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Student Managed Investment Programs: Maximizing Learning Opportunities by Increasing Student Control

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Student Managed Investment Programs (SMIPs) have been embraced by universities as a powerful learning experience. Although a large number of features have already been implemented by universities, SMIPs have potential for even greater educational benefits. In this paper, we argue students should be given increased control and responsibility for their SMIP to honor the intent of experiential learning and increase the breadth of their educational experience beyond direct money management. Maximizing the educational experience should be the design cornerstone, which can be accomplished through allowing complete student responsibility for the Student Managed Investment Fund (SMIF).
Keywords: *Full Control, Experiential Learning, Student Managed Investment Fund (SMIF), Student Managed Investment Program (SMIP)*

Introduction

Students began managing real assets as early as 1952 and 1970 through innovators like Gannon University and the University of Wisconsin – Madison, respectively. It took time for broader adoption of Student Managed Investment Programs (SMIPs), with only 22 U.S. universities offering SMIPs as of 1988 (Lawrence, 1990). University administrators and endowment advisory boards were anxious that student management violated fiduciary prudence, fearing students would underperform investment professionals, or incur significant losses. Yet, for a market efficiency believer, student asset management should not be feared since empirical evidence suggests students have fared as well as professional money managers (Haddad & Redman, 2006; Lawrence, 2008; Luthy & Hafele, 2013).

Widespread adoption of experiential education invigorated the expansion of SMIPs, which have become the hallmark of strong finance programs. By 2008, the worldwide number of SMIPs grew to 314 with over $400 million in managed assets (Lawrence 2008). Large participation at the annual Global Asset Management Education (GAME) Forum hosted by Quinnipiac University and scholarly research demonstrates SMIPs are integral to finance programs. SMIPs provide an impactful experiential education. Additional advantages include:

- Ongoing asset management promotes deeper student understanding of investment decision-making and portfolio management concepts. The quality of student decision-making is evaluated against professional money managers by the market, without accommodations for their status as students.
- SMIPs have a distinction over real-world projects from different business disciplines – the long-lived nature of the portfolio. Whereas typical management-based programs must seek new partners and projects periodically, the ongoing nature of a SMIP eliminates this effort.
- Unlike traditional finance courses with short durations (i.e. one semester), SMIPs require students accept responsibility for continuing the legacy of past managers to grow the portfolio.
- Students in SMIPs develop soft skills such as problem-solving, team dynamics, conflict resolution, and professional etiquette with a client.
- A SMIP provides a shared experience which bonds students and program alumni, often leading to job placement.
- A gift to an endowed SMIF provides a double benefit. First, students gain the educational benefit of managing the SMIF. Second, endowment earnings support program expenses such as scholarships, access to industry tools, and travel to investment competitions. Even if SMIF returns lag the market by 4%, students gained the educational benefit of fund management, which is equivalent to students benefiting from a 4% endowment payout.

Despite apparent acceptance of SMIPs, further analysis reveals concern regarding authentic student management. As universities began implementing SMIPs, restrictions were imposed on student to control the risk of portfolio declines. Indeed, Lawrence (2008) found major restrictions limiting the scope of student authority were the norm, including the amount of money managed, allowing students to conduct security analysis only, and restricting investment philosophy, investment strategy, or allowable assets.

Limits to student authority reflect ongoing tension between providing an authentic educational experience and fulfilling fiduciary responsibilities of the SMIP. For example, the Spellman Portfolio at the University of Wisconsin – La Crosse necessitates that student managers recommend asset transactions to the

fund advisory board (Krueger, 2011). The board had authority over asset selection, and from 2005 – 2010 it vetoed 69% of purchases and 75% of sales. *Ex-post* evaluation of portfolio returns suggested providing the board with such authority did not necessarily lead to better performance. Whether such veto power proves correct is not germane, however.

Rather, we argue that prohibiting student authority to execute trades demotes them to mere security analysts and severely hampers the educational experience. Without full control, student experiences in making recommendations in a SMIP are arguably no different than a valuation report done in a traditional investment analysis course. Without real responsibility, students do not accept the same level of commitment for investment decisions. Nor do they gain emotional experiences that occur when their actions impact portfolio performance, whether good or poor.

As SMIPs increased in prevalence, numerous approaches have been used which differentiate programs, such as:

- Specialized funds: These are funds that focus on a distinct asset class. For example, the University of Iowa's Fixed Income Fund, the University of Maryland's Global Equity Fund, the Venture Capital funds at the University of North Dakota and the University of Michigan – Ann Arbor.
- Investment strategy/style: Some SMIPs have a pre-determined investment strategy or style. Examples include a Value Fund at Western University – Canada, the Growth, Growth at a Reasonable Price, and Value Funds at the University of Richmond, and the long-flat strategy at California State University - Long Beach.
- Student Role Restrictions: SMIPs that progress students through different roles (intern, junior analyst, analyst, portfolio manager) over multiple years (University of Dayton) and SMIPs that specialize students by sectors (University of Texas – Austin).
- Non-Student Involvement: Many SMIPs operate with an advisory board, a faculty member and/or a practitioner such as a Professor of Practice from the investments industry. The authority of these non-student agents to countermand student decisions varies widely, questioning the actual degree of student management.

While each approach has merit, they also limit the educational experience. Our approach advocates maximizing the educational experience through full control by students. The Applied Portfolio Management Program at Michigan Technological University (hereafter, "APMP") is a SMIP in which students establish and operate an investment firm with a high degree of student autonomy that spans the entire asset management experience. Generally speaking, students are responsible for successfully operating all aspects of a start-up asset management firm. By complementing existing core approaches of a SMIP, we argue students benefit

not only from complete portfolio management decision-making, but also from the creation and operation of a firm.

In summary, the current SMIP landscape reflects variation in the degree of student autonomy. Indeed, there are strong programs with highly-structured approaches. Our paper offers these programs ideas to expand student control, thereby improving learning outcomes. It also proposes a framework for universities in the process of establishing a SMIP, asserting that increased student control is a worthy objective. We propose universities willing to relinquish additional control to students benefit by enhanced student learning experiences. The rest of the paper is organized as follows: literature review, student managed investment program learning features, the case for full control, and conclusion.

Literature Review

There is a rich vein of research on SMIPs, including accounts from specific programs, evidence regarding student managed performance, recommendations for administering SMIPs, and alumni perceptions regarding the value of SMIPs. In this section, we present papers to show the following: first, experiential learning improves educational outcomes, interpersonal skills, and connections to industry professionals. Second, indirect data available suggests student investment performance has been sufficient. Next, we demonstrate restrictions on student control are common. Finally, we were not able to identify any papers which explicitly entrust students with full control of a SMIP, motivating why this paper offers a new framework.

Regarding experiential learning, Loviscek, Crowley, and Anderson (2003) assert that problem-based learning (PBL) should be applied to a business context, complementing case studies as a cooperative learning technique. Their PBL-based portfolio project showed improved learning outcomes. King and Jennings (2004) compared traditional instruction to instruction plus experiential learning with a technology component to enhance learning of finance topics. Combining lecture with experiential learning using technology improved student learning and faculty effectiveness.

Promoting mastery of interpersonal skills, Siam (2005) provided a model for fully utilizing University Trading Centers to enhance student learning of managerial competencies, including basic industry skills, scientific knowledge, and interpersonal skills. Weber (2007) reinforced the need to strengthen students' professional skills such as team-building, communications, data analysis, and conflict resolution in a financial institutions class.

SMIPs now exist in over 300 universities, according to Lawrence (2008). How effective are such programs? Clinebell and Murphy (2016) explored this question by surveying SMIP alumni. Respondents concurred with the following statements:

program increased knowledge of investments (97%), communication skills (66%), leadership skills (83%), and interpersonal skills (84%). Alumni recommendations included: make the program one year long, use more external speakers, have teams present results to outsiders, and encourage students to attend conferences and competitions to hone skills and network with professionals.

Finance advisory boards connect faculty and students with industry professionals. Avila, Bratton, and Baur (2005) provided a framework for an effective finance advisory board. Benefits included gathering curricular advice, gaining advocates for program promotion, serving as a funding source for initiatives, and networking with industry professionals.

We now consider the structure of investment decision-making and trading authority within SMIPs to motivate why universities can entrust students with full control. Mallett, Belcher, and Boyd (2010) provide evidence of donors wanting investment professionals, rather than faculty, to direct SMIPs. Donors to Stetson University made their gifts explicitly so students would manage money under the tutelage of an investments professional, rather than faculty. While donor intent to permit student fund management was apparent, the role of the investments mentor advising the students was not clear.

The criticism was that faculty do not have practical investing expertise to make their investment prowess stronger than that of students. Doran and Wright (2010) surveyed finance professors to determine their investing styles and habits. Are techniques faculty teach students being used by the average finance professor? Apparently not, finding 66% of finance professors are passive investors. Those that actively invest relied on momentum and relative valuation strategies, rather than models and techniques they taught.

Related to portfolio performance, Luthy and Hafele (2013) conducted an experiment considering active and passive management, as well as professional versus student management. Students selected randomly from the S&P500 and intentionally chose stocks they deemed would outperform the S&P500. Portfolios were compared to one another, in addition to randomized portfolios, chosen by a child, professional staff, and recommendations by financial experts on television. Entrusting students to be decision-makers for the portfolio was not detrimental to performance, for either actively or passively managed portfolios.

Jones and Swaleheen (2014) documented a SMIP which showed students can be as effective as active portfolio managers. The fund operated as an enhanced index fund, with an equal mix of equity and fixed income. Although student-managed, authority for decision-making rested with the university's foundation finance committee and faculty. Operating within these constraints, the fund performed as well as the benchmark with slightly lower risk.

Charlton, Earl, and Stevens (2015) assert that soft skills learned are as important as asset management and documented a full-range leadership model

in the SMIP at the University of Richmond. While students were responsible for recruitment, development and managerial selection, other aspects of the program remained very structured. For instance, asset management roles were constrained to be either value or growth styles. Course sequencing and structure for this SMIP suggests, however, that effectively only finance majors can participate, foregoing the contributions offered by students from additional disciplines.

The literature thus far has not advocated for full control by students as a paradigm. Instead, there are varying restrictions on student management as reflected in differing constraints. We recommend constraints be removed and students be entrusted with a full-control model. While we propose a full-control model, any movement increasing student control will provide educational benefits.

Student Managed Investment Program Learning Features

SMIPs have matured as an educational construct. In this section, we summarize features present in many programs, as well as provide suggestions for improvements. We classify features which have already experienced widespread adoption as *foundational features* and features which may be new to many universities as *innovative features*. Table 1 contains a summary of these features, foundational *(F)* and innovative *(I)*, further broken down into four groups: development *(D)*, communications *(C)*, authority *(A)* and succession *(S)*. We integrate these features within each group and provide a symbol for our classification in italics. For example, *DF1* indicates the feature is the first in the development phase and is foundational.

A. Development

The development phase encompasses entrepreneurial aspects of starting an asset management firm. Activities start with staffing, new employee orientation, and familiarization with the firm and client. A unique component of APMP is that its advisory board, in addition to providing the benefits suggested by Avila et al. (2005), has as its primary role that of the client. From the onset, students participating in APMP understand and embrace the concept that there simply is no guaranteed money to manage. Rather, teams must "win the business" of the client in order for its newly created management firm to operate. Hereafter, we refer to the client as the entity which hires the student team to manage the SMIP, and is usually the SMIP advisory board. The advisory board is typically comprised of financial professionals, alumni, university leadership and faculty. Given this is a portfolio management experience, it is ideal the majority of board members be drawn from financial professionals.

Table 1: Summary of Features of Student Managed Investment Programs

	Foundational	*Innovative*
Development	Staffing *(DF1)* Familiarize team with client's historical information *(DF2)*	Establish roles and responsibilities for team members *(DI1)* Request and interpret client's Request for Proposal *(DI2)* Explore investing philosophies and create an Investment Policy Statement *(DI3)*
Communications	Select communications platforms and procedures within team *(CF1)* Meet with client periodically *(CF2)* Provide client with portfolio updates *(CF3)*	Initiate and maintain communications with client *(CI1)* Create written response to RFP *(CI2)* Schedule and organize meetings with client *(CI3)* Secure client's approval of IPS *(CI4)*
Authority	Conduct macroeconomic analysis; Prepare security and sector reports *(AF1)* Administer asset allocation and timing strategies *(AF2)* Maintain accounting records; Track portfolio performance, risk and continued asset suitability *(AF3)*	Select assets and place trades *(AI1)* Monitor adherence to IPS *(AI2)*
Succession	Organize and maintain historical records *(SF1)* Communicate with successor teams *(SF2)*	Meet with client and deliver final portfolio performance update *(SI1)* Suggest improvements for interactions with future teams *(SI2)*

An early step in the development phase involves *staffing (labeled DF1 in Table 1)*. Just as firms use their employee network to hire the best possible staff, current students fill an ambassadorial role for the SMIP to recruit future students. When it is time to formalize new teams, a communication should be directed to students to apply for admission to the SMIP.

SMIPs are designed to incorporate appropriate number and types of students to form manageable teams, mirroring practice. Teams should be large enough to engage various individual strengths and share the management burden, yet small enough to facilitate communication and limit free-riding. We have found teams of 7-8 students are ideal. Therefore, students should be admitted to the program in discrete groups to fill out needed team size requirements.

Once selected, students should *establish roles and responsibilities for team members (DI1)* from their various areas of expertise. For instance, finance expertise is needed to perform portfolio management tasks. Some students have IT expertise, whereas others have expertise gathering and interpreting accounting data. Project management opens the opportunity for management students. Promotion of

the program, brand management and preparation of client deliverables requires expertise in marketing. This opens up roles such as financial analyst, portfolio manager, information technologist, accountant, economist, project manager, and marketer. Siam (2005) called for this holistic approach to team breadth noting, "A successful fund-management depends on the efforts of talents of a host of individuals with diverse backgrounds and not just a few managers decision on portfolio mix." Indeed, a team of all finance majors should be the exception rather than the rule.

From roles, students will refine responsibilities as area experts, including an understanding of leadership structure and decision-making processes. This step is often difficult for students accustomed to top-down management styles. Students may seek input to establish these relations, but faculty should resist the impulse to interfere with this team process. Team dynamics necessitate students develop this understanding organically for ownership of the program. We classify this as an innovative feature because APMP affords students the ability to manage this process.

With an understanding of roles and responsibilities, the team must now *familiarize itself with the client's historical information (DF2)*. This task is characterized by reading and understanding client information and fund history. For SMIPs with a high degree of student authority, it will also involve familiarity with the client's Request for Proposal (RFP). As clients seek new portfolio managers, they publish an RFP for response by aspiring asset management firms. In practice, asset management firms build business by finding and winning clients. This involves understanding and responding to client needs with an Investment Policy Statement (IPS).

To provide an innovative feature, student teams should *receive and interpret the client's Request for Proposal (DI2)*. This challenge requires students develop a unique IPS, rather than merely administer a pre-existing IPS based on past practice or various constraints which hamper students' ability to learn the breadth of portfolio management. If there will be multiple teams, each should develop its own IPS in response to the RFP. Consequently, different investing approaches may be offered to the client.

After an understanding of the RFP is developed, student teams *explore investing philosophies to create an Investment Policy Statement (DI3)*. Depending on team background, additional readings of practice-based approaches may be needed in this stage. Flowing from the philosophy, the team must build internal consensus to create an IPS responding to the client's RFP. While developing the IPS, students will consider strategies appropriate for their investing philosophy, which may include more exotic asset classes and trades than are typically found in SMIPs.

Since its inception, APMP teams have adopted a variety of investment philosophies summarized in Table 2. The fear students will engage in overly

risky techniques if given full control is naturally tempered by the need to "win the business" of the client. In order to best implement the IPS, APMP teams also develop unique stock and bond screens.

Table 2: APMP's Investment Philosophy (2005-2019)

Year	*Investment Philosophy*
2005-2006	Large Cap Top Down
2006-2007	Value Investing Top Down
2007-2008	Blended Equity Investing
2008-2009	Contrarian Value Investing
2009-2010	Applied Financial Macroeconomics
2010-2011	Neglected Firm Effect
2011-2012	Value Investing Bottom Up
2012-2013	Neglected Firm Effect
2013-2014	Black-Litterman with Bayesian Updating
2014-2015	Catalyst Event
2015-2016	Applied Financial Macroeconomics
2016-2017	Black-Litterman
2017-2018	Neglected Firm Effect
2018-2019	Fama French Three Factor Model

Developing the IPS is an innovative feature that most SMIPs do not enable students to experience. Ongoing IPSs with constraints are often the default. Although exercises in portfolio simulation commonly require students trade in derivatives, foreign issues and shorts, such liberty is not generally permitted in university-mandated IPSs. Our requirement that each APMP team develop its own IPS reflects granting full control to student managers.

B. Communications

Before communicating with the client, a team must develop an internal communications plan. The first step in the communications phase is to *select communications platforms and procedures within teams (CF1)*. Important elements of communications include team preferences for meeting venues and frequency, information and file sharing preferences, and establishing voting procedures for decision-making. Good internal communication, as students soon learn, is essential before reaching out to the client. An understanding of how the client should be

contacted is also necessary (which may require facilitation by the faculty advisor).

When entrusted to do so as an innovative feature, the next step is for student teams to *initiate and maintain communications with the client (CI1)*. Student teams should be establishing communications directly with the client's representative, often the chairman of the advisory board. This is important so students can experience the process of professional communication, including email and conventional mail correspondence, telephone, and both face-to-face and virtual meetings. Throughout the portfolio management experience, there will be ongoing communication with the client.

If student teams developed an IPS, they must communicate it to the client by *creating a written response to the RFP (CI2)*. Creation of the IPS is the team's response to the RFP and attempt to win the client assignment. This involves preparing engaging client deliverables. Materials sent should include a cover letter, the IPS, and information about the asset management firm.

The logistics of *scheduling and organizing meetings with the client (CI3)* may necessitate coordination of other participating teams, as well as faculty schedules, meeting locations and other resources. After the date and location are set, student teams should handle meeting logistics, including room scheduling, catering arrangements, ensuring technology works, and preparing materials. A safety net should not be provided to enable students to learn from their mistakes.

If an IPS is proposed to the client, the team must *secure the client's approval of the IPS (CI4)*. This involves several aspects of communication. A presentation must be prepared and practiced to include all team members, rather than a subset of students. The client meeting will oftentimes include negotiations about the IPS. The client's objectives will also be clarified. This allows further understanding of the client's level of risk tolerance and aversion to certain types of investment positions. If funds are donated for the purpose of portfolio management, maximum control should be extended to students to learn as much as possible, even with exotic asset classes. Rather than students requesting *carte blanche*, a discussion of trade types and assets should be part of the IPS process.

The process of an IPS "sales pitch" requires tailoring to client objectives and risk-aversion levels. The client should have authority to approve or deny the proposed IPS. If the IPS is rejected, a reattempt is needed to win the business. The possibility of failing to win the business creates incentives for students to work hard to ensure an initial, successful pitch. Most importantly, placing "veto power" with the client at the IPS proposal stage, rather than having it held by an advisory board during the active portfolio management stage, is a key innovative feature of APMP and promotes a full student control model.

The initial meeting is a challenging task and a great learning opportunity for teams. The team should then *meet with the client periodically (CF2)*. These meetings will be needed to *provide the client with portfolio updates (CF3)* and

information regarding adherence to the IPS. From the student's perspective, the ability to network with professionals is an important aspect of a SMIP. Therefore, client meetings should require that all team members make a meaningful contribution to the presentation. Students participating in APMP consistently report that client presentations are among the most daunting and yet rewarding aspects of the program. The client provides feedback which generally notes improved presentation performance as APMP students progress through the year, responding to the need for interpersonal skill development as an integral component of an SMIP (Charlton et al., 2015; Siam, 2005; Weber, 2007).

C. Authority

Using the IPS, ideally developed by the team, portfolio management now rests with each team. At this point, teams have authority to *conduct macroeconomic analyses, prepare security and sector reports (AF1)* as well as *administer asset allocation and timing strategies (AF2)*. Now, students conduct the work traditionally associated with portfolio management, including creating security and sector reports, implementing trades, tracking portfolio performance and risk measures, and monitoring the suitability of current and new fund assets. These foundational features enliven classroom learning by applying knowledge to real-world asset management. Students begin to understand how much analysis and decision-making are required to achieve or beat benchmark returns. These foundational features are historically strong in established SMIPs.

Once analysis has been conducted, student teams are ready to *select assets and place trades (AI1)*. This is an innovative feature which puts decision-making authority in students' hands. In a highly structured program, non-student agents may be tempted to reject certain trades. In a full student control SMIP, however, the trade would be executed so long as it adheres to the IPS.

Why can students be afforded this genuine authority? Research indicates SMIPs perform within a reasonable distance of the benchmark (Haddad & Redman, 2006; Lawrence, 2008; Luthy & Hafele, 2013). Furthermore, fund management overseen by experts have missed opportunities to generate alpha (Krueger, 2011). Finally, given most finance professors trade passively (Doran & Wright, 2010), it would not be appropriate for them to override team decisions. If the intent of SMIPs is for students to learn by actually managing assets, then real authority is a necessary element of this process.

Consistent with authority to run a firm comes responsibility to *maintain accounting records; track portfolio performance, risk, and continued asset suitability (AF3)*. Thus, teams should ensure to prepare and maintain transaction records, portfolio reports, historical buy reports and sector reports. To track performance and portfolio risk, analyses will need to be prepared and records

made ready for reports to the client at appropriate intervals. Continued attention to portfolio assets is essential, and the decision of when to sell a security should be continuously monitored.

Whether an IPS is developed or inherited, student teams must also *monitor adherence to the IPS (AI2)*. The IPS should consistently be applied to each portfolio management decision made by students. At each client meeting, all members of APMP are required to attest that they have, to the best of their knowledge and belief, adhered to the IPS.

D. Succession

Finally, succession should be considered. Once responsibility of managing the firm has ended, how can what has transpired and what is recommended be effectively conveyed to incoming teams? This necessitates being *organized and maintaining historical records (SF1)*. Adams and Belcher (2013) assert transition can be eased by maintaining documents in a learning management system to facilitate knowledge transfer. If possible, outgoing teams should *communicate with successor teams (SF2)*, in writing or in person as conditions permit. The key is to consider the client's need for a smooth transition.

The team will need to *meet with the client and deliver final portfolio performance update (SI1)*. At the final meeting, teams can *suggest improvements for interactions with future teams and the client (SI2)*. We suggest as least three client meetings. Multiple face-to-face meetings involving all students, and as many professionals representing the client as possible maximizes networking opportunities.

The Case for Full Student Control

By accentuating the foundational features and embedding the innovative features set forth in the previous section, we propose allowing full student control of the SMIP. In entrusting students, universities are taking risks similar to that of firms that hire our students. To afford students opportunity to succeed, universities must place them in positions where failure is possible. Students afforded full control of the SMIP will need to secure client acceptance of their approach prior to managing the portfolio. Thus, risk-taking on behalf of students will be tempered by assuming responsibility for the entire asset management process. By not only removing restrictions from student money managers, but also expanding the scope of experiential education available via the SMIP structure, students will exhibit the strongest growth in their learning and professional development. Our experience indicates students place reasonable risk controls on themselves as part of the establishment of the new asset management firm's investment strategy.

The motivation for full student control honors the original purpose of SMIPs. While outperformance and cash flows from income are desired outcomes, restraints

on full student control designed to promote such outcomes can obscure the intent of student fund management. Lawrence (2008) reminds faculty that, "SMIF returns are secondary in nature to the educational mission." The educational mission is experiential learning in the real-world environment of portfolio management. To achieve a high degree of realism, students should be given full control of the breadth of tasks associated with fund management, including both project management and portfolio management of the SMIP.

Perhaps permitting students to have full control is worrisome for some university members. Although increasing student control may be a potential stumbling block, the data supports this direction for SMIPs. The University of Wisconsin – Madison (UW-Madison) has sought to maximize student control of their SMIF since its inception in 1970, which they state is the longest operating student fund. It allows students complete control to create an investment strategy and invest in any stocks, bonds, futures, or derivatives in the world. Based on 50 years of student-management experience, UW-Madison has optimized the delivery of this experiential education by allowing a fund in excess of $20 million to be entirely student managed. Furthermore, significant portfolio underperformance has not occurred over these decades.

