

Appendix 2

(CSCO Interactive Stock Chart, 2014)