Table 3: APMP's Portfolio vs. Benchmark Performance

*Year**	$SMIP_R$	$SMIP_{Value} - \$1$	BM_R**	$BM_{Value} - \$1$	$SMIP_R - BM_R$
2005-2006	11.26%	$1.11	3.99%	$1.04	7.27%
2006-2007	13.21%	$1.26	7.96%	$1.12	5.25%
2007-2008	0.43%	$1.27	−1.85%	$1.10	2.28%
2008-2009	−25.21%	$0.95	−26.36%	$0.81	1.15%
2009-2010	30.92%	$1.24	24.87%	$1.01	6.05%
2010-2011	10.06%	$1.36	11.32%	$1.13	−1.26%
2011-2012	2.28%	$1.39	2.90%	$1.16	−0.62%
2012-2013	8.83%	$1.52	9.79%	$1.27	−0.96%
2013-2014	16.63%	$1.77	12.58%	$1.43	4.05%
2014-2015	9.48%	$1.94	9.71%	$1.57	−0.24%
2015-2016	−0.44%	$1.93	0.80%	$1.59	−1.24%
2016-2017	11.35%	$2.15	11.14%	$1.76	0.21%
2017-2018	10.93%	$2.38	8.97%	$1.92	1.96%
2018-2019	5.71%	$2.52	5.94%	$2.04	−0.23%

*Calculated based on May-April, except 2005-2006 (September-April) and 2018-2019 (May-March).

**Benchmark returns assumed a portfolio of 70% equities/30% fixed income. The equity benchmark was either the S&P500 or the S&P1500 based on client agreement. The fixed income benchmark was the Barclays Aggregate Bond Index.

In terms of APMP's performance, evidence from portfolio returns and results from national competitions supports the full-control approach. Table 3 provides APMP's return data from September 2005 through March 2019. APMP outperformed the benchmark in 8 of the 14 periods. Measurement periods of outperformance saw APMP beating the benchmark from 21 to 727 basis points, while measurement periods of underperformance saw APMP lagging the benchmark by 23 to 126 basis points. Most notably, $1.00 invested in APMP in September 2005 grew to $2.52 through March 2019, versus $2.04 for the benchmark, with APMP's portfolio never lagging the benchmark value. Furthermore, APMP has won six national investment championships, exceeding the number of victories based on random chance. Further consideration by universities to incorporate the innovative features in a full-control model such as APMP is warranted given its demonstrated performance and recognition.

Conclusion

We have argued SMIPs that endorse full student control enhance and provide better breadth of the educational experience. This goes further than recommendations from prior research on SMIPs, which has largely reflected investing constraints and limited control of portfolio management. Too many constraints are contrary to the experiential learning objective. It also removes incentives for students to take appropriate risks and hampers the experiential learning of real-world asset management. Allowing full student control of the SMIP provides a true asset management experience and, in many instances, demonstrates a commitment to better align the program with donor intent.

We ask firms to trust our students' asset management skills when employing them, and we should be willing to bear that risk within the context of their educational experience. Ideally, universities will extend full control to student teams to operate the SMIF. Granting students full control will increase their marketability, whether they follow careers in asset management or other related business fields. Portfolio returns generated and performance in investment competitions by APMP, which has incorporated a full student control model since its inception, provides support for programs to embrace such a model or, at a minimum, contemplate increasing current levels of student control. This paper offers a framework for new and existing programs to address this challenge.

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Determining the Optimal Capital Structure and Measuring the Cost of Capital

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This pedagogical paper explains and illustrates a simple procedure for students to employ in applying important financial concepts to the determination of the optimal capital structure and the cost of capital for a company. The article supplies an excellent framework for students to practically learn exactly how financial distress costs affect financing and capital budgeting decisions. An illustrative example of applying the processes to Walmart in late 2018 is provided that can be easily duplicated for any public company at any time. The methodology is shown to explain Walmart's decision to reduce its financial leverage over the prior year but subsequently increase its debt, as the rise in interest rates in 2018 raised the value of the tax shield relative to Walmart's marginal financial distress costs. Empirical evidence is supplied indicating the model is generally consistent with the capital structure decisions of the individual firms of the S&P 500 over the 2003-2017 interval. Besides demonstrating how the optimal capital structure for a firm may be calculated along with the cost of capital, this paper also supplies some insights on the impact of financial distress costs on stock returns and various market anomalies.

Introduction

This paper is designed to facilitate application of the theory of optimal capital structure and practical computation of the cost of capital in the real world with financial distress. Existing textbooks, such as by Ross, Westerfeld, Jaffe, and Jordan (2019), indicate that the a firm's capital structure is optimally selected to minimize the overall cost of capital but fail to indicate how to measure the financial distress costs which are critical to financing decisions. Methods for incorporating financial distress costs into the calculation of the cost of capital are not specified at all in

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the most widely used texts. This paper supplies and illustrates concrete procedures which can be utilized to teach students how to make informed financial decisions that are affected by financial distress costs.

The mechanical techniques exhibited in this article supply a simple instructive means for determining the type of financing a company should optimally use to fund its asset investments. A theoretically consistent method is also supplied for computing the cost of capital in the real world in which debt financing has both income tax benefits and financial distress costs. The overall approach derives from the incorporation of financial distress costs into the theory derived by Modigliani and Miller (1963), widely referred to as MM, who showed that debt with tax deductible interest is always cheaper in a world with no market frictions. To determine a firm's optimal capital structure in the real world, it is necessary to find the level of debt financing where the tax savings from increasing financial leverage equals the related marginal cost of financial distress (Elkamhi, Ericsson, and Parsons, 2012). This paper demonstrates a precise methodology for making those financial decisions that has been found to be empirically consistent with the capital structures selected by a large sample of companies.

Estimating Financial Distress Costs

As proven by Modigliani and Miller (1958) in a world without taxes and financial distress costs, the form of financing doesn't matter because the gains from funding more with debt (upon which investors require a lower return than on equity because debt has a less risky claim on a company's cash flows) are exactly offset by the increased cost of both debt and stock at higher levels of leverage However, in the real world, the tax benefits of debt financing must be weighed against the full costs of financial distress when evaluating financing alternatives (Korteweg, 2010*),* The damages to a business from excessive use of debt capital stem from reduced investment and operating opportunities (due to an inability to obtain financing when the risk of failure is high), forced sales of assets at distressed prices (in order to obtain cash needed to make payments on debts), decreased revenues (due to loss of reputational reliability among customers), and increased administrative or other expenses that arise from an increased chance of failure (Bergman and Callen, 1995). Almeida and Philippon (2011) have shown the expected value of those financial distress costs can be calculated as the annual probability of bankruptcy times the losses incurred by financial failure.

Estimating Bankruptcy Costs

Warner (1977) has found empirical evidence indicating that the direct legal and administrative expenses of bankruptcy alone average about 5% of a company's assets, being lower (much larger) for very large (very small) firms (Bris, Welch,

and Zhu, 2006). Compared to those direct costs, the losses suffered by companies forced by financial distress to suspend operations tend to be much higher (Alderson and Betker, 1996). Fire sales of a company's assets needed to make payments to creditors can result in especially large declines in firm value (Shleifer and Vishny, 2011). In addition, there is a reduced value for any of the company's continuing operations in financial distress because of the resulting deterioration in the company's credibility with customers, suppliers, employees, and providers of capital that reduces revenue and raises costs (Glover, 2016).

As a result, the net present value (NPV) of new as well as existing company investments may be lost for firms with insufficient equity capital. The total reduction in company value caused by bankruptcy may therefore be computed to equal 5% of assets plus the excess by which the market value of a firm's stock exceeds its book value (Murphy, 2018). The total costs of financial distress are thus especially large for firms with high market capitalizations relative to equity book value (Glover, 2016). To measure financial distress costs on an annual basis, these summed losses in bankruptcy are multiplied by the annual probability of a company being unable to make payments on its contractual obligations.

Estimating the Probability of Default

There are many complex methods for estimating the likelihood of default, such as those indicated by Iwanicz-Drozdowska, Laitinen, Suvas, and Altman (2016). However, Albusayyes, Emm, and Wehrly (2018) have suggested a simple procedure of matching a company's credit rating with the historical default rates of companies with the same credit grade, or alternatively using a variable such as Altman's (1968) Z-score in some fashion to estimate bankruptcy risk. A similar procedure involves estimation of the impact of a change in financial leverage on the probability of default (and hence the impact on financial distress costs) through the computation of leverage effects on a single interest coverage ratio that is a core indicator of credit risk (Murphy, 2000). Estimating the likelihood of default using the Times Interest Earned (TIE) ratio, which is computed as earnings before interest and taxes (EBIT) divided by interest expense (I), is consistent with commercial lending practices and full structural models of debt valuation (Leland and Tofi, 1996).

The likelihood of bankruptcy for any amount of interest expense at an existing or prospective new capital structure can be estimated from historical data on TIEs and default rates. Information published by credit rating agencies for each letter grade permits tabulation of such relationships in a form that facilitates seeing how higher coverage ratios correspond with lower default rates (Murphy, 2000), as is illustrated in Table 1. This table enables cross referencing any given TIE with a corresponding probability of default and credit rating, and linear interpolation may be utilized for TIEs between the rows. The exact process for using the table to compute financial distress costs is explained in the next subsection.

Table 1: Credit Rating Characteristics*

(1) Credit Rating	(2) Default Probability	(3) Default Losses.	(4) TIE	(5) Beta
Aaa	0.10%	0.04%	16.1	0.03
Aa	0.15%	0.07%	11.1	0.09
A	0.23%	0.13%	6.3	0.18
Baa	0.50%	0.33%	4.1	0.27
Ba	1.95%	1.29%	2.3	0.36
B	2.83%	1.87%	1.2	0.45
Caa	3.96%	2.61%	0.5	0.54
Ca	10.00%	6.60%	<0	0.57
C	$>20.00\%$	$>13.2\%$	<0	0.60

*Source: Murphy (2000). Only the information in Columns #1, #2, and #4 are necessary for the analysis of a firm's capital structure and cost of capital. The other columns are provided to enable estimation of credit spreads when company yield data are not available. In particular, spreads can be roughly estimated by adding Column #3 to the premium yield required for systematic risk that may be assumed to equal a historical average of 5% times the beta in Column #5.

Estimating the Marginal Financial Distress Costs of a Change in Capital Structure

When a firm varies its capital structure (such as by financing more of the company with debt rather than equity), its interest expense changes. For instance, if a firm obtains more debt financing to buy back shares of its stock, its interest expense will rise by the amount of the new debt financing times the interest rate on the company's debt. The firm's operating income (EBIT) can then be divided by this higher interest expense to compute a new TIE, which may be cross-referenced in Table 1 with the probability of default at that new interest coverage ratio. The change in the likelihood of bankruptcy can then be computed by subtracting the table probability at the existing TIE (with the current capital structure) from the chance of the firm defaulting on its obligations at the new coverage ratio.

In order to calculate the incremental financial distress costs caused by the change in capital structure, the difference between the new and old default probabilities can then be multiplied by the sum of 5% of assets and the excess by which a firm's equity market capitalization exceeds its book value. In particular,

$$\text{Incremental Financial Distress Costs} = (D_{after} - D_{before})(.05A + MV - BV), \quad (1)$$

where D denotes the probability of default (with the subscript indicating before or after an increase in financial leverage), A is the company's assets, and MV (BV) is the market value (book value) of the firm's equity (with MV-BV set equal to

zero if negative). The change in aggregate financial distress costs measured by equation (1) can then be divided by the amount of additional new debt to compute the marginal cost per dollar of new debt.

This amount of additional dept that could be issued at a new credit rating can be computed by first estimating the change in the firm's interest expense that would result in a TIE corresponding to a new credit rating. This incremental interest expense can determined by using Table 1 to compute a leverage multiplier, which equals the TIE in the table at the existing credit rating divided into the difference between the TIE in the table at the current credit rating and the TIE corresponding to the lower grade with more financial leverage. Dividing this additional new interest expense by the interest rate on the firm's borrowings indicates the amount of new debt the firm could issue and have the new lower credit rating.

Evaluating the Net Benefit or Cost from a Change in Capital Structure

The annual gross benefit provided by each dollar of debt financing may be calculated by multiplying the company's income tax rate by the interest rate on the debt (Miller and Modigliani, 1963). The marginal cost of financial distress computed in the prior section can then be subtracted from this gross benefit to compute the net gain or loss resulting from a company changing its capital structure. The procedure is summarized conceptually in Table 2, along with a means of measuring the cost of capital at the existing capital structure.

An increase in financial leverage would be optimal if there is a net benefit from increasing debt. Otherwise, the net benefit from a reduction in debt financing can be examined by using the same procedure but in reverse. In the latter case, a larger reduction in financial distress costs in excess of the tax benefit lost from increasing the portion of equity financing (through retaining earnings or issuing new shares of stock) would imply the firm should optimally use equity capital to pay off debt.

An Example using Walmart in late 2018

An illustration of this analysis is provided Table 3 for Walmart (ticker symbol WMT) on November 19, 2018. This table indicates that Walmart should issue $29.537 billion in additional debt to buy back outstanding shares of stock. Walmart's cost of capital before and after such an increase in financial leverage is also computed.

Table 2: Procedures for Determining the Optimal Capital Structure and the Cost of Capital

A. Computing the Tax Benefit of Adding More Debt

1. Add your firm's 5-year credit default swap (CDS) market rate (where one basis point or bps in a typical quote equals 0.01%) to the 5-year Treasury bond yield to compute the long-term interest rate required on your firm's debt. If CDS rates are not available, use the yield to maturity on the company's debt minus the T-bond yield with the same maturity.
2. Multiply the rate in #1 by the tax rate (of 21% currently).

B. Computing the Financial Distress Cost of Adding More Debt

1. Add 5% of your firm's assets to the difference between your firm's equity market capitalization and the book value of stockholders' equity to compute your firm's bankruptcy costs.
2. Find the Table Default Probability for your firm's credit rating using Table 1 and subtract this from the Default Probability at the next lower credit rating to compute the increased chance of bankruptcy arising from increasing financial leverage.
3. Find the Table 1 TIE for your firm's credit rating, subtract out the TIE for the next lower credit rating, and divide by your existing TIE to compute the leverage multiplier
4. Multiply the amount of your firm's interest expense by the multiplier determined in #3 of this **Section B** to compute the additional new interest expense.
5. Divide the additional new interest expense in #4 of this **Section B** by your firm's interest rate in **A**.1 to compute the amount of new debt that can be issued at the lower credit rating.
6. To compute the marginal financial distress costs incurred each year at the lower credit rating per dollar of debt, divide the amount of new debt in #5 into the product of #1 and #2 of this **Section B** (the latter product of bankruptcy costs and the marginal probability of bankruptcy represents the expected value of the reduction in the cash flows to shareholders resulting from the higher risk of financial failure).

C. Determining the Optimal Capital Structure

Compare the marginal cost of financial distress per dollar of new debt (i.e., the value in **B.6**) with the marginal tax benefit (i.e., the value in **A.2**) from that debt. If the value in **A.2** is larger than that in **B.6**, then existing shareholder wealth can be increased by raising the amount of debt financing employed. If the **B.6** value is larger, no increase in financial leverage is optimal (and the optimality of lowering financial leverage can be evaluated using the same processes used in **A** and **B** but in the reverse direction). The optimal capital structure exists where there is no net benefit from increasing or reducing financial leverage.

If the foregoing indicates the existing capital structure should be changed, the net benefit from the change can be obtained immediately by issuing debt to finance the repurchase of stock to increase financial leverage, or by selling new equity shares to finance paying off existing debt. However, this increase in shareholder value resulting from the replacement financing (*computed as the difference between **A.2*** and ***B.6** times the size of the replaced financing computed in **B.5***) must exceed the flotation costs of the changed financing. Otherwise, changes in capital structure are optimally made over time by adjusting payout policies to retain more or less earnings and thereby avoid the issuance or flotation costs of raising external capital.

D. Computing the Net Cost of Debt
Compute the net cost of debt at the optimal capital structure determined in **Section C** by multiplying the firm's interest rate computed in **A.1** by one minus the tax rate; and then add the product of the Table 1 probability of default for the rating at the existing capital structure times the bankruptcy costs (computed in **B.1**), with the latter product being a dollar amount to be divided by the company's total interest-bearing debt.
E. Final Computation for the Cost of Capital:
Multiply the net Cost of Debt in **Section D** by the amount of total debt and add this figure to the product of the cost of equity and the market capitalization. Then divide this figure by the total capital (which is the sum of the total debt and market value of equity). If a more optimal capital structure is indicated, merely subtract the net percentage net benefit from that cost.

Table 3: Analyzing the Capital Structure and Cost of Capital at Walmart on 11/19/18

Step	Compute	Description/Explanation
	0.35%	Annual cost of insurance on WMT debt (credit default swap or CDS)
	+2.89%	+ Default-free Treasury yield (5-year corresponding to CDS price)
A.1	3.24%	Interest rate to be paid on new debt of WMT
	× 0.21	× Tax Rate (business)
A.2	0.68%	Benefit per dollar of new debt from tax deductibility of interest expense
	$204,522	Assets of WMT in millions
	× 0.05	× Typical bankruptcy costs as % of Assets
	$10,226	Legal costs of bankruptcy for WMT (in millions)
	+$286,108	+ Market capitalization (Present value of all WMT stock) in millions
	−$80,822	− Book Value of WMT stock (Capital invested by shareholders, mill.)
B.1	$215,512 million	Cost of bankruptcy for WMT (including loss of NPV projects)
	×{0.0023−0.0015}	× Change in probability of bankruptcy from adding debt
B.2	$172.4 million	Marginal financial distress cost of increasing debt (incl. For lost NPV)
B.3	(11.1-6.3)/11.1	Change in TIE with more leverage to lower rating of A (from AA)
B.4	×$2215 million	× Interest expense for Walmart currently

	$957 million	Additional interest expense with more leverage at lower rating
	/.0324	Divided by Interest rate on WMT debt (from step A.1)
B.5	$29,537	Additional Debt at lower rating
B.6	172.4/29.537=.0058	=B.2/B.5 (=marginal financial distress costs per $ of new debt)
C	0.0068>0.0058	So do increase debt* (because 0.0058 marginal financial distress costs are more than offset by .0068 tax benefit from taking on more debt)
D	3.24%×(1−.21)=2.56%	After-tax cost of debt before financial distress costs
	+(215,512×.0015)/42,446=0.76%	+%Financial distress costs at Current Debt Level
	3.32%	*After-tax cost of debt after financial distress costs*
The company should pay off some of existing debt given cost of debt exceeds interest cost*.		
E	1/15.33=6.52%	Earnings yield on stock market (earnings/price for S&P500)
	−1.26%	−TIPs real annual yield long-term (for 30 years)
	5.26%	Market risk premium (often called the equity premium)
	×0.64	×WMT stock beta
	3.36%	Premium return required on WMT stock above risk-free rates
	+3.34%	+Yield to Maturity on long-term 30-year Treasury bond
	6.70%	*Expected return required by investors on WMT stock*
	$42,446+$286,108=$328,554	million total WMT capital
	$42,446/$328,554=12.9%	financed by debt currently
	$286,108/$328,554=87.1%	financed by equity currently

Cost of Capital = (.129×3.32%) + (.871×6.70%) = 6.32%
(to be used to discount capital budgeting cash flows at the Existing Capital Structure).

*If the firm changed its capital structure by replacing $29.537 billion in equity with $29.537 billion in additional debt, it would reduce the cost of capital by only ($29.537/$328.554)×(.0068−.0058) =0.01% to 6.31%.

As indicated in Table 3, using debt to buy back stock would lower Walmart's

credit rating and raise its financial distress costs. However, those costs are more than offset by the value of the tax deductions obtained from the added interest expense in November 2018. The analysis indicates that Walmart would optimally increase its financial leverage then and thereby lower its cost of capital.

Analyzing the Impact of Reducing Financial Leverage

A similar analysis could be conducted with respect to the impact of reducing financial leverage, albeit in reverse, since paying off debt would create a benefit by decreasing financial distress costs but at the same time lower the tax benefit to the firm. For instance, at a higher AAA rating, Walmart would reduce its interest expense by [(16.1−11.1)/11.1]×$2215=$997 million, which indicates $997/.0324=$30,794 million in less debt. That debt decrease lowers marginal distress costs by (0.0015−0.0010)×$215,512=$107.8 million, which would represent a marginal reduction in financial distress costs per dollar of the $30,794 decrease in the debt load that equals $107.8/$30,794=0.34%. However, because this reduction in financial distress costs is less than the 0.68% lost tax benefit per dollar of debt replaced by equity (i.e., 0.34%<0.68%), Walmart should not decrease its financial leverage in November 2018. These additional calculations aren't actually necessary in the 2018 Walmart case, because it had already been determined previously that the firm should increase the portion of its capital financed by debt (as shown in Table 3).

Adjustments to the Optimal Capital Structure over Time

Companies seeking to change their existing level of financial leverage to the optimal targeted capital structure may make the necessary adjustments only slowly over time in order to reduce the large expenses that may be associated with replacing funding sources all at once. In particular, emerging gaps between actual and optimal capital structures are typically closed only slowly over several years to avoid the flotation costs of new security issues (Flannery and Rangan, 2006).

To minimize the costs of obtaining external capital, firms typically fund their operations as much as possible through retention of earnings (that raise the portion of equity financing). While financing their operations and investments via the retention of earnings and other internally generated funds to the extent possible (Strebulev, 2007), dividend payouts and stock repurchases may be used to raise financial leverage to the optimal capital structure. A significant portion of capital outlays can be funded through asset sales when the expenses of such transactions are less than cost of raising outside funds (Arnold, Hackbarth, and Puhan, 2018). External capital is optimally obtained only if the expenses associated with raising outside financing are less than any incremental costs of capital caused by the use of internally generated funds that lead to temporary deviations from the target capital structure.

When internal funds are insufficient to finance operations, companies often obtain extra short-term bank credit to meet their funding needs, thus resulting in temporary deviations from their optimal financing mix (DeAngelo, DeAngelo and Whited, 2011). Cash and dividend policies are generally established to minimize the costs associated with such a temporarily suboptimal capital structure by setting a low (high) target payout ratio if a company forecasts a large (small) need for internally generated funding in the future (Gryglewicz, 2011). When a new security issue is needed to finance a project, the flotation costs can simply be added to the initial investment cash outflow associated with any capital budgeting project to compute the NPV, as is indicated in most textbooks.

Ex-Post Actions by Walmart and Tests on the S&P500 over the 2003-2018 Interval

Subsequent to this case example being provided to introductory finance students in late 2018 (in order to assist them in the same analysis on other companies of their choice for class projects), Walmart did in fact increase its financial leverage significantly (as the analysis in Table 3 indicated it should). In particular, in the February-to-April 2019 quarter for the firm, the debt on the company's balance sheet rose by about $20 billion while Walmart's equity book value dropped as a result of stock repurchases and dividends to shareholders exceeding its profits over that quarter. Although a sizable portion of the increase in debt was related to an accounting reclassification of operating leases, the rise in financial leverage remained material even allowing for this book-keeping effect.

In contrast, over the year prior to November 2018, Walmart had been reducing its debt by billions of dollars despite no material difference in its equity book value and market capitalization. The analytical procedure supplied in this paper provides an explanation for that opposite movement in financial leverage over the 2017-2018 period. In particular, while financial distress costs computed by the model for Walmart were not materially different in late 2017 compared to 2018, yields on Treasury notes were 0.83% lower in that earlier year (2.06% on November 19, 2017 compared to 2.89% in the Table 3 analysis on November 19, 2018). The lower base risk-free rate in 2017 meant lower borrowing costs for Walmart that then translated into a lower tax benefit of 0.83%x0.21=0.17%. This decreased tax savings from debt effectively more than offsets the net 0.10% benefit for Walmart shown in Table 3 for November 2018, thus explaining why the company reduced its debt during the 2017-2018 period but increased its financial leverage in 2019. When the value of the tax shield dropped after interest rates reversed downward going into 2020 (after rising through the spring of 2019), Walmart was again motivated to reduce its debt load (as the firm subsequently did).

The procedures utilized in this case illustration have previously been found to explain the capital structures for the hundreds of companies in the S&P

500 companies in a recent year (Murphy, 2018). To supplement that empirical validation of the analytical procedures suggested in this paper, an investigation is conducted by examining the financing choices of those firms over the entire 2003-2017 interval. The results (not shown) indicate that nearly half of the companies in that index would not have benefited from use of more debt capital. For those firms with implied net benefits from increasing financial leverage, the median net gain derived from using more debt capital would have represented shareholder value increases equal to less than 1% of their equity market capitalizations. The tendency of companies to only gradually move away from suboptimal financial structures in order to avoid the adjustment costs associated with immediate changes to the existing mix of securities outstanding (Flannery and Rangan, 2006) might explain at least a portion of the small deviations found between the actual and optimal capital structures.

Further investigations over the 2003-2017 interval showed that firms which the model indicated could benefit from increased financial leverage had higher existing levels of both debt and cash ratios (as a percentage of assets). The latter results provide support for Acharya, Almeida, and Campello's (2007) theory that many firms use cash holdings to hedge against the existence of financial constraints that may inhibit obtaining more credit in the future at a reasonable cost. DeAngelo, Goncalves, and Stulz (2018) have also shown that companies are motivated to actively seek to maintain some capacity for external funding to meet potential future liquidity needs in the face of potential restrictions on new debt issuance in the future. Goldstein, Ju, and Leland's (2001) have demonstrated that companies optimally maintain some financial slack in a world of uncertainty about their future situations because they always have the option to obtain additional tax benefits by increasing the portion of capital funded by debt, and the value of that option is incorporated into the prices of their equity securities.

Separately, Acharya, Almeida, Ippolito, and Perez (2014) have indicated that lower rated companies with higher risk of being unable to raise external capital tend to maintain larger cash balances, as opposed to lines of credit, to hedge against future funding needs. However, in the empirical investigation undertaken in this research over the 2003-2017 interval for the S&P 500 companies, the optimality of increasing debt leverage was not found to be significantly associated with the companies' unused lines of credit or agency credit ratings.

Measuring the Cost of Capital

The cost of debt employed in the weighted average cost of capital (WACC) computation (that is utilized as the discount rate for capital budgeting decisions) is generally specified in textbooks to simply equal the existing average interest rate on borrowings multiplied by one minus the tax rate. This formula, which is

based on the Modigliani and Miller (1963) theory, doesn't incorporate the financial distress costs associated with the use of debt financing in the capital structure. That textbook calculation therefore significantly underestimates the true cost of capital and can therefore result in faulty capital budgeting decisions that reduce shareholder value.

This paper indicates a precise method for measuring the total cost of debt that involves merely adding the financial distress costs per dollar of debt to the net after-tax interest expense. For instance, as indicated in Table 3, this total net cost of debt for Walmart is 3.32%, which is similar to the actual pretax payout to the firm's creditors because the total financial distress costs effectively offset the tax benefits in this case.

To complete the WACC computation, a procedure is needed to estimate the cost of equity. Sharpe's (1964) Capital Asset Pricing Model (CAPM) has long been widely used in practice for this purpose (Levi and Welch, 2017). The CAPM has been shown to be consistent with empirical risk-return trade-offs on bonds (Fu, Murphy, and Benzschawel, 2015) as well as on stocks when the model variables are estimated using statistical procedures to allow for changing means and variances of returns due to leverage changes (O'Doherty, 2012) and when Bayesian beta estimates are employed to measure systematic risk (Jostova and Philipov, 2005). Practitioners often use simple Bayesian procedures to estimate betas by merely adjusting the Ordinary Least Squares (OLS) regression coefficient (obtained from a regression of a stock's return in excess of Treasury bill yields against the excess return on the market portfolio proxy) a third of the way toward a cross-sectional mean of 1.0 (Blume, 1975). The latter Bayesian estimates have been demonstrated to represent superior measures of a stock's future contribution to the risk of a diversified portfolio compared to OLS (Levi and Welch, 2017) as well as explain the varying returns on different stocks better (Murphy, 1990).

Application of the CAPM requires an estimate of the excess return on the market portfolio above risk-free rates. As shown by Murphy and Sahu (2001), this aggregate equity premium can be effectively estimated by just subtracting the real return promised on long-term Treasury Inflation-Protected Securities (TIPS) from the inverse of the Price/earnings (P/e) ratio of the S&P 500 (where this P/e ratio is measured as the current index value divided by the highest S&P 500 earnings reported in any past year). That computation of the excess return on the stock market derives from the claim of purchasers of those 500 blue chip stocks on any day being equal to the annual future income of those firms, so that the current earnings yield to new shareholders equals the ratio between the existing profits and market prices. These earnings claims increase in the future to the extent of any inflationary growth in income, thereby commensurately raising the nominal return to shareholders. That latter future normal growth in the earnings yield (that effectively assumes any future corporate investments only average stockholders' required rates of return) can be estimated as the market forecast of the future

inflation rate, which itself may be calculated as the difference between the yield to maturity on long-term fixed-rate Treasury bonds and the real yield on long-term TIPS (which pay that real rate plus the rate of future inflation). The fixed-rate T-bond yield then cancels out when computing the excess return expected on stocks above Treasury rates. Murphy, Fu, and Benzschawel (2014) have empirically found this equity premium (the earnings/price ratio, expressed as a percentage yield, minus the TIPS yield) to have remarkably strong predictive power in forecasting future stock returns.

The product of this equity premium and a company's stock beta can be added to the long-term yield on government Treasury bonds in order to complete this applied CAPM measure of the cost of equity. Then the relative percent of capital supplied by debt and equity in the firm's current financing structure can be multiplied by the respective costs of equity and debt, as indicated in Table 2. The WACC then equals the sum of these two weighted costs of capital.

As shown at the bottom of Table 3, the WACC estimated for Walmart in November 2018 is 6.32%, which is the rate the company needed to earn after taxes on any invested capital provided by the firm's existing investors. In particular, that 6.32% would have been optimally utilized as the discount rate to compute the NPV of any investment (such as made to add or modernize more retail outlets) or of any operating outlay (such as expended to enhance the firm's marketing and online sales strategies) if Walmart maintained the same funding weights as exist in the firm's current capital structure.

As also shown in Table 3, this cost of capital would be reduced by 1 basis point (0.01%) through financing more with debt. The discount rate would then be 6.31% if the firm funded its new capital budgeting projects at the optimal financing mix indicated by the model. This computation merely takes the existing cost of capital and subtracts out the net benefit from the changed leverage.

The overall results for Walmart are virtually identical to what is implied by the original Modigliani and Miller (1958) model, which ignored both taxes and financial distress costs. While the combined effect of tax and financial distress costs may often be largely offsetting in measuring the cost of capital for many companies adopting optimal financing policies, the benefit/cost trade-off remains important for determining the optimal financial leverage which minimizes the cost of capital.

The Impact of Financial Distress Costs on Stock Returns

Incorporating the costs of financial distress into management decision-making enhances shareholder value by discouraging the use of excessive debt financing (that would otherwise increase the total cost of capital) and avoiding low estimates of the cost of capital (that would distort capital budgeting decisions). In efficient

markets where prices incorporate all public information (Fama, 1970), the impact of such optimal decision-making will result in a higher stock price at any time (and not just eventually).

However, there is some evidence that investors trading stocks may underestimate financial distress costs when forecasting company earnings and the present value of dividends received from those stocks. Many market anomalies relating to abnormal returns associated with equities exhibiting particular characteristics may reflect such underestimation of financial distress effects. For instance, Avramov, Chordia, Jostova, and Philipov (2013) have shown that the stocks of financially distressed firms earn abnormally low rates of return, and that factors such as momentum, size, and value become insignificantly related to equity returns when the impact of credit rating proxies for financial distress is factored out.

As shown theoretically and empirically by Callaghan, Murphy, and Parkash (2010), financially distressed firms needing external equity funding have their stock prices shorted down, so that these companies have to issue more shares because short sellers reduce the firms' share prices. The resulting greater dilution from the new share issuance by such a company results in a lower value per share, so that the investors taking short positions on the stock succeed in profitably driving down both the price and value of the securities of a financially distressed firm. Efficient anticipation of such shorting down stock values by other investors only serves to drive prices and values down further as investors avoid holding long positions on these stocks.

Griffin and Lemmon (2002) discovered that low returns to financially distressed stocks are concentrated in equities of firms that are smaller but have high growth potential. This empirical result is consistent with the Callaghan, Murphy, and Parkash (2010) theory that such companies are shorted down due to their need to access external capital to survive and grow. In any event, the costs of financial distress are important when making investment as well as corporate financial decisions. Also contributing to the downward movement in the stock prices of companies needing equity financing is a rising beta and required return on such equities due to more shares having to be issued in overall market declines (Murphy, 1998), thus raising the discount rate on the firm's expected future earnings and dividends that decreases their stock prices even more.

Nevertheless, it should be mentioned that one study by Vassalou and Xing (2004) using a structural model measure of distance to default (based on market prices, leverage, and volatility without considering internal corporate liquidity) found no significant evidence that the equities of companies with higher default risk earn lower risk-adjusted returns. In addition, O'Doherty (2012) has empirically shown that any lower returns on stocks of financially distressed companies may stem from the limited liability of stock that lowers the overall systematic risk of equity, as that downside protection is more valuable for firms nearer to insolvency.

In particular, the latter author explained that the greater uncertainty about the future solvency of financially distressed firms results in their equities having relatively lower betas when the aggregate equity market premium is higher, thereby resulting in less downside risk for those stocks. Schneider, Wagner, and Zechner (2020) have also demonstrated empirically how many anomalies observed in average equity returns may be explained by the negative return coskewness of stocks with the market portfolio that theoretically exist on companies closer to insolvency and that reduce the downside portfolio risk for diversified investors.

Conclusion

This article shows how to measure financial distress costs and incorporate them into financial decisions relating to capital structure and computation of the discount rate used in conducting capital budgeting analysis. A tabular application of the procedures to financial data for Walmart in late 2018 supplies a simple example of the necessary calculations which students can easily duplicate for any public company at any time.

For the millions of privately held companies, the model can also be applied by using appraised values of the firms' equity along with subjective evaluations of credit quality. Such appraisals, which optimally employ predictions of proforma financial statements to compute the present value of cash flows to shareholders using judgmental inputs, are inherently subjective (Murphy, 2000). However, even for publicly traded companies, these internal corporate opinions may actually be superior to the use of agency credit ratings and security market values, which themselves represent mere consensus estimates of outside investors who may not be as informed about the future as the company managers.

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A Comprehensive Approach to Evaluating Credit Policy Changes

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We propose a model for evaluating changes in a company's credit policy following a methodology suitable for a short-term financial management class. The model extends existing models by including growth in sales, matching the evaluation horizon to the company's product's life cycle and including the impact of changes in both long-term investment and working capital. Our flexible approach allows students and analysts to address many different alternatives with the use of a spreadsheet.

Introduction

Accounts receivable in US-based non-financial companies continue to grow. Data obtained from the Federal Reserve Bank of St. Louis (2018) indicate that between 2010 and 2017 accounts receivable of non-financial companies increased by 56%. The increase suggests that functions associated with receivables management remain an important component of corporate finance and, specifically, working capital management. Managing receivables involves evaluating the company's credit policy, such as terms of sale, credit granting, and collection policies. Corporate finance textbooks present models for evaluating credit policy changes. Scherr (2006) reviews the most commonly used models. After evaluating the strengths and weaknesses of these models, Scherr (2006) develops a model for evaluating changes to credit policy, along with a simplified version that employs approximations in order to make calculations more suitable for an introductory finance course. The most comprehensive model available for evaluating credit policy changes is in the Zietlow, Hill and Maness (2017) textbook, *Short-Term Financial Management* (hence, ZHM). While the Scherr (2006) model solves for the present value of collections that occur at time *t* (days), the ZHM model provides separate terms that discount sales from customers taking trade discounts (at time day *DP*), sales on a net basis (at time "CP"), variable costs (at time t = 0) and

credit and collection costs (at time *CP*). With their model, ZHM include several assumptions:

1. Credit policy changes will not affect cash sales;
2. Bad debt percentages are the same for customers that take a trade discount and those that pay at the end of the credit period;
3. Changing the credit policy will not require additional investment outlays other than accounts receivable;
4. The forecasted values for the proposed policy are known with the same certainty as those for the current policy.

Along with the above assumptions, the ZHM model treats the daily change in NPV that results from changing the terms of sale as a perpetual cash flow:

$$\Delta NPV = \Delta Z/i$$

where ΔZ is the change in NPV for a 1-day period between the proposed and current credit policies, and i is the daily interest rate. Since a product's life cycle is not perpetual, the ΔNPV calculation would tend to overstate the true NPV.

In this paper, we propose a model for evaluating changes in a company's credit policy that works within a horizon that is consistent with the life cycle of the company's products (rather than assuming perpetual cash flows). Zietlow et al. (2017) note that investments in capital and working capital should be included in an evaluation of a company's terms of sale. However, they do not provide a framework for capturing these changes. The approach that we suggest includes the effects of changes in both long-term investment and working capital. In the following section, we review changes in credit policy models from Scherr (2006) and Zietlow et al. (2017) and develop our life-cycle based model.

The Scherr (2006) and Zietlow, Hill and Maness (2017) Models

Scherr (2006) suggests a model in which the NPV of a proposed change in a company's credit policy with a two-term model captures both the NPV of cash flows generated but not collected under the current credit policy and the NPV of cash flows anticipated under the new credit policy,

$$NPV_n = \sum_{t=1}^{P_c} \frac{CF_C}{(1+k)^t} + (1/(1+k)^{P_n}) \left(\frac{CF_n}{k}\right)$$

where:

CF_C is the daily cash flow from sales (not yet collected) made under the current credit policy.

CF_n is the daily cash flow from forecasted sales made under the new credit policy.

P_C is the collection period in days under the current policy.
P_n is the collection period in days under the new policy.
k is the daily discount rate.

The first term captures the present value of cash flows resulting from sales the company made previously under the current credit policy. The second term captures the present value of cash flows from sales beginning on day $P_c + 1$ (the first day in which sales were collected under the new policy). The daily discount rate is

$$k = (1 + k / n)^{\wedge}(1 / 365) - 1$$

where k_n is the nominal cost of capital.

The NPV of the expected cash flows generated by sales under the current credit policy (if the company does not change its terms of sale) is:

$$NPV_c = {}^{CF_c}/_{k}$$

NPV_c is the present value of a series of perpetual cash flows generated from sales the company expects to generate if the current credit policy continues. The company will adopt a new credit policy if $NPV_n - NPV_c > 0$, or:

$$\textit{Change Policy if: } \sum_{t=1}^{P_c} \frac{CF_c}{(1+k)^t} + (1/(1+k)^{P_n})\left(\frac{CF_n}{k}\right) - \frac{CF_c}{k} > 0$$

The above model might be challenging for introductory finance course students. Accordingly, Scherr (2006) uses approximations and restates the model as a single equation that accurately captures the initial period's effects of the proposed change:

$$NPV = [CFY_n(360 - P_n) - CFY_c(360 - P_c)]/360 + (CFY_n - CFY_c)/k(k + 1)$$

where,
CFY_n is the annual cash flow associated with the new policy.
CFY_c is the annual cash flow associated with the current policy.
P_n is the collection period in days associated with the new policy.
P_c is the collection period in days associated with the current policy.
k is the annual discount rate applied to credit policy decisions.

The first term, $CFY_n(360 - P_n) - CFY_c(360 - P_c)]/360$, is an estimate of the annual changes in accounts receivable. A portion of the expected annual cash flows remains uncollected at the end of the year. As an example, if the company collects in 60 days under the current policy, then receivable turnover is $360/60 = 6$ times per year. Thus, at the end of the year, 1/6 of sales will remain uncollected. If under the proposed policy the collection period can be reduced to 45 days, the receivables turnover would increase to $360/45 = 8$ times per year, leaving 1/8 of sales tied up in receivables at the end of the year. The first term in the equation captures this change.

The second term, $(CFY_n - CFY_c)/k(k + 1)$, estimates the present value of the change in annual cash flows between the proposed and current policies. Given that the model specifies annual cash flows, the first full year of cash flows occurring under the new policy occur at the end of year 2. Discounting the differential cash flow by $k(k + 1)$ rather than k is more accurate with the end of year 2 assumption.

While the Scherr (2006) model estimates that a company collects in either P_c days (under the current policy) or P_n days (under the new policy), the ZHM (2017) model includes separate terms for collection of sales made on a discount basis (*DP* days) and on a net basis (*CP* days). The model estimates one day's profit as follows:

Table 1. ZHM model equations

	NPV of one day's sales (Z):	
−	$S * (V)$	Variable costs
+	$S * (P) * (1 - D) * (1 - B) / (1 + (r/365) * DP)$	PV of discounted sales
+	$S * (1 - P) * (1 - B) / (r/365) * CP)$	PV of non-discounted sales
−	$S * (EXP) / (1 + (r/365) * CP)$	PV of credit and collection costs

	where,	
	S	is the sales/day
	V	represents variable costs
	P	is the percent taking discount
	D	is the discount percentage
	B	is the bad debt percentage
	r	is the nominal cost of capital
	DP	is the discount period (days to collect sales made on a discount basis)
	CP	is the collection period (days to collect sales made on a net basis)
	EXP	is the collections expense

The model's NPV terms recognize variable costs immediately, while discounting sales made on a discount basis back *DP* days and net sales and credit and collection expenses back *CP* days. Figure 2 is a diagram of the ZHM model's cash flows.

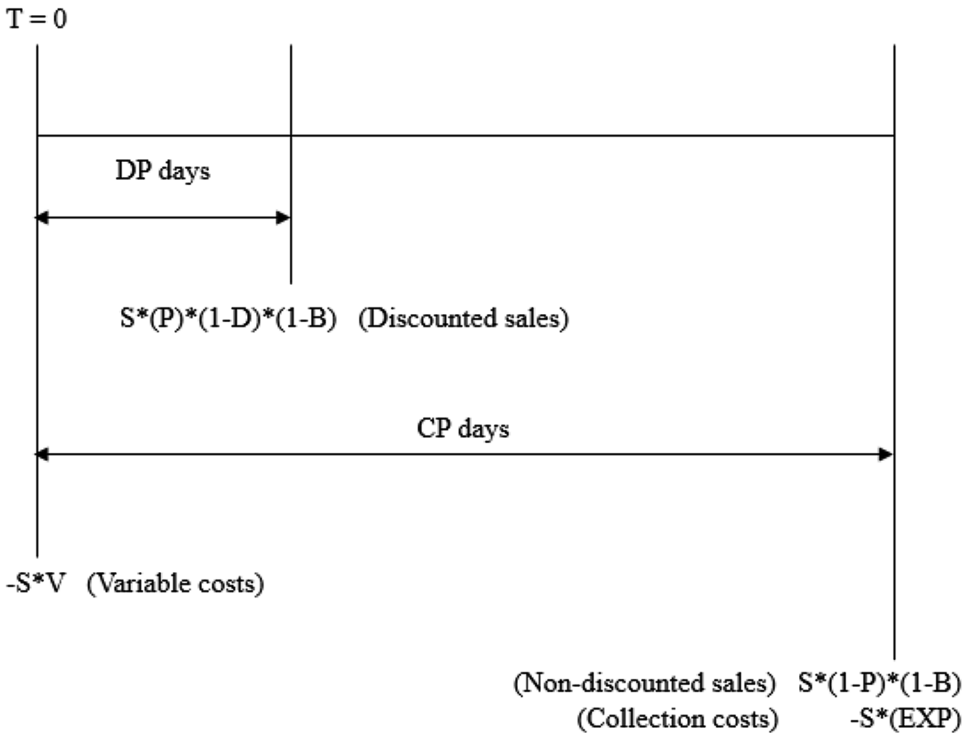

Figure 1. ZHM model cash flows

An analyst would calculate the NPV of one day's sales for both the proposed and current credit policies. The change in NPV that would result if the proposed policy is adopted is estimated as,

$$\Delta NPV = \Delta Z / i = (Z \text{ proposed policy} - Z \text{ current policy}) / i$$

where i is the daily discount rate equal to r/365. A ΔNPV > 0 would favor the proposed policy.

An implicit assumption of the above ΔNPV calculation is that changes in daily profits (ΔZ) are perpetual and do not grow (the Scherr (2006) model assumes constant perpetual annual cash flows). Perpetual profits or cash flows overstate the true NPV resulting from changing a company's terms of sale. Neither the Scherr (2006) nor the ZHM (2017) model address several other effects that changing the terms of sale could have. A comprehensive model would:

1. Find the value of the proposed change over the life cycle of the company's product line rather than assuming an infinite time horizon;
2. Account for changes in long-term capital expenditures;
3. Account for changes in both accounts receivable and inventory;
4. Account for growth in sales beyond the first year.

The only characteristic above that is addressed in either Scherr (2006) or ZHM (2017) is changes in accounts receivable (Scherr). The traditional net present value (NPV) model as we apply it to capital budgeting decisions addresses all the items listed above. However, the NPV methodology typically utilizes estimates of annual cash flows. It will not properly take into account the change in timing of collections that would result from a change in a company's credit policy (as an example, collecting in 45 days instead of 60). In the following section, we propose a comprehensive model that captures the effects listed in items 1 through 4 above and changes in the timing of collections and costs.

The Model

We propose an approach to evaluating credit policy changes that begins with the ZHM model and fine-tunes it to match the company's product life cycle, includes the effects of changes in working capital and capital investment and allows for growth in sales. To evaluate changes in working capital, we use the company's receivables, payables, and inventory turnover ratios. We employ the multi-period model developed by Satoris and Hill (1983) and Collins (1985) as laid out in Scherr (1989) to find the present value of all capital investment changes (both working and long-term capital). To illustrate our approach, we will use the company described in the following paragraph.

The PBR Company is trying to market more aggressively its circuit boards while speeding up collections. The circuit boards have an expected life cycle of 5 years. After 5 years, PBR expects that a circuit board with newer technology will replace the current design. PBR currently does not offer a discount and collects on average in 73 days. The credit manager and sales force believe that by offering terms of 3/10 net 45 the company can increase its growth for the next 5 years to 9% from its current 6% forecast. With stronger enforcement of the new terms of sale, the company can decrease the collection period for non-discounted sales to 50 days. The credit manager estimates that 60% of customers will take the discount and pay on day 10. The credit policy change is expected to increase PBR's inventory turnover (measured as Sales/Inventory) to 13.8 from the current level of 11.0. Current year's sales were $61,600,000. A breakdown of PBR's variable costs are shown in Table 2:

Table 2. PBR variable costs

Direct Labor	5.35%
Direct Materials	60.80%
Direct Overhead	3.14%
Sales Commissions	12.71%
Total	82.00%

PBR's cost of capital is 12%. The extra emphasis on collecting more quickly will increase credit and collections expense to 1.00% from 0.75% while reducing bad debt expense to 0.75% from 1.15%. PBR will continue to pay for its purchases in 30 days regardless if the company changes its credit policy. With projected growth of 6% under the current policy, PBR has a planned capital expenditure of $35 million next year with a projected 5-year salvage value of $18 million. Increasing growth to the proposed policy's 9% will require increasing the capital expenditure to $40 million with a 5-year salvage value of $20 million.

The evaluation begins with the ZHM model. Table 3 lists the input values for the model's equations (sales values are in thousands):

Table 3. Input values for ZHM model

Symbol	Variable	Proposed Policy	Current Policy
S	Sales/day (X 1,000)	$183.96	$178.89
V	Variable costs	82.00%	82.00%
P	Percent taking discount	60%	0
D	Discount percentage	3.0%	0
B	Bad debt percentage	0.75%	1.15%
r	Nominal cost of capital	12%	12%
DP	Discount period (days)	10	0
CP	Collection Period (days)	50.00	73.00
EXP	Collections expense	1.15%	1.00%

For the proposed policy, the sales/day are:

($61,600 × (1 + 9%)) / 365 = 183.96

For the current policy, 6% growth is expected, resulting in sales/day of:

($61,600 × (1 + 6%)) / 365 = 178.89

Tables 4 and 5 contain the calculations of the NPV for one day's sales for the proposed and current policies, respectively.

Table 4: NPV of one day's sales for proposed policy

Variable costs	−150.85	=−183.96*82.0%
PV of discounted sales	105.91	=183.96*60%*(1-3%)*(1-0.75%)/(1+(12%/365)*10)
PV of non-discounted sales	71.85	=183.96*(1-60%)*(1-0.75%)/(1+(12%/365)*50)
PV of credit and collection costs	−2.08	=−183.96*1.15%/(1+12%/365*50)
NPV	24.84	

Table 5. Present Value of one day's sales under current policy

Variable costs	−146.69	=−178.89*82.0%
PV of discounted sales	0.00	(no discount offered)
PV of non-discounted sales	172.69	=178.89*(1-0%)*(1-1.15%)/(1+(12%/365)*73)
PV of credit and collection costs	−1.75	=−178.89*1.00%/(1+(12%/365)*73)
NPV	24.25	

At this point in the evaluation, we would favor the proposed policy over the current policy. To find the change in NPV that results from the change in credit policy (following the ZHM model) we would divide the change in the one day's NPV by the daily interest rate:

$$\Delta NPV = (24.84 - 24.25) / (12\% / 365) = \$1{,}778\ (000)$$

In the next section, we complete the multi-period analysis to find the present value of the capital investment and the change in working capital for the proposed and current policies.

Multi-period Analysis

Recall that if PBR continues to grow at 6%, a $35 million investment is required next year, while a $40 million investment is required if growth increases to 9% as forecasted under the proposed credit policy. Working capital requirements would also change if the proposed policy is adopted. We find the present value of the cash flows generated by working capital changes following Sartoris and Hill (1983), Collins (1985), and Scherr (1989). The multi-period analysis calculations for the current policy are shown in Table 6.

We utilize turnover ratios to find the initial values of receivables, inventory, and payables. PBR collects receivables on average in 73.0 days. Thus, receivables turnover is,

$365 / 73.0 = 5.0$ *times per year*

Initial receivables are,

Sales net of bad dept / Receivables turnover $= 60{,}600 / 5.0 = 12{,}178$

For inventory, the current turnover is 11.0. Therefore, the initial inventory is,

Inventory = Sales / Inventory turnover $= 60{,}600 / 11.0 = 5{,}600$

Finding the initial value of payables requires that we first calculate purchases. Purchases are found by the accounting relationship,

Purchases = Ending inventory − Beginning inventory + costs of goods sold

However, this relationship does not hold well for a manufacturing company such as PBR. We tie purchases to direct materials and exclude direct labor and direct overhead. From Table 1, direct materials are 60.80% of sales. The initial value of purchases is the direct materials cost of sales,

Initial purchases = 60,600 / 60.8% = 37,450

Table 6: Present value of changes in investment and working capital, current policy

	Year					
	0	1	2	3	4	5
Gross Sales	61,600	65,296	69,214	73,367	77,769	82,435
Bad Debt and allowances	708	751	796	844	894	948
Net Sales	60,892	64,545	68,418	72,523	76,874	81,487
Receivables	12,178	12,909	13,684	14,505	15,375	16,297
Change in Receivables		731	775	821	870	922
Inventory	5,600	5,936	6,292	6,670	7,070	7,494
Increase in Inventory		336	356	378	400	424
Purchases	37,450	39,901	42,295	44,833	47,523	50,374
Payables	3,078	3,280	3,476	3,685	3,906	4,140
Change in Payables		201	197	209	221	234
Change in Working Cap:		−865	−934	−990	-1,049	−1,112
Recovery of Receivables						16,297
Recovery of Inventory						7,494
Remittance of Payables						−4,140
Working capital Cash flows:		−865	−934	−990	-1,049	18,539
Capital investment		−35,000				
Depreciation Tax Shields			1,488	1,488	1,488	1,488
Salvage Value						18,000
Total Capital cash flows		−35,865	554	498	438	38,026
PV, Capital cash flows, r = 12%		−9,372	(Both Long-term and working capital)			

With PBR's policy of paying in 30 days, payables turnover is,

Payables turnover = 365 / 30 = 12.17

Payables are then found by:

Payables (t = 0) = *Purchases / Payables turnover* = 37,450 / 12.17 = 3,078

Capital investment is $35 million at the end of year 1, as shown in Table 6. The salvage value is $18 million at the end of year 5. Using straight-line depreciation and a tax rate of 35%, the annual depreciation tax shield is:

($35 *million* − $18 *million* / 4 × 35% = 1,488 (000)

Combining the working capital and investment cash flows, we obtain the "Total Capital Cash Flows" on the penultimate row of Table 6. Discounting these cash flows at PBR's 12% cost of capital, we find the present value of the expected capital (working and long-term) cash flows to be - $9,372. This value will be added to the present value of the operating cash flows.

For the proposed policy, we follow the approach shown in Table 7 as we did for Table 6 for the current policy. All the values in the year "0" column in Table 7 are identical to those in Table 6 given that the proposed credit policy, if accepted, would not go into effect until year 1 (year 0 values are historical). The differences in Tables 6 and 7 are due to the higher receivables and inventory turnovers and the larger capital investment required by the higher growth rate of sales for the proposed policy.

To find the expected receivables turnover for the proposed policy, we find the weighted average days-sales-outstanding (DSO) of the discount period (10 days, 60% taking the discount) and the collection period (50 days, 40% not taking the discount):

60% × 10 + 40% × 50 = 26.0 *days* = *DSO*

The associated turnover ratio is 365/26 = 14.04. Thus, for receivables in year 1,

Receivables (t = 1) = *Net sales / Receivables turnover* = $65,441 / 14.4 = $4,662

Reducing the DSO to 26 days from 73 days (increasing receivables turnover to 14.04 from 5.0) reduces receivables from $12,178 to $4,662. Under the current policy, receivables are expected to increase from $12,178 to $12,909. Similarly, increasing inventory turnover to 13.80 from 11.0 decreases inventory from $5,600 to $4,866. Under the current policy, inventory increases from $5,600 to $5,936. The decrease in receivables and inventory creates positive working capital cash flows as does the increase in payables. After year 1, receivables and inventory increase, resulting in negative working capital cash flows.

For the long-term capital investment, we depreciate the $40 million investment over the remaining 4 years of the product life cycle. With a salvage value of $20 million and a tax rate of 35%, the resulting tax shield is:

($40 *million* − $20 *million* / 4 × 35% = 1,750 (000)

Combining the working capital and investment cash flows and discounting them at 12% results in a present value of −$8,761. Hence, with the higher receivables and inventory turnover ratios of the proposed policy, the total capital investments that PBR expects to make over the remaining years of the company's product life cycle are lower for the proposed policy when compared to the current policy. In the next section, we combine the capital costs and the present value of the operating cash flows over the product life cycle to complete the evaluation.

Table 7: Present value of changes in investment and working capital, proposed policy

	Year					
	0	1	2	3	4	5
Gross Sales	61,600	67,144	73,187	79,774	86,953	94,779
Bad Debt and allowances	708	504	549	598	652	711
Discounts	0	1,200	1,307	1,425	1,553	1,693
Net Sales	60,892	65,441	71,331	77,750	84,748	92,375
Receivables	12,178	4,662	5,081	5,538	6,037	6,580
Change in Receivables		−7,517	420	457	498	543
Inventory	5,600	4,866	5,303	5,781	6,301	6,868
Change in Inventory		−734	438	477	520	567
Purchases	37,450	40,374	44,761	48,789	53,180	57,966
Payables	3,078	3,318	3,679	4,010	4,371	4,764
Change in Payables		240	361	331	361	393
Change in Work Cap:		8,492	−497	−603	−658	−717
Recovery of Receivables						6,580
Recovery of Inventory						6,868
Remittance of Payables						−6,531
Working capital Cash flows:		8,492	−497	−603	−658	7,967
Capital investment		−40,000				
Depreciation Tax Shields			1,750	1,750	1,750	1,750
Salvage Value						20,000
Total Capital Cash Flows		−31,508	1,253	1,147	1,092	29,717
PV, Capital cash flows, r = 12%		−8,761	(Both working and capital Long term)			

Net Present Value Calculations for the Proposed versus Current Policies

From Table 4, we found the NPV of one day's sales for the proposed policy to be $24.84. We evaluate this NPV if it were to grow every day for the next 5 years (until the end of the product's life cycle). Table 8 is a summary of the required calculations.

Table 8. Net present value of the proposed policy

Daily growth rate in profits	0.024%	=(1.09)^(1/365) − 1
Daily cost of capital	0.031%	=(1.12)^(1/365) − 1
PV if infinite growth	333,860	=24.84*(1+0.024%)/(0.031%−0.024%)
Last day, year 5 cash flow	38.21	=24.84*(1+0.024%)^(365*5)
Continuing Value year 5	513,684	=38.21*(1+0.024%)/(0.031%−0.024%)
PV, Continuing Value	291,478	=513,684/(1+0.031%)^(5*365)
PV, 5 years of daily profits	42,381	=333,860−291,478
PV Capital costs	−8,761	(From Table 7)
Total NPV, Proposed policy	33,620	(000)

We diagram the present value of daily profits from Table 8 in Figure 2.

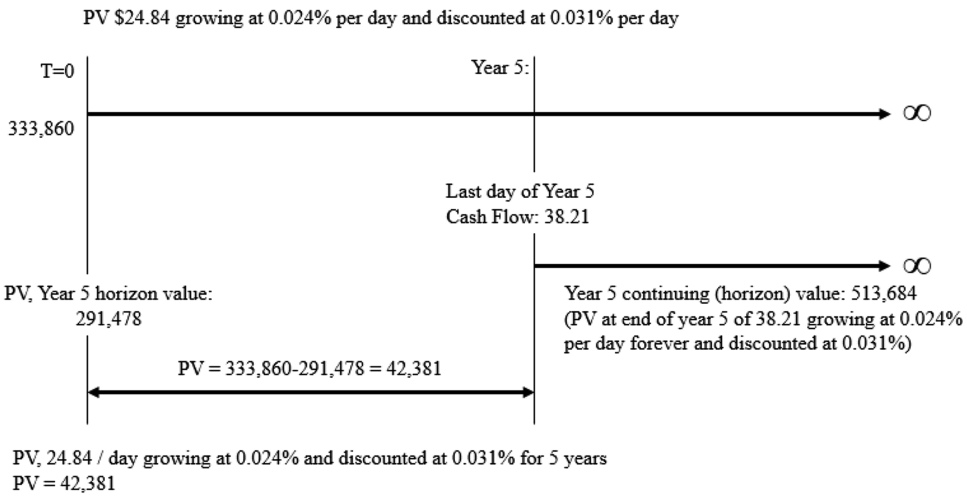

Figure 2. NPV of one day's sales growing over PBR's product life cycle

We first find the PV of an infinite series of cash flows, beginning at a value of $24.84, growing at 0.024% daily and discounted at 0.031% daily, or $333,860. At the end of year 5, the $24.84 cash flow would have grown to $38.21. If the $38.21 were to continue to grow beginning the first day of year 6 to infinity, it would create a horizon value of $513,684 at the end of the 5th year. The present value of the horizon value at t = 0 is $291,478. We find the present value of the

$24.84 growing at 0.024% daily over the 5-year product life-cycle by subtracting the $291,478 from the present value of the infinite series ($333,860), resulting in a value of $42,381. This compares to the NPV of $24.84 / (12%/365) = $75,541, the present value of an infinite series of constant daily cash flows of $24.84 (as prescribed by the ZHM model). Following the same approach, we found the NPV of the current policy.

From Table 5, the NPV of 1-day's sales is $24.25. Table 9 summarizes the NPV calculations for the current policy.

Table 9. Net present value of the current policy

Daily growth rate in profits	0.016%	=(1.06)^(1/365)−1
Daily cost of capital	0.031%	=(1.12)^(1/365)−1
PV if infinite growth	160,755	=24.25*(1+0.016%)/(0.031%−0.016%)
Last day, year 5 cash flow	32.45	=24.25*(1+0.016%)^(365*5)
Continuing Value year 5	215,126	=32.45*(1+0.016%)/(0.031%−0.016%)
PV, Continuing Value	122,068	=215,126/(1+0.031%)^(5*365)
PV, 5 years of daily profits	38,686	=160,755−122,068
PV Capital costs	−9,372	(From Table 6)
Total NPV, Proposed policy	29,315	(000)

The change in the NPV between the proposed and current policies is $33,620-$29,315 = $4,305 (000). This compares to the $1,778 (000) value found previously if we had followed the ZHM model. We noted above that the positive difference would favor PBR adopting the proposed policy.

Given the uncertainty involved in estimating the values that we used in this analysis, relying on a single number could result in forgoing valuable insights in the decision-making process. A useful question is, "How far off can our estimates of key values be and still favor the proposed policy?" To answer this question, we conduct a break-even analysis.

Break Even Analysis

In this section, we solve for the values of key proposed policy variables that would cause the NPV of the proposed and current policies to be equal.[1] Table 10 is a summary of the key variables, their values that would cause the NPV of the proposed policy to equal that of the current policy and the break-even value differences from the forecasted values.

Table 10. Break even values for key proposed policy variables

Proposed Policy Variable:	Forecasted value	Break even value	Difference
Growth	9.00%	5.49%	−39.00%
Capital investment	40,000	46,567	16.42%
Investment salvage value	20,000	6,959	−65.20%
Collection period	50	117	134.00%
Inventory turnover	13.8	4.00	−71.01%
Credit and collection expense	1.15%	2.54%	120.87%
Percent taking discount	60%	100%	66.67%
Bad debt expense	0.75%	2.17%	189.33%

In Table 10, the forecasted and break-even values for growth are 9% and 5.49%, respectively. Accordingly, the 9% growth rate that PBR forecasted for the proposed policy could be as low as 5.49%, or 39% below the forecasted value for PBR to have the same NPV as the company would expect from the current policy. Of the variables in Table 10, capital investment's break-even value has the smallest difference from its forecasted value. Thus, PBR should thoroughly check the accuracy of all the key variables' estimated values while paying special attention to the capital investment forecast.

TEACHING THE MODEL

The Short-term Financial Management Course that includes the section on evaluating credit policy changes is a senior level elective course. Typically, students have completed several if not all the required core courses (Corporate Finance, Investments, Financial Markets and Institutions) prior to enrolling. The topic is part of the receivables management section of the course. The course uses a lecture format with extensive in-class use of Excel-based examples. Below is a summary of the components that are included in the terms of sale unit:

1. Introduce terms of sale: net 30 vs. 3/10 net 30.
2. Present the ZHM model from Chapter 6 of the *Short-term Financial Management* textbook, including the equations from Table 1 and the cash flow illustration from Figure 1 in the current paper.
3. The class is an elective with a laptop requirement. From the University's class databases (we use Canvas), students will download a file that has all the given information for the example. This file includes the information given in the section "The Model" above.
4. Beginning with a blank worksheet, the class will create Table 3 above. Table 3 contains all the inputs that are required to complete the equations

in Table 1. Directly below Table 3, the class creates the equations from Table 1 by referencing the values in Table 3 for the proposed terms of sale. Once the values for variable costs, present value of discounted sales, present value of non-discounted sales and present value of the credit and collections costs have been obtained for the proposed terms of sale (Table 4 above), students can copy their equations across to the right to obtain the values for the same terms as they relate to the current policy (Table 5 above). The organization of the worksheet and values that the class will obtain are shown in Figure 3 below. The equations are relatively straight forward. Most students are able to complete the calculations. Those who experience difficulties typically make equation structure errors (such as missing a parenthesis or a mathematical operator ("*", "/")).

	A	B	C	D
1			Proposed	Current
2			Policy	Policy
3	S	Sales/day	183.96	178.89
4	V	Variable costs	0.82	0.82
5	P	Percent taking discount	60%	0
6	D	Discount percentage	3%	0
7	B	Bad debt percentage	0.75%	1.15%
8	r	Nominal cost of capital	12%	12%
9	DP	Discount period	10	0
10	CP	Collection Period	50	73
11	EXP	Collections expense	1.15%	1.00%
12				
13		Variable costs	-150.84	-146.69
14		Discounted sales	105.91	0.00
15		Non-discounted sales	71.85	172.69
16		Collection and credit costs	-2.08	-1.75
17			24.84	24.25

Figure 3: Screen capture of in-class ZHM model calculations.

5. If completed correctly, students will obtain the present value of one day's sales of $28.84 and $28.25 for the proposed and current policies, respectively. Following the ZHM model, students divide the difference in the NPVs ($0.58) by the daily interest rate (12%/365), giving the present value of the infinite series cash flows of $1,778. We point out that the company's product life cycle is 5 years (not infinite), that sales are expected to grow and that the company will be making investments in both property plant and equipment and working capital over the next 5 years. None of these points are addressed in the Scherr (2006) or the ZHM (2017) models. By displaying the equations for these models, we can emphasize that they discount their cash flows by dividing by their periodic rates – the appropriate method for an infinite no-growth annuity. We then proceed to the capital cost estimates.
6. Starting with a blank worksheet (no "templates"), we lead the class while creating Tables 6 and 7. We emphasize that the Year 0 values for both tables are identical because they are historical. The basis for making working capital forecasts are the respective turnover ratios (receivables and inventory) and the number of days that the company takes to pay for its purchases (payables). The turnover ratios and the capital investments that the company expects to make for the proposed and current terms of sale are included in the given information.
7. After completing the worksheets shown in Figure 3, we have the present values of one day's sales for the proposed and current policies. Rather than treating these as constant no-growth cash flows, we find their present values as finite life (5 years) growing annuities. While we would expect students to be familiar with the constant growth model, they might not have been exposed to finite period constant growth annuities. Eck (1996) develops an equation for calculating the present value of a finite period constant growth annuity. The equation is:

   $PV = CF(1+g)(1-[(1+g)/(1+r)]^{N})/(r-g)$ where:
   CF is the present value of one-day's sales from the ZHM model
   g is the growth rate of daily sales
   r is the daily periodic discount rate
   N is the number of days of constant growth.
   For the proposed terms of sale, the PV equals:
   $PV = (25.83*(1+0.024\%)\ X\ (1-[(1+0.0024\%)/(1+0.0031\%)]^{1825})/(0.0031\%-0.0024\%) = 42{,}381$

Rather than using the Eck equation directly, we display the graphic shown in Figure 2 to help the class visualize the cash flows for which we are estimating a

present value. After completing Table 8, we verify the results by applying the Eck Equation. We then have the class recreate Figure 2, complete Table 9 and the Eck equation for the current policy.

8. We find the advantage of adopting the proposed policy to be $33,620 − $29,315 = $4,305 (000).
9. Assurance of learning has two components. First, the class will complete a short case that is similar in structure to the example but with different values (such as a 10-year product life cycle, a 10% nominal cost of capital and a 4% growth rate). We provide online "check figures" that will indicate to students that they are progressing successfully as they complete the assignment. An example of a check figure is the present value for the proposed policy of the non-discounted sales for the ZHM model. Class presentations are supplemented with several office hours available between the class periods in which we introduce the example and collect the assigned case. Second, the midterm exam will have a question that requires students to complete a sampling of the computations from the example and the case (using values that differ from either). They are required to complete the calculations without using Excel. The exam has an "open note, open book" format (but no computer). Covering the example and going over the case requires approximately 2 class periods (75 minutes each) while the allotted time for the exam question is approximately 25 minutes. While we have no metric that indicates whether the receivables management section improves student learning outcomes, we have surveys of students who complete internships noting that the Short-term Financial Management course specifically helped prepare them for the assignments that they completed during their internships.

Conclusion

We have presented a comprehensive model for evaluating changes in a company's credit policy. Our approach should be suitable for a short-term financial management class, but it is probably too detailed for either an introductory or intermediate corporate finance course. The model extends the Zeitlow et al. (2017) model by including growth in sales, matching the evaluation horizon to the company's product life cycle and including the impact of changes to long-term investment and working capital. We employ elements of the multi-period model of Sartoris and Hill (1983) and Collins (1985). The multi-period model is an annual cash flow model and does not capture the timing of receipts. However, it is a well laid out tool for tracking changes in long-term investment and working capital.

Our approach is quite flexible. As an example, we could assume that the growth rate will begin to decline toward the end of the product's life. While this

would complicate the analysis, a spreadsheet should enable students and analysts to address many different alternatives with minimal additional effort.

Endnotes

[1] Excel's "Solver" function is useful to find the break-even values. We set the difference between the NPVs of the proposed and current policies to a value of 0 by changing one of the key variables at a time. As an example, in order to find the break-even value for growth, we set the difference between the NPV's to a value of 0 ("Set Objective" (cell containing difference between NPVs) "To: Value Of" (enter a value of 0) "By Changing" (cell containing proposed policy growth). For the "Solving Method", choose the "GRG Non Linear". Click on "Solve" and you will find that a proposed policy growth rate of 5.49% will reduce the NPV of the proposed policy to $29,315, which equals the NPV of the current policy.

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Enhancing Critical Thinking and Analytical Reasoning Skills with Financial Ratio Analysis

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This study proposes a method of using a financial ratio analysis course project, a conventional method, in an unconventional way to enhance students' critical thinking and analytical reasoning skills. The proposed project introduces a systematic, logical, and reiterative approach to solve a complex problem—explaining unusual variations in a firm's financial ratios—in four steps: (1) identify one or more anomalous ratios that exhibit unusual deviations from expected patterns; (2) develop hypotheses that might explain the anomaly; (3) investigate and develop tests to rule out alternative hypotheses; and (4) reach a conclusion. This approach can advance students' learning outcomes from lower levels of cognitive learning, such as remembering basic concepts and comprehending facts and ideas, to higher levels of learning including analysis and evaluation.
Keywords: *ratio analysis, critical thinking, analytical reasoning, financial statement*

Introduction

Recent studies find that there is a perception gap between college students and employers on students' preparedness for the workforce. A 2015 Association of American Colleges and Universities survey shows that college students think they are well prepared in a variety of knowledge areas and skills, but employers do not agree on the preparedness of recent college graduates (Hart Research Associates, 2015). While students concur with employers on the importance of key skills including critical thinking and analytical reasoning, oral and written communication, teamwork, and the ability to apply knowledge and skills to real-world settings, the ratings given by college students on their level of abilities in those areas are more than double that given by employers. For example, 66% of the student participants think they are well prepared in critical thinking and analytical reasoning skills, but only 26% of the employers feel that way. ICIMS (2017) reports that employers also gave low ratings on entry-level job applicants' qualifications:

32% of the candidates are not qualified for the workforce. Furthermore, a recent PayScale survey finds that 60% of employers identified critical thinking skills as the soft skill that college graduates lack the most (PayScale, 2016).

A similar perception gap exists between educators and employers. A 2013 McKinsey Center for Government report finds that 72% of education providers from nine countries think their new graduates are adequately prepared for entry-level positions, but only 42% of employers found their recent hires to have sufficient skills for the workforce (Mourshed, Farrell, & Barton, 2013). Arum and Roksa (2011) show that 45% of U.S. college students in a large sample did not experience any significant gains in their critical thinking skills during college. Hart Research Associates (2013) reports that 82% of employers surveyed say that college should put more emphasis on students' critical thinking and analytical reasoning skills.

To close the gap between college education and workforce, this study proposes using a conventional method—financial ratio analysis—in an unconventional way to improve students' critical thinking and analytical reasoning skills, and the ability to apply knowledge in real-world contexts.

Financial ratio analysis has been considered an important topic and is taught in most of the introductory corporate finance courses (Cooley & Heck, 1996; Gup, 1994). However, the conventional way to teach financial ratio analysis, similar to the sponge approach described by Browne and Keeley (2012), requires students to memorize formulas of certain financial ratios and use calculated results to evaluate firm performance without involving much strenuous mental effort. For example, a typical term paper on financial ratio analysis may require students to calculate a group of financial ratios for a firm and its competitors over a period of time, provide a brief definition of each ratio, and evaluate the firm's performance by commenting on whether a calculated ratio is better, worse or on par with that of the competitors. Nonetheless, students are not required to investigate why the firm's ratios are different from those of its competitors or why a certain ratio has changed over time. This passive way of learning ratios may cause learning outcomes of financial ratio analysis to remain at low levels of cognitive learning, such as remembering basic concepts and comprehending facts and ideas (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Very few students move beyond the knowledge and comprehension stages to higher levels of cognitive learning including analyzing and evaluating stages (Bloom et al., 1956). For example, often students are taught that a firm with a higher return on assets (ROA) is preferable than its competitor with a lower ROA because ROA measures profitability. However, they may not understand that a higher ROA could be due to several alternative explanations, such as, a depreciated asset base, lower stockpile of cash, higher operating leverage, or exchange rate fluctuation. One possible reason is that the scope of a typical financial ratios assignment is limited by students' familiarity with financial statements and financial ratios. Furthermore, regular class lectures might not have provided a theoretical framework or schema to facilitate the investigation

of financial statements and examination of the components of financial ratios. Consequently, it is challenging for students to make connections between events in the business and the impacts such events have on its financial ratios.

The unconventional way of teaching financial ratios proposed in this study addresses the scope and framework issue by requiring students to: (1) calculate and sift through a large number of financial ratios across time on one company and its main competitors; (2) identify one ratio that either is inconsistent with the students' prior knowledge or has unusual variations across time; (3) explore the components of that ratio to explain its abnormity. Thus, students can gain a deeper understanding of the company, its financials, and its industry, and apply critical thinking and analytical reasoning skills to solve a puzzle—the "abnormal" ratio. This project can elevate students from the knowledge stage into the analysis stage. Furthermore, this process flow is similar to the methods used by professional financial analysts in corporate finance.

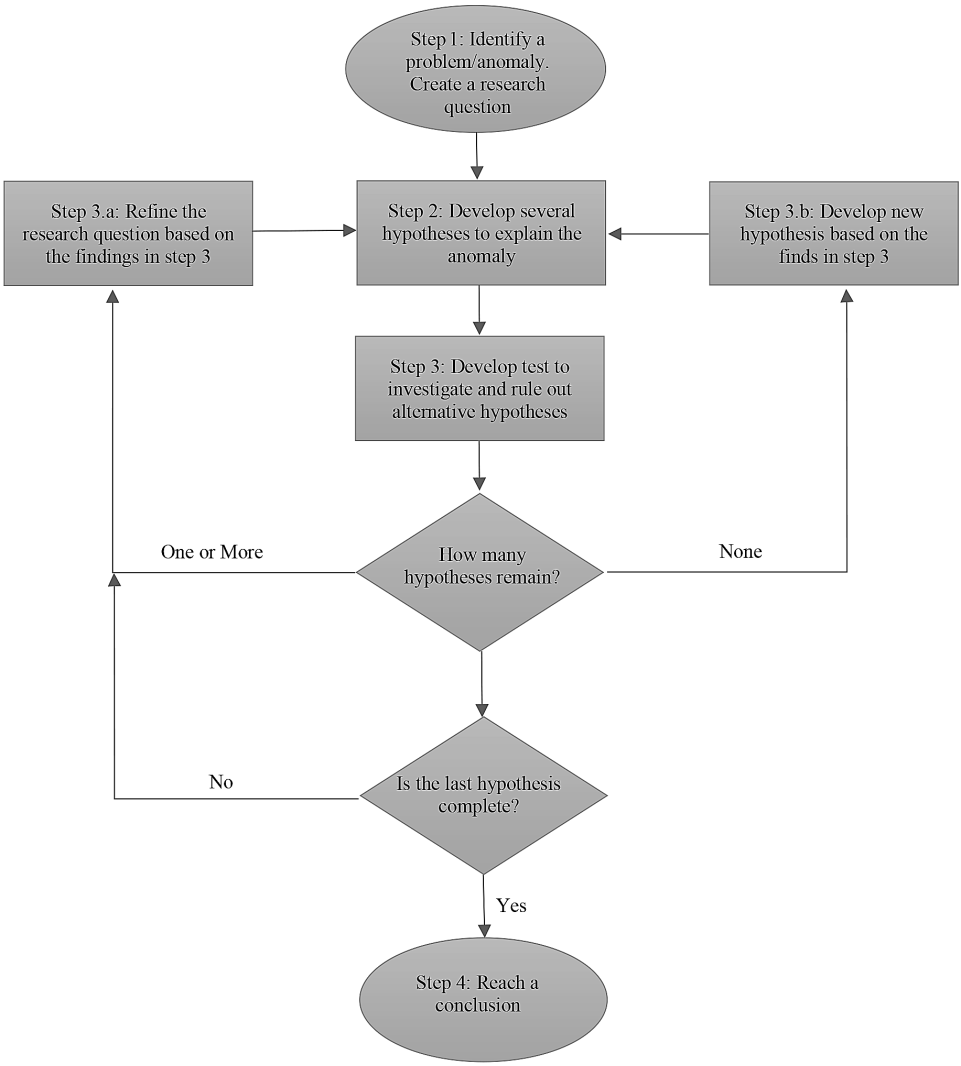
In addition to enhancing students' critical thinking skills and problem-solving skills, this approach improves students' spreadsheet skills, and data analysis and visualization skills. For example, in a course project (refer to Appendix for a sample assignment), students are required to calculate financial ratios for three different companies within the same industry each year over a period of 5 years. They also need to create charts to visualize data, and then interpret and analyze the meaning of the data.

The proposed financial ratio course project enhances students' critical thinking, data analysis, and analytical reasoning skills and help reduce the perception gap between students and employers and that between educators and employers.

The Problem-Solving Framework

The proposed schema is a reiterative process with four basic steps (Whetten & Cameron, 2010), which is widely used in analytical problem-solving models and is based on the scientific and the exploratory data analysis methods: (1) identify a problem/question—the abnormal ratio; (2) develop several hypotheses that might explain the abnormal ratio; (3) investigate and develop tests to rule out alternative hypotheses: (4) draw a conclusion and write a report. Figure 1 shows the process flow.

Figure 1. Process Flowchart



Identify a Question, Problem, or Anomaly

A key part of the proposed financial ratio analysis project is to explore corporate financial data, so that an anomaly is recognized and a research question is developed. First, students should pick three companies that are competitors in an industry. At this point, it is not necessary for the students to determine the company they will analyze. The decision on which company to evaluate should be decided after financial ratios are calculated and analyzed. It is recommended to have students begin with a company they are interested in, and then find two

competitors. Students should be allowed to switch companies if they cannot identify any anomalies after the ratios are calculated. Next, students should gather data, create common-size financial statements, calculate financial ratios, and visualize the data and ratios with charts and graphs. Then students should inspect and analyze the ratios, charts, and graphs for anomalies. Though the step "defining a problem/question" is relatively simple and seems obvious, the process causes the student to focus on one question, which is gleaned from a large set of data.

Students may download companies' financial data from Yahoo Finance, NASDAQ.com, Compustat, or other sources that have current and historical financial statements. Although some of these sources also provide pre-calculated ratios and charts, it is recommended to require students to download only raw financial data, calculate the ratios, and create their own charts to reinforce the students' knowledge of financial statements. Thus, when students start to analyze the ratios, they will have a better understanding of the components that are causing a ratio's abnormality.

One challenge often faced by students is lack of understanding of financial statements, and this may lead to incorrect conclusions. For instance, students may get accrual and cash accounting confused, and believe that an increase in accounts receivables causes a decline in profits. Another example is that students may not understand that large or persistent negative profits can lead to negative cumulative retained earnings. To avoid these types of problems, it is suggested that students begin their project after financial statements and ratio analysis have been covered in class.

Once the financial ratios are calculated and charted, students should analyze the graphs for unusual variations (trends, spikes, or patterns within a ratio for the same firm) and unusual covariation (trends, spikes, or patterns between the ratios across the firms). Figure 2 shows an example of an unusual variation in the asset turnover ratio for Home Depot, where the overall trend for the asset turnover ratio is disrupted in 2015. Figure 3 shows an example of an unusual covariation among Home Depot and its two main competitors: Lowes and Sears, where the value for Lowes' day sales outstanding is zero, while Home Depot and Sears's ratio follow a similar trend. Unusual variations and covariations like these could serve as a starting point for further inspection and analysis to identify an anomaly. As an outcome of sifting through the ratios, students should pick one ratio with an abnormal variation or covariation. This ratio will be the students' research question, problem or anomaly that they will seek to answer or explain.

Figure 2. Home Depot Asset Turnover

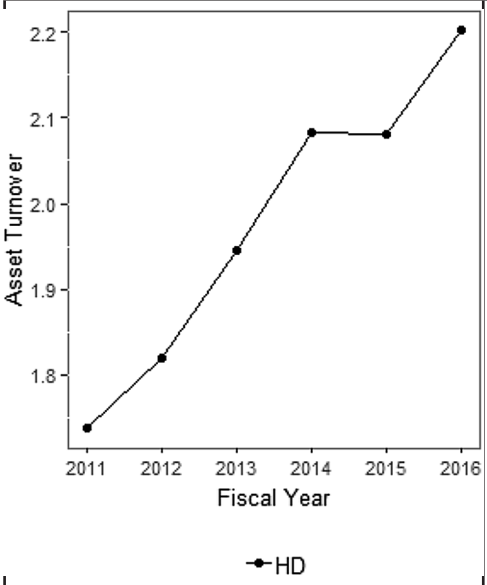
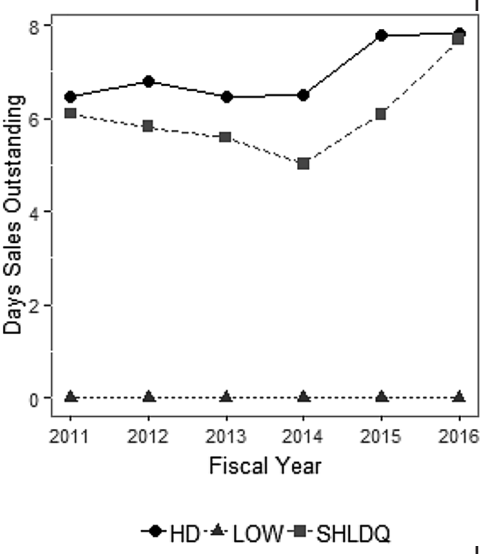


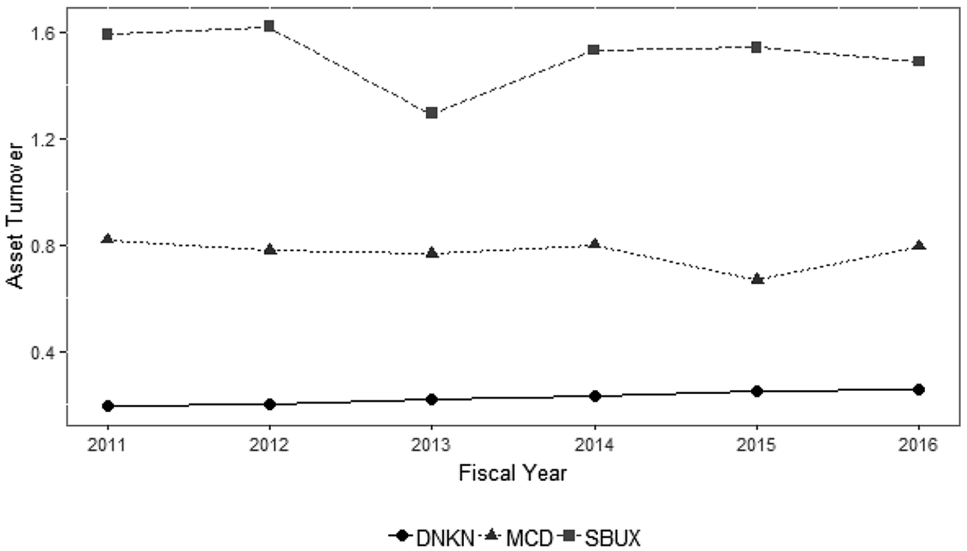
Figure 3. Days Sales Outstanding for Home Depot (HD), Sears (SHLD), Lowes (LOW)



It is recommended that the question is narrow in scope. A well-focused question usually focuses on an event that occurs within a one-year period. For example, "looking at Starbucks financial ratios, it is apparent that something occurred within 2013, causing an unusual variation in the asset turnover ratio." (Anonymous student 1) (See Figure 4 for Anonymous student 1's findings). It is possible for a student's question to cover a trend over several years; however, the level of difficulty increases as the student will need to examine several years of a company's financial reports and its competitors'.

Students may have a hard time recognizing an abnormal variation or covariation. This is usually the case for students that are overwhelmed by the number of charts and ratios they are required to examine. Once an abnormal variation or covariation has been identified, students may also have difficulty moving forward, as they are uncomfortable about exploring issues with unknown outcomes. In general, this is an issue with open-ended questions. To address these issues, we recommend communicating with the students that the conclusion is not as important as the analysis, or the learning process. The objective of the assignment is to improve problems solving skills by using financial statements and ratios. The main outcome we want from the students is for them to learn (1) how to recognize the source of a problem using data analysis, (2) something about financial statements they did not know, and (3) how the actions of the firm are reflected in the firm's financial statements. Sometimes this is not enough and students still have troubles picking a

Figure 4. Asset Turnover for Starbucks (SBUX), McDonald's (MCD), and Dunkin Donuts (DNKN)



research question. In these circumstances, the instructor can meet with the students to review a set of possible questions they can choose from.

Students should be warned not to pick a question that is based on a preconceived answer. A question that is based on a preconceived answer is one where students already have an opinion, and they are using their analysis to justify their belief. An example is "the problem is, can Amazon continue to lead and can their competitors like eBay and Overstock stand a chance and get a piece of this growing industry?" (Anonymous student 2) This is a question with a preconceived answer because how does the student know that Amazon leads, as this can only be revealed with a thorough analysis of the company and its competitors. A preconceived question defeats the purpose of letting the evidence drive the analysis.

Another type of question that is also based on a preconceived answer is one where the student defines the question from news events. Defining a research question from current events rather than from the ratios and the financial data usually results in poor analysis, with ratios typically not matching the conclusions made in the paper. Furthermore, students do not learn critical-thinking and problem-solving skills when they try reverse engineering their question using current events.

Students should be advised not to pick a research question that is too broad. A broad question seeks to explain an overall trend, which may involve too many factors influencing the question for a student to use financial ratio analysis to arrive at a conclusion based on facts. An example is "based on current and past trends, the question is raised, how is it possible for an unprofitable and highly indebted

firm [Tesla] to outperform in the stock market against a big giant like Ford?" (Anonymous student 3) This question is unanswerable as there are many factors, beyond the firms' financials, that are influencing the performance of Tesla and Ford, such as the firm's growth options and investors' expectations. Often, such questions are also derived from preconceived answers.

There are scenarios where a student picks a research question that seems too easy and will require little investigation. In these circumstances, it is advised that grading focus on the level of knowledge gained by the student from their analysis. This is preferred over rejecting such research questions as some of these questions lead to unexpected and interesting outcomes. For example, one student learned that an increase in Kohls' days sales outstanding in 2014 was due to a $26 million federal tax refund (Anonymous student 4). Instructors may ask students that pick those easy questions to discuss how the firms' actions affect other aspects of their financials. For example, suppose a student has learned how discontinuing operations can affect a firm's profit margin ratio, and not necessarily the firm's operating profit margin ratio. The student may continue the analysis by discussing how discontinued operations should impact the total assets and possibly the firm's financial leverage. The process (Figure 1) used in this paper could still be used to answer such a question. For example, the refined question would become which other components of the financial statement were affected by the discontinued operations?

Develop Hypotheses to Explain the Anomaly

The next step is to develop several hypotheses to explain the identified problem/question. For example, to explain the unusual variation in Starbucks' asset turnover ratio in 2013 (please refer to Figure 4), the following alternative hypotheses may be developed:

- **Hypothesis A**: The fall in Starbuck's asset turnover ratio in 2013 is due to sales. The asset turnover ratio could decline if the growth in sales was slower than the growth in assets.
- **Hypothesis B:** The fall in Starbuck's asset turnover ratio in 2013 is due to assets. The asset turnover ratio could decline if asset grew faster than sales did.
- **Hypothesis C:** The fall in Starbuck's asset turnover ratio in 2013 was due to both an increase in assets and a decrease in sales. (Anonymous student 1)

This step forces students to investigate how individual components of the firm's financial statements influence the variation of the ratio in question. Furthermore, as more complex hypotheses are developed, the students also need to evaluate how the firm's actions may cause a ratio to change.

Since this is an iterative step (refer to Figure 1), the first few hypotheses are closely related to the students' original question, and might seem trivial, as is the case of Starbucks mentioned above. However, the iterative process lets the student take small and focused steps to arrive at the cause of the unusual variation or covariation.

Develop Test to Investigate the Hypotheses

Step 3 is to design a test to decide which explanation is most viable. A typical test process is to perform new calculations, create new ratios, reexamine previous calculations, and create charts that shed light on which hypotheses are rejected or accepted. For example, based on the three hypotheses in the prior section, "Starbucks asset turnover ratio declined due to a change in the relative growth rates of sales and assets", the hypotheses are tested by calculating and plotting the growth rate of assets and sales (Anonymous student 1). Figure 5 shows the growth rates of asset and sales of Starbucks during 2011-2016.

In this step students need to ponder which possible set of tests will reveal the most about each hypothesis. Going through this process helps enhance problem-solving skills. For instance, based on the Starbucks example, although examining of the total debt ratio, the current ratio, and the net fixed asset ratio (all these ratios contain assets) would provide information concerning the movement of assets, investigating the growth rate of asset is more appropriate.

Figure 5. Starbucks (SBUX) Growth Rate for Sales and Assets

As a robustness check or an evaluation of the quality of evidence, it is advisable to develop several tests to examine one explanation. An example of a robustness

check that verifies sales growth did not contribute to the decline in Starbuck's asset turnover ratio is to examine the profit margin ratio, the operating profit margin ratio, and total sales. By performing robustness checks, students think about how the financial ratios and components of the financial statements are interrelated. Another important property of this step is that it reveals to the student calculation errors, mislabeled charts, and/or misconceptions concerning their understanding of financial statements.

Refine the Research Question

This step requires students to review the results of their prior findings to help them refine and revise their research question. For example, based on the prior tests, Starbucks assets grew at a faster rate than sales did in 2013, the operating profit margin ratio increased, and the profit margin ratio decreased, thus it is concluded that the fall in the asset turnover ratio is a result of an increase in assets. Based on these facts, the new refined research question is "which asset item(s) caused the asset turnover ratio to decline?" Once all the prior findings are reexamined and the research question has been refined, the next step is to repeat steps 2 and 3 until a conclusion is drawn.

Some students may have difficulties with these two steps: develop test to investigate the hypotheses and refine the research question. This typically occurs for four reasons: (1) they choose a question based on a preconceived answer, (2) their question is too broad, (3) the question is too easy and the students prematurely jump to the company's annual reports, (4) or the students' understanding of financial statements is not solid enough. To minimize questions that are based on preconceived answers, or that are too broad, instructors may reiterate the pitfalls of choosing such questions to students. To address the too-easy question problem, students can be required to investigate a problem in more depth by determining how a firm's actions affect other parts of the firm's financial statements. To address the problem that some students lack of a solid knowledge of financial statements, it is recommended that students begin their project after financial statements and ratio analysis is covered in class.

Develop New Hypotheses

Sometimes all the initial hypotheses are rejected, so the student needs to develop new hypotheses. This may occur because of the following reasons: (1) the original question is not focused; (2) the student does not fully understand how financial statements work; (3) there are calculation errors; or (4) there are multiple unrelated material changes influencing the anomaly. In the case where the question is not focused, the student needs to go back to step 1 to revise the research

question. For the other cases, the student should go back to step 2 to develop new hypotheses to explain the anomaly. Beware that there is a minimal chance that all the hypotheses are rejected because there are multiple unrelated non-material changes influencing the anomaly.

Reach a Conclusion

The final step is to draw a conclusion. The conclusion needs to relate the identified unusual variations or covariation in a firm's financial ratios to an action or an event in the firm. This step is preceded by a refined research question, hypothesis and tests that identify the line items on the financial statements. The final test is to search the company's annual report and/or the company's 10-K for a conclusion to their question. For example, by searching the Starbucks' annual report, Anonymous student 1 found that Starbucks' cash and cash equivalents increased by 4.6%, which accounted for 28% of Starbucks' total assets, and this increase was largely due to earmarked cash for the $2.7 billion litigation payment to Kraft Foods in the first quarter of 2014 (Starbucks Corporation, 2013). The Kraft Food litigation explains why the profit margin ratio fell in 2013 and then rebounded in 2014. The event also explains why cash levels declined in 2014 and the asset turnover ratio reverted to its normal trend. Similar to Anonymous student 1's experience, the proposed process and a search of the company's annual reports can help students to bridge the connection between the firm's financial statements and its business environment.

As demonstrated in the Starbucks' case, students utilize a systematic, logical, and reiterative approach to identify firm events that explain unusual variations and covariation that occur in several, seemly-unrelated ratios. By using the proposed approach, students would gain a deeper understanding and greater appreciation of how the financial ratios and financial statements interrelate. Often data may suggest there is more than one cause to the problem, as was the case with Starbucks, i.e. there are many factors that influence Starbucks' cash holding. In this case, a student can pick the one that has the most significant explanatory power, even though multiple factors may affect a single financial ratio.

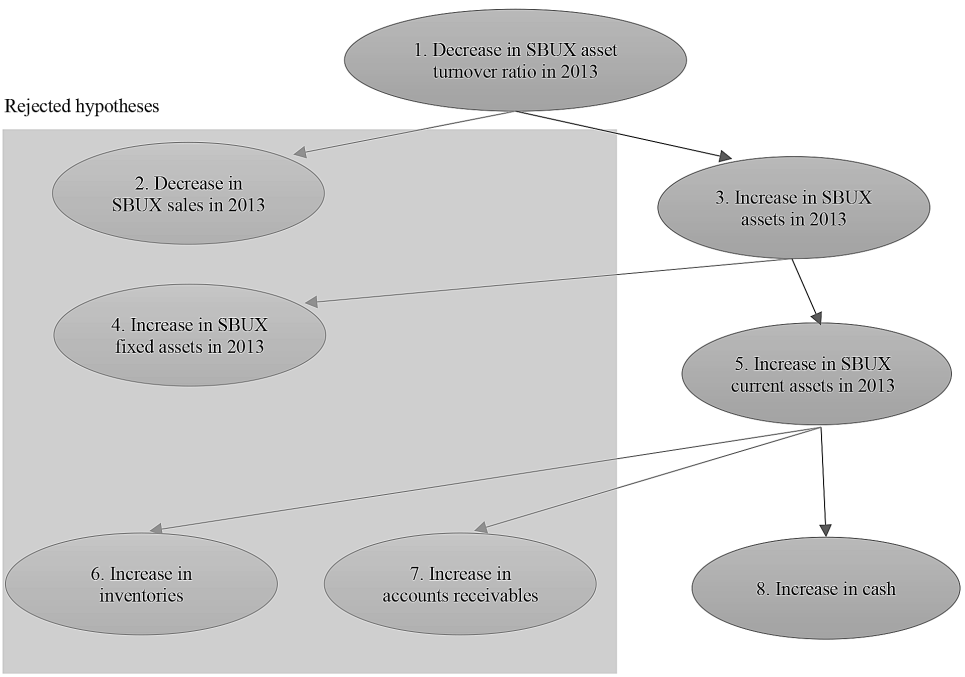
A potential problem with the conventional ratio analysis assignment is that the connection between the data (financial ratios) and the events of a firm may be weakly based. For instance, a typical student statement is "when comparing asset turnover, we can see that Allegiant is using their assets more efficiently than Southwest and JetBlue, which also gives Allegiant a higher percentage in the profit margin ratio." (Anonymous student 5) Here the weak connection is that Allegiant is more efficient with its assets, but the student may not understand how Allegiant's asset base or its business model influences its asset turnover ratio. Having students search for the cause of their question in the firms' annual reports helps students

to draw a connection between a firm's financials and the actions or events of the firm. Hence, students learn how to analyze data to make connections to real-world events, and vice versa, students better understand how real-world events influence firms' financials.

Conclusion

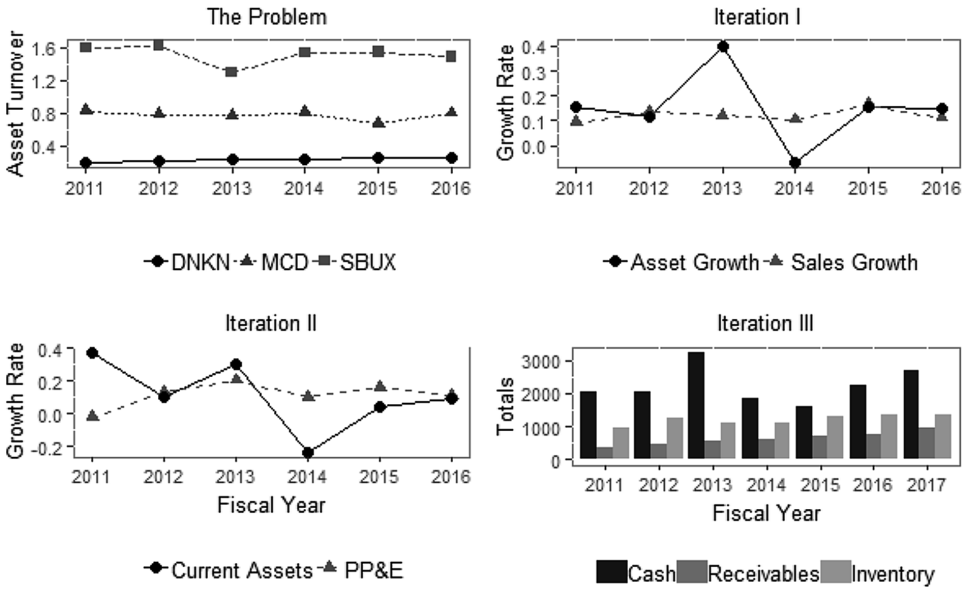
In closing, this paper proposes a financial ratio analysis project that aims to stimulate college students' interest in the business environment and operations, increase their critical thinking, analytical reasoning, and data analytic skills, improve written communication skills, and strengthen the ability to apply knowledge and skills learned in the classroom to real-world settings. This is done by applying an adapted scientific method to a ratio analysis project. The framework is an iterative process of (1) identifying a problem/question/anomaly; (2) developing several hypotheses to explain the anomaly; (3) developing tests to investigate and rule out alternative hypotheses, refining the research question based on the findings in step 3 or developing new hypotheses based on the findings in step 3; and (4) repeating steps 2 and 3 until a conclusion is drawn. Figure 6 illustrates this decision-tree process for Starbucks, used in Anonymous student 1's project, in which the top node is the original question/problem. The final node represents the actual event in the firm. The nodes in between represent the different hypotheses that were accepted or rejected.

Figure 6. An Example of Decision Tree



At the beginning of Anonymous student 1's investigation, the student did not know why Starbucks' asset turnover ratio decreased. By using the iterative process describe in this paper, the student started the investigation by recognizing an anomaly with Starbucks' asset turnover ratio, which led to the examination of the growth rates of total assets and total sales. From there the student compared the growth rates of fixed assets and current assets, and then examine the components of Starbucks' current assets (Figure 7). The last step to finding the answer to the student's original research question is done by searching the company's annual reports. The learning outcome of this iterative process is that students can apply critical thinking and problem solving skills to discover something they did not know, i.e. Starbucks' litigation payment to Kraft Foods. This process is similar to what financial analysts do: They use financial data to understand what is happening in the business environment.

Figure 7. An Example of Iterative Process



To our knowledge, this is the first study to utilize financial ratio analysis and a problem-solving framework as a tool to close the perception gap and skills gap between college students, educators, and employers. By bridging the divide, all the members involved will begin the journey towards mutually beneficial outcomes.

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Appendix

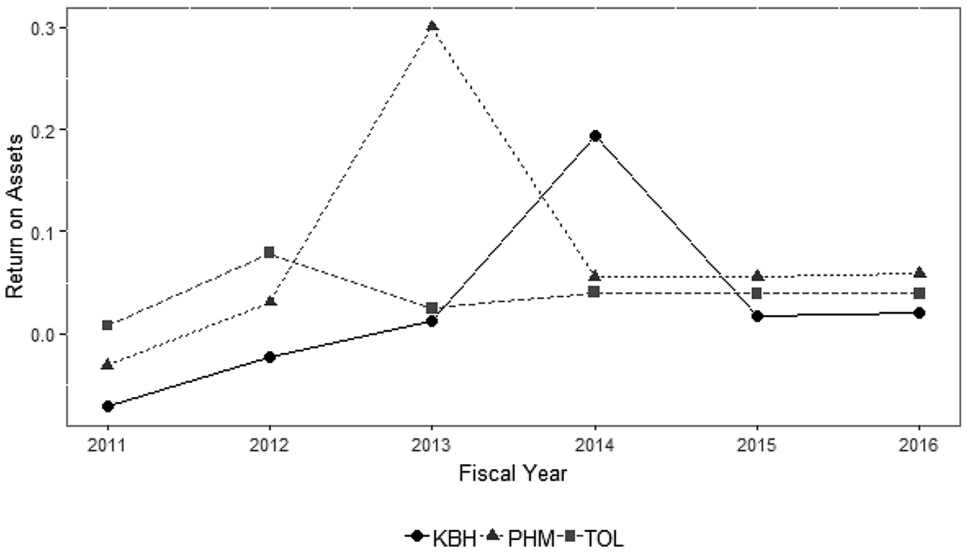
Sample Course Project Description

Sample Project 1—Term Paper

The objective of the project is to examine financial data, identify at least one financial ratio anomaly that shows unusual variations, develop hypotheses that might explain the anomaly, test the hypotheses to rule out false explanations, and provide a conclusion to the anomaly. Figure 1 illustrates the process flow and the four steps. The analysis begins with the examination of common-size financial statements and financial ratios, inspecting data visually with charts and graphs, and then lastly ends with researching annual reports and news articles to draw a conclusion.

Identifying a question, problem, or anomaly (step 1) requires analyzing visual representation (i.e. charts) of the financial ratios of a company and its competitors for unusual patterns. Figure A1 displays the returns on assets of KB Home (KBH), PulteGroup (PHM), and Toll Brothers (TOL). KBH's and PHM's return on assets show an unusual pattern in that the ratios first increased dramatically and then returned to their usual trend in 2013 and 2014, respectively (Anonymous student 6). KBH is used as the example for this project.

Figure A1. KB Home, PulteGroup, and Toll Brothers

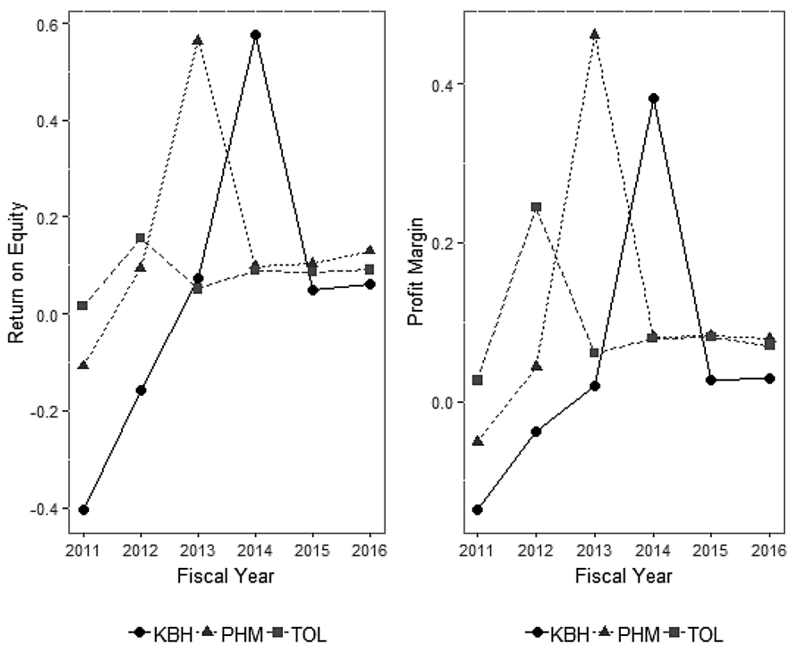


Once the research question is determined, the next step (step 2) is to develop several hypotheses that could explain the cause of the unusual pattern. For instance,

since the return on asset ratio is net income divided by total assets, either an increase in net income and/or a decrease in total assets could explain the increase in KBH's return on assets in 2014 (Anonymous student 6).

Step 3 is to design tests to determine which hypothesis is most valid, net income increasing or total asset decreasing. A typical test is to continue to examine charts to see if the results are consistent with the hypotheses. For example, checking KBH's return on equity and profit margin ratios can filter out the impact from total assets, as both ratios include net income and exclude total assets. Figure A2 shows both return on equity and profit margin ratios spiked in 2014, which is inconsistent with the hypothesis that the increase in return on assets is caused by a decrease in total assets. As a robustness check, it is important to develop several tests to examine one explanation and not to limit one's analysis to one or two ratios. For instance, looking at several other items, such as asset turnover ratio and total assets over time (not shown here for the sake of space saving), the KBH's total asset hypothesis can be ruled out.

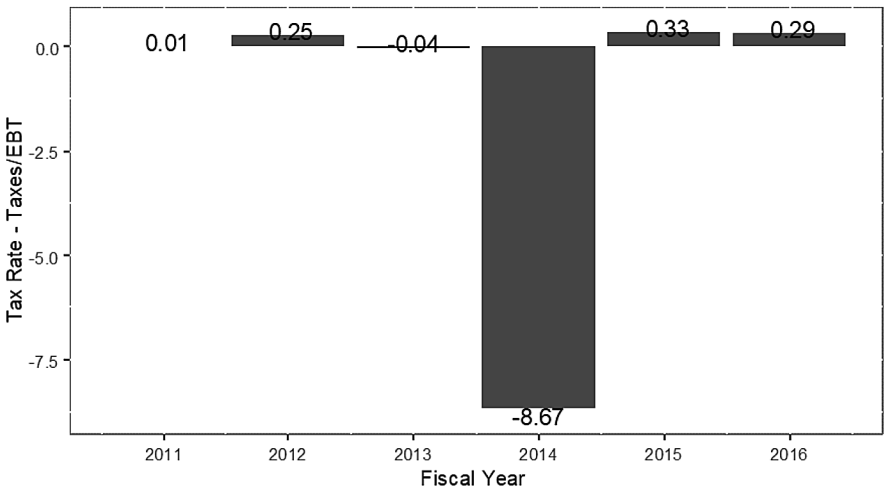
Figure A2. Return on Equity and Profit Margin



Refining the research question (step 3.a and 3.b) is to use the information gained from the prior tests to develop new tests and charts to further investigate the research question. For example, in the KBH's illustration, based on the results of the prior steps, the inference is that profits caused return on assets to increase. Leading to the refined research question: What caused the net income to increase, which in turn also caused the return on asset ratio to rise? Once the research question is

refined, steps 2 and 3 are repeated, until it is impossible to create more tests and the culprit for the anomaly is identified. For instance, after several iterations of steps 2 and 3, it is determined that the increase in profits is a result of taxes decreasing (Figure A3).

Figure A3. Tax Rate



After the financial culprit is identified, a conclusion needs to be drawn (step 4). To determine possible explanations for the anomaly, search the company's annual reports for the line item that is identified as the anomaly source and then draw a conclusion. In the case of KBH, the source of the anomaly has been identified as taxes. Researching KB Home's 10-K (2015) for the word "Income taxes" revealed the increase in return on assets is from the company's reversal of its deferred tax asset valuation allowance, which was a result of the 2008 recession (Anonymous student 6). In closing, by learning to read financial statements and financial ratios, you will gain insight on how the actions of the firm reveal themselves in the financial statements.

Sample Project 2 – Homework Assignment with Provided Charts

For this assignment, the student analyzes charts, financial statements, and annual reports that the instructor provides, to answer the cause of an anomaly that occurred with a firm. Starting off with the return on equity chart (charts and the starting chart determined by the instructor), determine the anomaly and the research question (see Figure 1). Then identify two hypotheses, from the research question, and test the hypotheses with the other supplied charts (step 2 and 3). After ruling out one of the hypotheses, develop another two hypotheses from the information gained from the first set of tests (steps 3.a and 3.b). Repeat steps 2

and 3 by investigating the new hypotheses with the provided charts. Continue the process until the line item on the financial statement that has caused the anomaly is determined. Once the line item on the financial statements is determined, search the set of annual reports that are provided to determine the actual cause of the anomaly.

For this assignment, the instructor can develop their own set of companies and anomalies or use the illustrated companies provided in this paper: Home Depot, Starbucks, or KB Homes.

A Classroom Experience to Introduce Behavioral Finance and the Endowment Effect

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Despite Nobel recognition and far-reaching implications, behavioral finance is only beginning to make its way into finance curricula. As finance professors, we can do better. In this paper, we present a successfully implemented, hands-on exercise based on Richard Thaler's work which uses the student's valuations of an item to demonstrate how they themselves behave in a predictably irrational way. This exercise can play a role in entry level finance classes to introduce behavioral finance and show some of the limitations of one of the fields most basic assumptions: rational choice theory. Additionally, this exercise can be used in a behavioral finance course to demonstrate the endowment effect.
Keywords: *Behavioral Finance, Endowment Effect, Disposition Effect*

Introduction

For his contribution to behavioral economics and behavioral finance, Richard H. Thaler was awarded the 2017 Nobel Memorial Prize in Economic Sciences. His contributions built on the work of two previous Nobel Laureates, Herbert Simon (in 1978) and Daniel Kahneman (in 2002), among others. Through the work of Thaler and his colleagues, we have learned that behavioral finance has broad and deep applications. Research has shown how psychological factors affect critical aspects of finance including activities such as spending, investing, trading, financial planning, and portfolio management. Despite Nobel recognition and far-reaching implications, behavioral finance is only beginning to make its way into finance curricula. As finance professors, we can do better. Obviously, the creation of in-depth behavioral finance courses is one way to address this, but we can also consider ways of introducing the basics of behavioral finance into introductory courses.

In this paper, we present a successfully implemented and hands-on exercise based on Thaler's work. This exercise has been designed for use in a higher-level behavioral finance course to demonstrate the endowment effect. In addition to its

application for higher-level courses, this exercise can also play a role in entry level finance classes to introduce behavioral finance and show some of the limitations of one of the fields most basic assumptions: rational choice theory.

At its core, behavioral finance holds that people behave in predictable ways that defy traditional finance theory. One manifestation of predictably irrational behavior is that owners of an item report a higher price to sell an item than they would to acquire the same item. This is known as the endowment effect, and we have designed an exercise to bring this to life in the classroom.

To perform this exercise in your class, divide your students into two groups. Endow half of the students with an item like a water glass, coffee mug, a pen, or even a chocolate bar. According to traditional finance theory, given the same information about the item, although their individual prices may differ, the averages of the two groups ought to be the similar. Instead, because of the small behavioral manipulation (namely endowment), one group (the owners) will predictably value the item at several times the price of the other group. This exercise clearly demonstrates how your student's perceptions of value follow predictably irrational patterns, the core tenet of behavioral finance.

Behavioral Finance and the Endowment Effect

According to the standard economic model, rational choice is the process of determining what options are available and then choosing the most preferred one (according to some consistent criterion). This process forms the foundation of the efficient market hypothesis. The efficient market hypothesis holds that market participants set stock prices rationally based on all knowable information. That is, at any given time, in a highly liquid market, stock prices are efficiently valued to reflect all available information.

However, the past six decades of psychological research on decision making has shown us that people do not always behave in a way that economists would describe as "rational". Behavioral finance recognizes the limitations of rational behavior and proposes that psychological factors affect financial behavior and investment decisions. Much of the work in this field centers on showing when and how behavioral biases influence financial decision making, resulting in market anomalies that do not conform to the efficient market hypothesis.

The endowment effect is one example of a behavioral bias that affects financial decision making. A simple explanation of endowment is that people value things more when they own it. In the stock market, this means that investors may irrationally over (or under) value an asset simply because they own it (or do not).

The endowment effect is largely driven by loss aversion. Once we own an item, forgoing it feels like a loss so higher value is attributed to the object itself (Kahneman, Knetsch, and Thaler, 1991). Carmon and Ariely (2000) provide a

strong example of the effect. They found that students' who already owned tickets to an NCAA final four tournament game had a hypothetical selling price that was 14 times higher than they would be willing to pay for the same tickets if they did not own them.

The endowment effect combined with loss aversion give rise to the disposition effect which describes the tendency of investors to sell assets that have increased in value, while keeping assets that have declined in value. Specifically, individuals tend to sell winning stocks and irrationally hold losing stocks. While investors acknowledge the loss in value, the difference between the paper loss and financial loss keep them from selling the stock. Because of the endowment effect, stocks that have lost value do not conform to the investor's beliefs about the stock price. This violates the efficient market hypothesis because stock prices no longer reflect all available information.

The idea of the disposition effect was first identified and named by Shefrin and Statman (1985). Odean (1998) provides a test of the disposition effect using data from a large US retail brokerage. They found that investors were roughly 50% more likely to sell a winning position than a losing position, despite the fact tax benefits. They also found that the tendency to sell winners and hold losers harmed investment returns. The disposition effect has been linked to stock pricing phenomena such as post-earnings announcement drift and stock-level momentum Barberis and Xiong (2009). In addition, evidence consistent with disposition effects have also been uncovered in the real estate market and in the exercise of executive stock options.

Endowment Effect In-Class Exercise

The exercise exemplifies the endowment effect by showing that the price that a student is willing to sell an item for is greater than what another student is willing to pay to acquire the same item. In other words, people's maximum willingness to pay (WTP) to acquire an object is lower than the minimum amount they are willing to accept (WTA) to give up that same object when they own it.

The experiment begins by randomly selecting half of the students to receive an item of some value. These items should be present for the experiment so you can directly hand them to the students. In terms of stimuli, we have successfully used coffee mugs and pint size "water" glasses. Suppose that the item you choose is a water glass.

The next stage of the experiment is to administer an anonymous survey of the students. Students who received a glass should be asked, "What is the minimum amount of money that you are willing to sell your glass for?" For the other students (who did not receive a glass) ask, "What is the most you are willing to pay to buy a glass?"

Tabulate and record the results, obtaining means for the willingness to pay for the non-owners and the willingness to accept for the current owners. Enlist the help of classroom volunteers. Have one volunteer collect the surveys of the owners and another volunteer collect the rest. The student-volunteers then read each price aloud to be immediately entered into a simple 2 column spreadsheet.

Take a moment for class discussion. Before proceeding with results or explanation, ask students to comment on what they observed. Without any prompting or prior discussion, students were able to identify that the average WTA was considerably higher than the average WTP.

Calculate the average, standard deviation, and t-statistics, confirming that the students' observations are correct.

These results can be used to highlight several points critical to behavioral finance. First, the results expose the empirical shortcomings of rational choice theory. Second, this exercise highlights that behavioral finance is not simply the idea that people are irrational, but that people behave in predictably irrational ways. It is not just that people act randomly, but that there are fundamental ways of processing information and making decisions that affect us all in similar ways. Next, this exercise illustrates the endowment effect; students who already owned the glass found it far more valuable (both economically and statistically) than those who did not receive the glass. Finally, the exercise can used to describe the disposition effect, which derives from the endowment effect, but is unique to financial instruments.

Class Results

The results of the in-class exercise are provided in Table 1. The same experiment was run in two classes. The table provides the results of the students' valuations of the glass based on whether they owned a glass (WTA) or not (WTP). Before calculating any summary statistics, students were able to identify the pattern. Namely, that students who had been endowed with the glass would assume greater worth more than the students who had not been assigned to own a glass, matching the pattern predicted by the endowment effect.

The summary statistics confirm the observed pattern. In each class, we calculated the average Buy (WTP) and Sell (WTA) prices. In each case, the difference was economically and statistically significant. In the Class 1, the WTA price was $4.23 was nearly 3 times larger than the WTP price at $12.42. In Class 2, the WTA price of $12.60 was more than 5 times higher than the WTP price. In Class 2, the difference is the result of several students who had not received the class who considered the glass to be worthless – saying they would not pay anything for it. The results clearly indicate that the students behave in a predictably irrational way.

Table 1. Student Results from In-Class Endowment Effect Exercise				
Price per Glass	Class 1		Class 2	
	Sell	Buy	Sell	Buy
	$15	$1	$10	$0
	$5	$2	$12	$3
	$5	$5	$20	$5
	$15	$5	$10	$5
	$20	$5	$15	$3
	$10	$2	$10	$3
	$10	$10	$4	$1
	$30	$5	$25	$0
	$15	$0	$12	$5
	$2	$5	$8	$1
	$10	$5		$5
	$12	$5		$0
		$5		$0
Average	$12.42	$4.23	$12.60	$2.38
Sell - Buy		$8.19		$10.22
t-stat		0.003		0.0004

Even if the students were rational actors, we would not expect them to all agree to the same price of the glass. Of course, it could be possible that one could have a greater affinity or need for a "water" glass. That said, the random assignment of student to ownership condition would negate any idiosyncratic differences in glass valuation.

The results clearly indicate that the act of ownership causes systematic differences in valuation to exist. Students (like the rest of us) behave in a predictably irrational way. In both classes where the experiment was run, students that had been assigned to own a glass provided higher valuations than the students who were not.

Modifications for Success

Past research has determined the efficacy of this experiment even when there is no cause for attachment, and even if the item was only obtained minutes earlier (Horowitz and McConnell, 2002). However, several theories suggest modifications to enhance the endowment effect—providing the maximum opportunities to achieve a successful experiment in the classroom. Possible modifications include allowing the students to touch the item, personalization, gift wrapping the item,

making the item feel like a win, and increasing the duration of ownership by letting the students take the item home.

Touch

Although it is theoretically possible for this experiment to work without the students receiving an item, research has shown that when subjects touch an item, they value it more (Peck and Shu, 2009). To enhance the results, use a physical item rather than an experience or hypothetical good.

Personalization

Attachment theory suggests that if a student incorporates an item into their self-concept, then it becomes part of their identity. Once an attachment has formed, the potential loss of the item is perceived as a threat to the self (Beggan, 1992). This deeper sense of ownership and sense of loss should serve to further increase the valuation provided by the assigned owners.

To do this in the classroom, create an item that a student can easily assimilate into their self-identity. For example, rather than using a blank mug, use a university mug. This clearly supports the student's current identity as a student at the university.

Our experiment took this one step further. To create our goods, we used a simple customization webpage to create mugs and glasses with a relevant image and the words "Behavioral Finance" above and "Stillman School of Business" below the image. (Examples of customization webpages include discountmugs.com and customink.com.) As a current student in this class, this related directly to them.

Flattery

The effect may also be deepened by encouraging students to see the item in a flattering way. Rather than handing out the mugs at random, give out the item as reward. For example, we started class by thanking the students for attending and handed each student a "lottery ticket" for attendance. This encourages students to see the item as earned, a positive self-association.

Effort

Prior research has also shown that there is a link between effort and valuation. In a novel experiment by Norton, Mochon, and Ariely (2012) participants were

assigned to either construct a piece of Ikea furniture or not. Both groups were then asked to bid on the assembled piece. Those who had just assembled the furniture provided higher valuations than those who had not, demonstrating a link between effort and endowment. To simulate effort, we wrapped the item like a gift in tissue paper and ribbon. Because unwrapping the glass prior to evaluation would require extra effort by the owners, we predict that this would magnify the WTA for the ownership group.

Time

While the endowment effect has been observed after mere moments of owning the item, the endowment effect grows stronger over time. This is because a longer duration of ownership allows the students to more fully incorporate the item into their self-identity (Strahilevitz and Lowenstein, 1988). To enhance the results, we gave out the mugs/glasses in one class and then waited until the following class to conduct the experiment.

Summary of the Steps

1. Preparation
   - Buy an item.
   - Gift wrap the item.
   - Prepare 2 versions of the one question survey.

1. Class period 1
   - Hand out tickets.
   - Conduct lottery.
   - Give out "prizes".

1. Class period 2
   - Hand out survey.
   - Record Results.
   - Discuss.

Assurance of Learning

We found the experiment was easily understood and remembered by students. A quiz later in the semester asked, "Describe the glass experiment and what it taught us." All of students were able to describe the experiment, implications, the endowment effect, and the disposition effect.

Anecdotally, students frequently refer to the class experiment in discussions about other topics. Most recently, a guest speaker came to visit class and after describing the endowment effect in alternative terms and language, students spontaneously mentioned that this was the endowment effect, and they were quick to answer the speaker's questions. One student described the experiment in detail to the speaker.

Popularity

Students are enthusiastic about this experiment. Halfway through the semester, we conducted a "start, stop, continue" exercise. Students overwhelming asked for more experiments like this that could be incorporated into other topics. In addition, they come into class relaying stories of describing the exercise to their parents and friends. They want to know more about prior experimental stimuli. And, they are always excited to offer input for next year's experimental item (mugs, glasses, string backpacks, tote bags, pens, hats, and shirts all seem to be popular choices) and what should be printed on it.

Conclusion

This high impact, hands-on, class exercise uses the student's valuations of an item to demonstrate how they themselves behave in a predictably irrational way. The exercise described in this paper provides empirical evidence highlighting the shortcomings of rational choice theory. Our experiences and student feedback evince that this experiment is a powerful way to introduce behavioral finance to a general finance class by highlighting a Nobel worthy effect: endowment.

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Finance in the Cinema: A Survey of Professor Ratings of Movies for Finance Students*

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This paper reports and discusses the results of survey of members of the Financial Education Association regarding their ratings of 30 movies for finance students. The survey results also include additional recommended movies and respondents' comments regarding whether and how they utilize movies and excerpts in their finance classes.

Teaching finance and other business disciplines poses the continuous challenge of linking the wide variety of theories to the "real world" and providing students with an organizational frame of reference that helps them understand and appreciate the relevance and context within which the subject matter applies. It is also challenging to include the human dimensions of our disciplines. It is ultimately men and women who practice finance, people who are motivated by egos, desire for career success, lust, money, job security, excitement, competition, greed, and power.

We have found that movies and short excerpts from movies (film clips) can be used to bring finance and other business subjects alive in ways that that are difficult to achieve in traditional lectures and assignments. Used properly, movies or film clips can complement traditional pedagogical methods by helping student place learning in a broader and richer context.

Movies can help make abstract concepts, such as agency theory, corporate culture, ethical dilemmas, and corporate governance, more compelling and real. It is difficult to imagine that young undergraduate students, with little or no business experience, especially at the managerial level, can appreciate the relevance and

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**The results of our survey were presented at the Academy of Economics and Finance 55th Annual Conference in February, 2018. We greatly appreciate the comments of the participants who attended our session. Our original paper appeared in the conference proceedings (Kester and Michael, 2018).*

application of these and other finance topics outside of their organizational context. In his article discussing the use of the movie *Wall Street* in the classroom, Dyl (1991) described movies as "live cases."

Serey (1992), who uses the movie *Dead Poet's Society* to teach management and organizational behavior, points out that students prefer visualization over passive learning techniques and that the characters and plots dramatized in movies help students gain a deeper understanding of topics and their applications and relevance to the real world (at least as depicted in movies).

The list of Hollywood movies with finance and business themes has grown over the years. Some are well-known and award winning. Others are less well known, but nonetheless valuable in terms of the insights and lessons they provide. Some chronicle corporate takeovers, bankruptcies, or the global financial crisis; others focus upon the unethical and fraudulent behavior of individuals. Some are fictional and others are documentaries.

There is also a growing literature on the use of movies in the finance classroom. This includes articles by Dyl [1991], Beldon [1992], Chan, Weber and Johnson [1995], Graham and Kocher [1995] Nofsinger [1995], Peterson and Philpot [1997], Fairchild and Grayson [2004], Philpot and Ogelsby [2005], Hatfield and Buchko [2008], Kester, Cooper, Dean, Gianiodis, and Goldsby [2012], and Kester [2013], Goebel, Athavale and Weber (2016), Assad (2016), and Kester (2017).

In this paper, we develop an annotated bibliography of 30 movies with finance themes and report the results of a survey of members of the Financial Education Association regarding their ratings of the movies. Our survey also solicited recommendations regarding other movies or excerpts and included questions regarding whether and how respondents used movies or films in their classrooms.

Our results should be of interest to readers who may be considering the use of movies or excerpts in their finance classes, either for in-class viewing or assigned for student viewing outside of class. At a minimum, our results should be of interest to readers who are looking a good movie to watch at home.

The Movies

The 30 movies in our survey include 26 movies discussed by Goebel et al. (2016). Below is a list and brief summaries. They are listed in alphabetical order.

1. *Barbarians at the Gate* (1993, 107 minutes). Based on the bestselling book by Burrough and Helyar (1990), this movie chronicles the history of RJR Nabisco from its beginning in 1875 as RJ Reynolds Tobacco Company to its numerous food company acquisitions in the 1970s and 1980s to the well-publicized takeover battle and leveraged buyout of the company in 1988. The use of *Barbarians at the Gate* to discuss issues related to valuation, ethics, agency theory, leveraged buyouts and social responsibility is

discussed by Nofsinger (1995), Peterson and Philpot (1997), Kester et al. (2012), and Goebel et al. (2016). Kester (2008) discusses how the movie can be combined with Burrough's and Helyar's (1990) book, a Harvard Business School case that focuses on the valuations of RJR Nabisco, and articles in the popular press to provide students with a multidisciplinary perspective into the one of the largest leveraged buyouts in history.

2. *Boiler Room* (2000, 120 minutes). This movie, discussed by Kester et al. (2012) and Goebel et al. (2016), focuses upon the world of aggressive and unethical stock brokerage firms. It tells the story of a young stockbroker who learns how to call prospects and use aggressive tactics to generate clients. He learns that the firm's business is based on a "pump and dump" scam.
3. *Brewster's Millions* (1985, 100 minutes). Based on a novel by George Barr McCutcheon (1902), this movie tells the story of a man whose uncles dies and leaves him his substantial estate, but with various conditions. He can either take $1 million or spend $30 million over 30 days to receive $300 million. There are various stipulations on how he can spend the $30 million, including a limit on the amount he can donate to charity. He cannot tell anyone about the arrangement. See Goebel et al. (2016) for a description and discussion questions related to the 1945 version of the film which has been presented in seven film adaptations.
4. *The Bank* (2001, 106 minutes). An Australian thriller, *The Bank* tells the story of a mathematician who devises a method to predict movements in the stock market. He joins a bank that uses his computer program to make a large trade, but with devastating results. See Goebel et al. (2016).
5. *The Big Short* (2015, 130 minutes). This Academy Award-winning movie, based on the best-selling book of the same title by author Michael Lewis (2010), consists of three storylines about investors who correctly predicted and profited substantially from the collapse of the housing market in 2008.
6. *Company Men* (2010, 113 minutes). This movie tells the story of three executives who are laid off and their struggles with unemployment. See Goebel et al. (2016) provides several useful discussion questions.
7. *The Corporation* (2003, 145 minutes). This Canadian documentary, written by Joel Bakan, a University of British Columbia law professor, explores the development of the modern corporation as a separate legal entity. See Goebel et al. (2016).
8. *Enron: The Smartest Guys in the Room* (2005, 110 minutes). This academy award-nominated documentary based on the best-selling book by McLean and Elkind (2003), chronicles the demise of Enron Corporation. Its use in the classroom is discussed by Hatfield and Buchko (2008), Kester et al. (2012), and Goebel et al. (2016).

9. *Glengarry Glen Ross* (1992, 100 minutes). This critically-acclaimed movie, described by Kester et al. (2012) and Goebel et al. (2016), focuses upon the lives of four real estate agents over two days as they respond to the company's attempts to motivate sales by announcing that all but two of the salesmen will be fired within a week. The movie is based on the Pulitzer Prize and Tony Award-winning play by David Mamet.
10. *Heist: Who Stole the American Dream* (2011, 90 minutes). This is a documentary that explores the causes of the global financial crisis, including deregulation and free trade agreements.
11. *Inside Job* (2010, 109 minutes). This Academy Award-winning documentary chronicles how changes in the regulatory environment and banking practices led to the bubble in housing prices, the bankruptcy of Lehman Brothers, and near-collapse of the financial system. It is divided into five parts: I. How We Got Here, II. The Bubble (2001-2007), III. The Crisis, IV. Accountability, and V. Where We Are Now. Use of the movie in the classroom and related discussion questions is discussed by Goebel et al. (2016) and Kester (2017).
12. *The International* (2009, 118 minutes). This international thriller follows an Interpol agent and American district attorney who investigate a Luxembourg bank's funding of arms trading, money laundering, and terrorism. See Goebel et al. (2016).
13. *I.O.U.S.A.* (2008, 85 minutes). This film, described by Goebel et al. (2016), is a documentary that focuses on the U.S. national debt. The film follows David Walker, the former U.S. Comptroller General, as he travels around the country to let people know ("Fiscal Wake-Up Tour") about the problems associated with increasing deficits.
14. *It's a Wonderful Life* (1946, 135 minutes). The use of this popular and well-known holiday favorite in the finance classroom is discussed by Philpot and Ogelsby (2005) and Goebel et al. (2016). The movie tells the story of an angel sent to show a despondent building and loan company owner what life would have been like if he had never been born.
15. *Margin Call* (2011, 109 minutes). This Academy Award-nominated movie focuses on a 36-hour period at a large fictional investment bank in the early stage of the 2008 financial meltdown. See Goebel et al. (2016) for discussion questions related to *Margin Call*.
16. *Other People's Money* (1991, 101 minutes). Originally an off-Broadway comedy by Jerry Steiner, this movie portrays the hostile takeover of New England Wire & Cable by corporate raider Garfield Industries. The story culminates in a proxy fight with impassioned and memorable speeches at the company's annual shareholders' meeting. It is a story that combines colorful personalities, greed, comedy and romance. The use of the movie

as a case study of corporate restructuring, ethics, social responsibility and corporate takeovers is discussed by Chan et al. (1995), Graham and Kocher (1995), Kester et al. (2012), and Goebel et al. (2016).

17. *The Pursuit of Happyness* (2006, 117 minutes). This Academy Award-nominated biographical drama tells the story of an out-of-work and homeless salesman who becomes an unpaid intern and subsequently a highly successful stockbroker with Dean Witter Reynolds. See Goebel et al. (2016).
18. *The Queen of Versailles* (2012, 100 minutes). This documentary focuses upon the owners of Westgate Resorts as they build their private mansion, one of the largest and most expensive homes in the United States, and the challenges and crisis they face from the collapse of housing prices and 2008 financial crisis.
19. *Repo Men* (2010, 111 minutes). This science fiction film, set in the future, portrays an organization that repossessing artificial organs from recipients who have defaulted in their payments. See Goebel et al. (2016) for discussion questions.
20. *Rogue Trader* (1999, 102 minutes). This movie, discussed by Kester et al. (2012) and Goebel et al. (2016) is a dramatization of how futures trader Nick Leeson brought down 200-year old Barings Bank, the worlds' first merchant bank. The movie is based on Leeson and Whitley"s (1996) book, *Rogue Trader: How I Brought Down Barings Bank and Shook the Financial World*.
21. *Rollover* (1981, 118 minutes). This political thriller tells the story of a former film star who inherits her husband's company after he is murdered. Teaming up with a banker who helps her secure financing in Saudi Arabia, they discover a plot by an Arab company to destabilize the West. See Goebel et al. (2016).
22. *The Secret of My Success* (1987, 111 minutes). A recent college graduate, who travels to New York for a finance job, learns that his job has been eliminated. He finds a job working in the mailroom for a company run by his uncle. He poses as an executive for the company and eventually ends up as CEO. See Goebel et al. (2016).
23. *There Will Be Blood* (2007, 158 minutes). This Academy-award winning movie follows the life of an oilman in his ruthless quest for wealth during Southern California's oil boom. See Goebel et al. (2016).
24. *Too Big to Fail* (2011, 98 minutes). Based on Andrew Ross Sorkin's (2009) multiple-award winning book of the same title, this movie dramatizes the events leading to the bankruptcy of Lehman Brothers, the acquisition of Merrill Lynch by Bank of America, the bailout of AIG, the creation of the Troubled Asset Relief Program (TARP), and the U.S. Government capital

injections into the largest banks. The movie focuses on the decisions of U.S. Secretary of the Treasury Henry Paulson. The use of *Too Big to Fail* in the classroom along with discussion questions to help students understand the events leading to the global financial crisis is discussed by Goebel et al. (2016) and Kester (2017).

25. *Trading Places* (1983, 116 minutes). This well-known movie tells the story of a homeless street hustler and privileged commodities broker who unwittingly became part of wager between two brothers, owners of a commodities brokerage firm, who debate whether genetics or environment is the primary factor affecting human success. They conduct an experiment by switching the lives of the privileged broker and the street hustler. See Goebel et al. (2016) for related discussion questions.
26. *Trillion Dollar Bet* (2000, 48 minutes). This documentary chronicles the rise and fall of the hedge fund Long Term Capital Management founded by Nobel Laureate Myron Scholes and others. Its use in the classroom is discussed by Fairchild and Grayson (2004).
27. *Wall Street* (1987, 125 minutes). This well-known Academy Award-winning movie is the story of a young ambitious stockbroker who divulges inside information to unscrupulous corporate raider, the infamous Gorden Gekko, who has become synonymous with the phrase "greed is good." The use of *Wall Street* as a springboard for classroom discussion of insider trading and ethics is discussed by Dyl (1991), Beldon (1992), Kester et al. (2012), and Goebel et al. (2016).
28. *Wall Street: Money Never Sleeps* (2010, 136 minutes). This sequel to the original movie portrays Gordon Gekko after he leaves prison for insider trading. He tries to establish a relationship with his daughter, but ends up back to his old tricks. See Goebel et al. (2016).
29. *The Wolf of Wall Street* (2013, 179 minutes). Based on the 2007 memoir of Jordan Belfort, this Academy Award-nominated movie chronicles his rise on Wall Street to founding his own firm, Stratton Oakmont, and defrauding wealthy clients out of millions while at the same time living a wild life of parties, sex and drugs. See Goebel et al. (2016) for discussion questions.
30. *Working Girl* (1988, 116 minutes). A smart secretary, Tess, who works in mergers and acquisitions department of an investment bank and has been taking business courses at night, makes an excellent suggestion regarding a merger for one of the firm's clients to her boss, who successfully implements it without giving due credit to Tess. See Goebel et al. (2016).

Survey of Faculty Ratings

To obtain faculty ratings of these 30 movies, we used email and SurveyMonkey to survey 334 members of the Financial Education Association. We asked the respondents to rate each book using a four-point scale of 1 = not recommended, 2 = weakly recommended, 3 = recommended, and 4 = highly recommended. Respondents who had not seen a particular movie were asked to indicate 0 = no opinion. Our list of movies is certainly not all-inclusive. Therefore, our questionnaire also solicited other recommended movies from the survey respondents.

The questionnaire did not ask respondents to identify themselves or their universities. It was emailed on June 1, 2017, and we received 41 responses initially. Complete second and third emailings were subsequently conducted to improve the response rate. In total, we received 80 responses, an overall response rate of 24 percent.

Our cover letter email accompanying the questionnaire is shown in the Appendix A.

Results

Table 1 contains the results of our survey, including the weighted-average mean rating of each movie along with the number of respondents who rated each movie using the scale of 1 to 4. The 30 movies listed in Table 1 are ranked according to the mean rating.

The top ranked movie was—the envelope please—*The Big Short*, which was followed by *Trillion Dollar Bet*, *Too Big to Fail*, *Barbarians at the Gate*, and *Enron: The Smartest Guys in the Room*. The movie with the lowest rating among our list of 30 movies was *Working Girl*.

Not surprisingly, movies that were popular with audiences and received high ratings from critics were not necessarily rated highly for the financial education merit by the respondents of our survey. For example, The *Wolf of Wall Street* and *There Will Be Blood* had low ratings in our survey but received high ratings by critics (77 percent and 91 percent, respectively, by Rotten Tomatoes, a website that aggregates reviews from film critics). *Working Girl*, ranked last by our respondents, received a Rotten Tomatoes rating of 84 percent. Conversely, *Rogue Trader*, that ranked eighth by the respondents of our survey for its education merit, received a Rotten Tomatoes rating of only 30 percent.

When ranked according to the number of respondents who rated the movies, which may reflect how widely-viewed the movies have been by the respondents, the most frequently rated movie was It's a *Wonderful Life*, followed by *Trading Places* and *Wall Street*. This result is not surprising given the popularly of these classics.

Table 1. Survey Results:
Faculty Ratings of Recommended Movies in Finance
Ranked According to Mean Rating*

Movie	Number of Ratings	Percentage of Responses Within Each Rating** 1	2	3	4	Mean***
The Big Short	61	1.6%	3.3%	29.5%	65.6%	3.59
Trillion Dollar Bet	28	0.0%	7.1%	42.9%	50.0%	3.43
Too Big to Fail	49	2.0%	16.3%	36.7%	44.9%	3.24
Barbarians at the Gate	48	2.1%	16.7%	47.9%	33.3%	3.13
Enron: The Smartest Guys in the Room	54	1.9%	20.4%	42.6%	35.2%	3.11
Trading Places	63	9.5%	19.0%	31.7%	39.7%	3.02
Inside Job	28	7.1%	17.9%	42.9%	32.1%	3.00
Rogue Trader	25	4.0%	28.0%	32.0%	36.0%	3.00
Wall Street	63	11.1%	15.9%	36.5%	36.5%	2.98
Other People's Money	36	16.7%	19.4%	19.4%	44.4%	2.92
The Corporation	10	10.0%	10.0%	60.0%	20.0%	2.90
Margin Call	35	5.7%	31.4%	37.1%	25.7%	2.83
The International	8	12.5%	25.0%	37.5%	25.0%	2.75
I.O.U.S.A.	9	22.2%	11.1%	44.4%	22.2%	2.67
It's a Wonderful Life	66	12.1%	37.9%	24.2%	25.8%	2.64
The Pursuit of Happyness	31	16.1%	32.3%	29.0%	22.6%	2.58
Heist: Who Stole the American Dream	9	22.2%	11.1%	55.6%	11.1%	2.56
Boiler Room	34	8.8%	44.1%	32.4%	14.7%	2.53
The Bank	4	0.0%	50.0%	50.0%	0.0%	2.50
Glengarry Glen Ross	30	23.3%	40.0%	20.0%	16.7%	2.30
Company Men	10	20.0%	30.0%	50.0%	0.0%	2.30
Wall Street: Money Never Sleeps	35	20.0%	42.9%	28.6%	8.6%	2.26
The Queen of Versailles	9	22.2%	33.3%	44.4%	0.0%	2.22
The Wolf of Wall Street	54	33.3%	29.6%	25.9%	11.1%	2.15
Brewster's Millions	26	42.3%	26.9%	19.2%	11.5%	2.00
There Will Be Blood	21	28.6%	52.4%	9.5%	9.5%	2.00
Repo Men	14	42.9%	14.3%	42.9%	0.0%	2.00
The Secret of my Success	26	23.1%	57.7%	19.2%	0.0%	1.96
Rollover	9	33.3%	44.4%	22.2%	0.0%	1.89
Working Girl	38	36.8%	42.1%	21.1%	0.0%	1.84

* Respondents were asked to rate each movie on a scale of 1 to 4, where 1 = not recommended, 2 = mildly recommended, 3 = recommended and 4 = highly recommended. Respondents who had not seen the movie or chose not to rate it were asked to enter 0 = no opinion

** The percentage of responses within each rating are calculated based upon the ratings of those respondents who rated the movies with a rating of 1 to 4.

*** The mean ratings are calculated by multiplying the percentage of responses in each rating category with values of 1 through 4.

In addition to rating the 30 movies, respondents were given an opportunity to provide comments about each movie. The results, that are listed in the Table 2, are

Table 2. Survey Results:
Respondents' Comments About 30 Movies

1. *Barbarians at the Gate*

   Dated, but a good account of one of the deals that opened our eyes to the possibilities that mega-deals represented. Plus, KKR is still around and still a major player.

   A good educational piece on management leveraged buyout.

   Use with HBS case.

   I assigned this movie within a general finance course (e.g., required for accounting, finance, marketing, and management majors). Students gave this high ratings.

   Another good historical piece that explains the LBO process as well as corporate governance. The comedy can be a little distracting, and the abundance of profanity in the film is also problematic.

   Good story.

2. *Boiler Room*

   Good but overdone -- makes students think all finance is like this.

   First two-thirds are good. Falls apart at the end.

3. *Brewster's Millions*

   Would this have any academic financial content?

4. *The Bank*

   I assigned this movie once in a general undergraduate finance course servicing a variety of business and nonbusiness majors.

5. *The Big Short*

   I especially like the "Jenga" clip.

   Don't care too much about Hollywood sensationalism but it's a good educational piece about how much the financial system can go wrong. The book is better though. Overdone but interesting....have students research the events leading up to the movie...high interest rates and failures of savings and loans....moral hazards of creating government secondary mortgage market .... congressional finance committee under Barney Franks directing banks to make subprime loans and Fannie Mae to buy them....bank redlining regulations....housing becomes an investment rather than consumption....Fed leaving interest rates too low for too long stimulating the housing bubble...etc.

   Anything that Michael Lewis writes going to film is worth a look.

   Sex scene makes it impossible to use in class under school rules. GP version needed for class usage.

   Excellent movie to show in finance classes! I've shown it two semesters in a row and students really appreciated it!

   The best, brief descriptions of some technical elements.

   I assigned this movie in a recent undergraduate finance class, consisting solely of majors. This was in addition to a PBS movie via our university library.

   The book was much better.

   Superb. Educational.

Table 2. (*Continued*)

6. *Company Men*

   I have not seen this movie. However, I believe that it could help frame the shareholder vs. stakeholder debate. And it may also be useful in a personal finance class to discuss work/life balance and living within one's means.

7. *The Corporation*

   Some of the clips can help spur a discussion on the shareholder theory of the firm.

   Too one-sided for a classroom?

   This movie was very well received in an undergraduate class consisting of finance majors (seniors), particularly those who had secured internships the previous year at large firms.

8. *Enron: The Smartest Guys in the Room*

   Good for discussions on corporate culture.

   Is Enron common or does it represent an exception? Sarbanes Oxley likely has cost more in compliance than the savings to society – a good discussion question.

   Proof that intelligence and ethics don't necessarily go hand in hand.

   This is recommended, rather than highly recommend, but I didn't find good parts to use. I would not want to take a class period to view the movie. I have used this as an extracurricular event.

   I assigned this movie within a general finance course (e.g., required for accounting, finance, marketing, and management majors). Students gave this high ratings.

9. *Glengarry Glen Ross*

   I used to show the "motivational" scene at the beginning of the film to acquaint students with the pressures of having a "real" job. Unfortunately, there are several words used that are not politically correct and so younger students have a hard time getting past that point.

   Another great movie, more to do with sales than finance.

   A very slow and boring film to address a simple point of ethics.

   A good look at how intense the pressure can be in the sales field.

   Saw it but thought it was a little slow. But, that was also before I was a finance professor.

   This is more for organizational behavior than finance.

   Lots of profanity, if I remember correctly. Maybe my memory is wrong.

   This is both educational about this industry and thoughtful.

10. *Heist: Who Stole the American Dream*

    No comments.

11. *Inside Job*

    There are good info-graphics to explain complicated topics.

    Excellent.

    Haven't used this, but it looks good.

12. *The International*

    No comments.

Table 2. (*Continued*)

13. *I.O.U.S.A.*

    Note the date. The problem was about to get worse.

14. *It's a Wonderful Life*

    There's a recent article in The Atlantic that touches on the moralities of banking.

    I've used this effectively in a commercial banking class to show the popular media portrayal of bankers and the incomplete understanding of risk that many in society have (with respect to the savings and loan component).

    It's just a great movie, not strongly tied to finance.

    Are there any movies showing business people in a positive light?

    A classic.

    Saw a long time ago; do not remember the relevance for finance.

    Good to show why MBS are important.

    I assigned this movie to students in a seminar servicing a variety of majors. It was well-received.

    This one is a good piece about deposit institution regulation, operations and history. The bank run scene in particular is a good illustration that leads into the reason for the FDIC. The film does have several inaccuracies (e.g., George will NOT go to jail over the lost currency) and a slightly anti-capitalist slant. These can also be pointed out to students. The film can be separately used for ethics.

    Excerpts only. Two out of 30 have seen. Great movie. Money and Banking better fit.

    Well done movie. Emotionally satisfying. But the financial knowledge is high school level.

15. *Margin Call*

    Really bad from an entertainment standpoint and not real finance (at least not that I noticed. It was hard to watch).

    I assigned this movie in a required MBA finance class servicing all MBA students. It was well received.

16. *Other People's Money*

    I have used this film in my MBA Corporate Finance course for at least 15 years now, and in my advanced finance course as well. I use the chalkboard scene to illustrate how valuation works, and I use the two addresses to the voting shareholders to highlight that both speakers have valid points to make. I use at least those two scenes, but I have also used the whole film.

    The movie not only tells the detailed story of a corporate takeover but also presents the dilemma of making a profit versus taking care of company's employees.

    Two articles were published in FPE on how we can use the movie in the classroom.

    It is a good opportunity to compare the ugly side (the movie) to the good side of driving inefficiencies out of the market. What is wrong with resources seeking the most productive use? Does the film focus on a common situation or a rare one?

Table 2. (*Continued*)

I use clips from this. Great for valuation and goals of the corporation (maximizing shareholders wealth).

Clicheish.

This one is a very good illustration of divergence of manager and owner interests, as well as the simple need for businesses to remain competitive (and the corporate control market's enforcement of same). Again, the profanity and sexual references are problematic for classrooms, and the development of the romantic relationship between the lead characters is distracting.

Based on a true story and one that resonates with other stories.

17. *The Pursuit of Happyness*

    The big takeaway is that every moment is an interview. The Will Smith character got his break because his co-worker's boyfriend noticed his work ethic.

18. *The Queen of Versailles*

    No comments.

19. *Repo Men*

    Cheap take-off on the original cult classic "Repo Man"

    Does this have any academic financial content?

20. *Rogue Trader*

    Good for discussions on the social situation and ethics.

    I have used this several times. I ask students to research other rogue traders.

    Good story. Educational.

21. *Rollover*

    No comments.

22. *The Secret of My Success*

    A good movie to illustrate career pitfalls and choices that a young professional has to make, often on short notice.

    Funny but realistic today?

    Saw in 1987 before my interest in finance, so again I do not remember the relevance.

23. *There Will Be Blood*

    This movie was identified by my students from the oil industry as a huge reference for them, something they have watched over and over.

24. *Too Big to Fail*

    There are so many other good documentaries on the financial crisis.

    I have used this in my introductory finance class.

    I'd still read the book, though.

    I assigned this movie once in a general, introductory finance class at the MBA level. It was well-received.

25. *Trading Places*

    I remember seeing this in class as a student. We watched the derivatives trading scene in an investments course.

Table 2. (*Continued*)

I have used this in class to introduce trading terminology and show what a short squeeze can do. I can't use the entire movie, and I must be careful these days because students are much less tolerant of foul language, even in a comedic context.

Great shots of the futures pit.

Sadly, this is the only one I've even seen so far (I need to get out more!), but I was teaching investments when it came out, and every semester when we got to futures contracts the class perked up and started asking a bunch of questions pertaining to the movie.

End of the movie has a great example of short selling.

Only the last 1/3 of the film is financial. There is a good illustration of the trading pits (now almost obsolete) and the multiplying effects of margin. One inaccuracy is the large price movement in FCOJ, given that there are usually daily limits in these markets. The profanity and brief nudity are also problematic for the classroom.

Valid point taken to an extreme.

26. *Trillion Dollar Bet*

I use this one to introduce not only the LTCM incident, but to get students ready to study the Black-Scholes formula (and its limitations). This prompts a good discussion about the limits of scientific ability to mitigate risk, black swan events, nonlinearity in general.

I have used this successfully in class.

Great to motivate a discussion on hedge funds or derivatives. The interview with Myron Scholes makes him a "real person" rather than a name in a book.

Especially useful in derivatives course. Transcript available free online.

27. *Wall Street*

The classic clip is great for corporate culture and shareholder theory discussions.

I've used scenes from this one to illustrate the necessary finance mindset for many years. Although Gordon Gecko is portrayed as a criminal, much of what he says is true regardless. "Greed, for lack of a better term, is good." In seminar we also read Jensen's "The Nature of Man" to round things out.

This is my all-time favorite finance movie.

Even though this movie is 30 years old, the themes still resonate. I have found it to be an excellent vehicle for motivating discussion of the concepts of insider trading, agency theory, shareholder wealth maximization and ethics.

This is the first movie that was introduced by Edward Dyl on using movies in the finance classroom.

Oliver Stone "over emphasizes" the bad aspects of finance, but there are key learning points about inside trading and efficient markets.

Clicheish.

I have assigned several movies in my undergraduate finance foundation course, which is required for marketing, finance, management, and accounting majors. Some of the movies were not well-received; however, this movie was -- particularly when coupled with PBS series on Bernie Madoff and Wall Street.

Table 2. (*Continued*)

28. *Wall Street: Money Never Sleeps*

    Clicheish.

29. *The Wolf of Wall Street*

    Occasionally a student asks about this movie when I talk about the Pink Sheets for trading penny stocks. I'm happy to discuss the scene from the movie where the main character first learns about this part of the market (and is excited by the large bid-ask spreads), but I always caution students that before watching it, they should be aware that it has some really raunchy scenes.

    Only one example and overdone, but informative.

    Must heavily edit to show in the Christian south.

    Way too much profanity for use in class.

    Too many disgusting and inappropriate scenes.

    I couldn't get past the first 20 minutes so it might be better if I could get past the drugs and foul language.

    Stereotypes.

    I assigned this movie in addition to YouTube videos regarding the real wolf on Wall Street. Students assigned this movie high ratings. The movie was assigned to a finance class consisting of finance majors with one general finance course already completed as a prerequisite. This movie was assigned in addition to a PBS movie via our university library.

    Entertaining but doesn't say much about finance.

30. *Working Girl*

    I saw the adult version of this movie.

    I don't remember any strong finance tie.

    Does this have any academic financial content?

quite varied. On balance, their comments are positive and focus on the educational benefits of the movies. However, some respondents questioned the academic content and relevance of some of the movies and expressed concerns regarding profanity and nudity in others. One respondent commented that the movie *Wall Street* "overemphasized 'the bad aspects' of finance" and another said that *The Corporation* was "too one-sided for the classroom." Needless to say, instructors should guard against movies presenting distorted or biased views of finance, while at the same time acknowledging that there are numerous examples of bad behavior by people in finance.

Beyond the 30 movies listed in the questionnaire, the respondents were asked to suggest other movies and video presentations that they would recommend to finance students. Their recommendations are listed in Table 3. They include additional movies and documentaries, *Ted Talk* videos, documentaries presented on PBS *Frontline*, and various television series.

We next asked respondents if they used movies (or excerpts) in their classes. In response to this question, 52 percent of the respondents answered "yes." The

Table 3. Survey Results:
Other Films and Video Presentations Recommended to Finance Students in Finance

"Inside the WorldCom Scam" (CNBC *American Greed*, 2012)
"Mind Over Money" (*Nova* Season 37, Episode 7, 2010)
The True Cost (2015)
They Were There (2011)
The Black Scholes Formula: A Documentary (2012)
Tin Men (1987)
The Ascent of Money (2009)
The Godfather (1972)
The Godfather II (1974)
The Social Network (2010)
Founder (2016)
Atlas Shrugged: Part I (2011)
Atlas Shrugged: Part II (2012)
Atlas Shrugged: Part III (2013)
"Inside the Meltdown" (PBS *Frontline*, 2009)
Princess Bride (1987)
"To Catch a Trader" (PBS *Frontline*, 2014)
"Financial Weapons of Mass Destruction" (*60 Minutes*, 2012)
"Your Bank has Failed" (*60 Minutes*, 2009)
Mary Poppins (1964)
"Cosmopolis: 1919-1931" (*New York*, Season 1, Episode 5, 1999)
The Apprentice (Excerpts from Season 1, 2004)
Overdose: The Next Financial Crisis (2010)
"Money, Power, and Wall Street" (*Frontline*, 2012)
"The Warning" (*Frontline*, 2009)
"House of Cards" (*CNBC*, 2006)
"Valuation" (Aswath Damodaran, NYU)
"The Madoff Affair" (PBS *Frontline*, 2009)
"The Retirement Gamble" (PBS *Frontline* 2013)
"Breaking the Bank" (PBS *Frontline*, 2009)
"Inside the Meltdown" (PBS *Frontline*, 2009)
"Money, Power and Wall Street" (PBS *Frontline*. 2012)
"Secret History of the Credit Card" (PBS *Frontline*, 2004)
Becoming Warren Buffett (2017)
"Chris McKnett: The Investment Logic for Sustainability" Chris McKnett (*Ted Talk*, 2015)

Table 3. (*Continued*)

CSPAN Rep Paul Kanjorski Reviews the Bailout Situation (https://www.youtube.com/watch?v=pD8viQ_DhS4, 2009)
"William Black: How to Rob a Bank" (*Ted Talk*, 2013)
"Andrew Choi: How to Make a Profit While Making a Difference" (*Ted Talk*, 2015)
"Roger Stein: A Bold New Way to Fund Drug Research" (*Ted Talk*, 2013)
"Dilip Ratha: The Hidden Force in Global Economics: Sending Money Home" (*Ted Talk*, 2014)
"Annette Heuser: The Three Agencies with the Power to Make or Break Economies" (*Ted Talk*, 2013)
"Pavan Sukhdev: Put a Value on Nature!" (*Ted Talk*, 2011)
"Michael Metcalfe: A Provocative Way to Finance the Fight Against Climate Change" (*Ted Talk*, 2015)
Nerds 2.01: A Brief History of the Internet (1998)
"To Catch a Trader" (PBS *Frontline*, 2014)
"The Untouchables (PBS *Frontline*, 2013)
"Six Billion Dollar Bet" (PBS *Frontline*, 2012)
Shark Tank (TV Series, 2009-present)
The Business & Management Collection: Video Lectures & Case Studies (various)
Billions!! (TV Series, 2017-present)
A Civil Action (1998)
Silver Bears (1978)
Mindwalk (1990)

remaining 48 percent answered "no." For those who answered "yes" we asked them to "please list the courses and movies used and whether movies are shown during class or viewed outside of class time." The results, shown in Table 4, provide interesting and diverse examples of how the respondents use movies and excerpts to enhance their student financial education in various finance courses.

It is important to note the limitations of this research and our results. Firstly, there is probably response bias in our results. We surveyed members of the Financial Education Association, individuals who presumably have a special interest in teaching and financial education and who may therefore be more likely to employ nontraditional teaching techniques in their classrooms. Therefore, it would be problematic to extrapolate our results to the broader academic community.

In a few cases, respondents commented that it had been a long time since they had viewed a particular movie.

As previously acknowledged, the data presented in Table 1 is based on the particular movies that we selected for the survey. As indicated by the number of

Table 4. Survey Results:
Courses and Movies (or Excerpts) Used in Finance Classes
(Respondents who answered "yes" to "Do you us Movies (or Excerpts) in Your Classes?"

Trading Places excerpt showing commodity exchange. Investments course.

Trading Places

Trillion Dollar Bet and *The Big Short*

I have used *Other People's Money* in basic business finance, MBA corporate finance, and MS seminar in finance. I have used *It's a Wonderful Life* in my commercial banking class, and institutions and markets class. I have used *Glengarry Glen Ross* in several of my classes to give career information for students. I have used *They Were There* by IBM in my graduate corporate finance and MS seminar classes. I have used *Barbarians at the Gate* and *Wall Street* in both corporate finance and commercial banking at different times.

Investments, *The Black-Scholes Formula*, in class.

Course is "Philosophy of Business and Free Market Economics" Movies are assigned with clips shown in class. *Other People's Money*, *Ascent of Money*, *Trading Places*. I do NOT use films that add to the general misperception of business as a Den of Thieves.

Intro finance: *Inside Job*, Advanced corporate finance: *Barbarians at the Gate*, *International Finance: Rogue Trader*. I have students watch them outside of class. I provide discussion questions. Students are responsible for discussion and a short memo.

I use movies or clips of movies in Fin 3010 Introduction to Corporate Finance: In class we see and discuss full *Trillion Dollar Bet* video in class. Out of class for credit students pick from: *Barbarians at the Gate* (1993), *Too Big to Fail* (2011), *It's a Wonderful Life* (1946), *Boiler Room* (2000), *Trading Places* (1983), *The Big Short* (2015). I sometimes use a clip of *Trillion Dollar Bet* in Fin4860 International Finance.

I used to have students pick a movie and write a review through finance lens for extra credit. But I teach in Utah and I got complaints that all finance movies are R-rated ... so I do not give that extra credit anymore. I uses to show parts of the Niall Ferguson documentary of the *Ascent of Money* when I taught financial markets class.

The Big Short, Principles of Finance & MBA Advanced Financial Management, outside of class *Enron: The Smartest Guys in the Room*, MBA Advanced Financial Management, outside of class.

Capstone undergraduate class—*Wall Street* (1987) Intermediate corporate finance—*Other People's Money* MBA Finance class Students prepare by defining terms used in the movies and reading text & other articles in advance. The movies are viewed during class and stopped periodically to discuss the topic at hand.

Rogue Trader, during class of undergrad and graduate level "Investments" *Barbarians at the Gate*, during class of graduate level "Corporate Finance" *Other People's Money*, during class of undergrad level "Corporate Finance" *Margin Call*, during class of undergrad "Financial Institution Management"

Principles of Finance; *Other People's Money*; the movie clips are available at YouTube; allow me to circumvent copyright issue.

I use the movies I listed, but not all of them in the same semester. I often use one of the movies I listed and discuss the learning points of the movie, how representative is the movie of the real world, and why Hollywood picks such negative business themes. Many movies are "ethics gone wild" with many good points but there is too much generalization from specific events.

Table 4. (*Continued*)

Clips in class used in Personal Finance, Business Finance, Investments and Financial History. Clips change every semester.

I've shown "Inside the Meltdown" in my principles of financial management course to teach on the financial crisis. I've shown *The Big Short* in my problems & cases in finance course to teach on ethics and the financial crisis

Markets and institutions: *Princess Bride*, *Margin Call*, *The Crisis of Credit*.

Not lately, but I have in the past used the *Mary Poppins*.

In class, "Money and Capital Markets."

Advanced Financial Management—*Other People's Money*.

At least not to large extent. I would think it would be too time consuming to find them and make them.

Very selectively.

I did in classes that I used to teach.

Financial Management, *Other People's Money*, Shown in class due to copyright, excerpts available to students at class website.

The Big Short, *Billions* (TV series,) *Trillion Dollar Bet*.

I just occasionally TALK about the movie plots, as with *The Big Short*.

I utilize the following PBS Frontline videos since copyright is not an issue at our institution. In order of our student rankings, here is the PBS list. 1. Bernie Madoff Affair 2. Retirement Gamble 3. Breaking the Bank 4. Inside the Meltdown 5. Money, Power and Wall Street 6. Secret History of the Credit Card. I also assign YouTube videos from Bloomberg and other sources. Our university has a high proportion of first generation students, female students, and Latino/a students. Examples include: 1. History of KKR (https://www.youtube.com/watch?v=OtKizreanP0) 2. Bloomberg GameChangers Series 3. Mark Cuban, How I Became a Billionaire 4. Bill Ackman and Everything You Need to Know about finance in an hour (https://www.youtube.com/watch?v=WEDIj9JBTC8). 5. Charlie Rose and Jack Ma 6. Apple CEO sits down with Charlie Rose for a 52 minute interview 7. CEO Exchange: Down on Main Street: The Bank and the Drugstore in the 21st Century (Episode 407) DVD – 2006 8. Real Wolf on Wall Street (https://www.youtube.com/watch?v=qh3OmK_9A6M) 9. Women in Finance (https://www.youtube.com/watch? v=sbQ5I5WHOmI&list=PLdHNrgBvsSFTWArp1rZV6bYJkst7RgiHo) 10. Fintech in Latin America (https://www.youtube.com/watch?v=UmRhC3omN5M)

In the past I've shown, "Mind over Money" and some of the "Beyond Wall Street" videos, "To Catch a Trader" in my investments class. I like to show the end of *Trading Places* in investments to illustrate a short sale. I've also shown the clip on Cisco and venture capital to my money and capital markets class. I show some clips of *Shark Tank* in my corporate finance course. I wrote a paper on using *Shark Tank* in the classroom. You can find an overview here: https://www.questia.com/read/1P3-3812796301/swimming-with-the-sharks-case-studies-inventure

Undergraduate finance classes and in class.

Corporate Finance, International Finance, Commercial Banking, Financial Markets and Institutions. All excerpts from World Famous Experts are embedded in my online classes and Discussion forum questions are posed. In class I mention a lesson learned from a movie and ask someone in the class to describe the implications based on the theory.

Table 4. (*Continued*)

Inside Job and *Too Big to Fail* viewed in class in Cases in Corporate Finance course. *Other People's Money* and *Barbarians at the Gate* viewed in class in Corporate Mergers, Leveraged Buyouts and Divestitures course.
Capstone financial planning course—"A Civil Action"—outside of class.
I have done so in an honors course I taught in the past. We used one movie (*Bonfire of the Vanities*)
Corporate Finance, Investments Derivatives, Security Analysis/Portfolio Management, Behavioral Finance. Mostly, clips are viewed in class
MBA Investments Undergrad derivatives.
I did. I'm retired. I worked for the Federal Reserve Board more than 50 years ago and I started teaching 50 years ago.
As links for students to view as part of their readings and preparation, typically not often in class time.
Trillion Dollar Bet—in class; *The Big Short*—outside of class; *Other People's Money*—excerpts in class.

ratings shown in Table 1, none of the movies were rated by all 80 respondents. Six of the movies, *IOUSA*, *Heist: Who Stole the American Dream*, *The Queen of Versailles*, *Rollover*, *The International*, and *The Bank* were rated by fewer than ten respondents. This limits the comparability of the ratings.

Concluding Comment

Notwithstanding the limitations of our research, we believe that our results should be of interest to colleagues who are looking for good finance movies to view themselves, use in the classroom, and/or to recommend to their students. Movies (and excerpts) help bring finance alive in ways that journal articles, textbooks, lecture and cases cannot easily achieve and therefore enhance the understanding and application of our discipline.

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Appendix

Cover Letter for Faculty Survey

Dear Finance Colleagues:

Teaching finance and other business disciplines poses the continuous challenge of linking the wide variety of theories to the "real world" and providing students with an organizational frame of reference that helps them understand and appreciate the relevance and context within which the subject matter applies. It is also challenging to include the human dimensions of our disciplines.

We have found that movies and short excerpts from movies (film clips) can be used to bring finance and other business subjects alive in ways that that are difficult to achieve in traditional lectures and assignments.

The list of Hollywood movies with finance and business themes has grown over the years. Some are well known and award-winning. Some chronicle corporate takeovers, bankruptcies, and the global financial crisis; others focus upon the unethical and fraudulent behavior of individuals. Some are fictional and others are documentaries.

We would greatly appreciate your input. Our questionnaire contains a list of 30 movies that we have recommended to our finance students over the years. In some cases, we incorporate the movies into our finance courses. We are interested in your ratings of these movies. If you have not seen a particular movie, simply indicate "no opinion."

Our questionnaire provides you with an opportunity to list other movies that you would recommend to finance students. It also solicits your experience, if any, integrating movies into your courses. We would like to include these in the results of our research study.

We plan to present the results of the survey at the Financial Education Association/Academy of Business Education 2017 Conference. Please be assured, however, that the survey is anonymous and does not solicit any information identifying you or your university. To take the survey, please go to the following link: https://www.surveymonkey.com/r/FEAMovies

Thank you in advance,

(Signed by coauthors with titles and affiliations)

On Course Redesign and Games in a Financial History course

Arthur Wilson
George Washington University

Over the last several years, I developed and now teach "A Brief History of Finance", a financial history course at The George Washington University (GWU). Previous efforts at financial, economic, or business history at our university have often had to be cancelled for lack of sufficient enrollment. Three atypical features of the course were incorporated in order to attract and retain sufficient students, despite the small niche. The third feature, a game, is the main focus of this paper.
Keywords: *Financial History, Games, Course Design*

Introduction

Over the last several years, I developed and now teach "A Brief History of Finance", a financial history course at The George Washington University (GWU). The syllabus learning objectives were not unusual: "Our goal is to complement both your knowledge of finance with a sense of how it has changed over time, and your knowledge of history, particularly where it has been shaped by finance." However, the niche for this kind of course at GWU is rather small. Previous efforts at financial, economic, or business history at our university have often had to be cancelled for lack of sufficient enrollment. Three atypical features of the course were incorporated in order to attract and retain sufficient students, despite the small niche. The third feature, a game, is the main focus of this paper.

On Course Design

The first such feature is that the course is a WID course. WID stands for Writing In the Disciplines—at GWU such courses are intended to give students extra practice writing, ideally within the confines of their chosen field of concentration. The logic is that students may need to see that skills developed in the Freshman writing class are directly relevant to their concentration. To graduate, undergraduates normally take at least two WID courses. Such courses are more work for the faculty, and so are harder to staff and offer. One useful side

effect—there is an extra demand for WID courses, even beyond the attractions of the specific subject matter.

Second, the financial history course is cross-listed between the Finance Department (in the school of business) and the History Department (in the liberal arts college). Even though students in the various colleges could already take other courses as electives, they are not always aware of the options in other colleges. Initially, the course was offered only in the Finance department—only the one-time sufferance of a sympathetic, now former dean allowed the course to go forward that semester despite a very low enrollment.

With cross-listing, in recent semesters, roughly half of the students register for Finance 3401W, and the other half register for History 3001W. The first group are mostly business school students, mostly concentrating in finance. The second group are primarily history students, but also other liberal arts students. The two 'courses' are combined—they are scheduled for the same room and same time and use the same syllabus and course plan. Of course, with such diverse students, few pre-requisites are feasible without losing half my students. Instead, I make it a point to carefully explain new finance concepts as needed so that the history students would not be disadvantaged.

Third, the course features a 'game', developed by the author to help students interpret some aspects of the readings. In this experiment, the game modeled the spice trade as it was in late medieval/early modern Venice. We discuss the game more fully below.

On Course Redesign

One difficulty with such a combined class is that the two sets of students typically have somewhat different interests. The history students seem to be especially interested in the historically earlier material, perhaps because it is more basic, and also because it overlaps chronologically with material in their other history courses. Most of them know little finance. Many of the finance students seem especially interested in the historically later material. Some of the latter are surprised to find that there is a long history of finance before the 19th century, and may doubt the relevance of that earlier history to modern finance. Unfortunately, the late semester peak in interest on the part of the finance students is typically cut short by the usual end-of-semester logjam of assignments from other courses. When I structured the course chronologically, neither group was fully happy with it.

In prior semesters, for Financial History as well as most of the other courses I teach, I have noticed a decided drop off in student interest near the end of the semester, as evidenced by attendance. Some of that may have been due to limitations of my teaching style. Some of the drop off may have been a consequence of accumulating end of semester term papers, exams and other assignments in this

and other courses. My course had two main papers, several quizzes, but no final exam. In this and other courses, even those with final exams, the impression of a fall off in interest was supported by generally falling quiz scores near the end of the semester.

With poor course evaluations, my course would always be in danger of being cancelled due to low enrollments. It was cancelled in Spring 2015. I was allowed to teach it in Fall 2015. The following Summer, I took advantage of an intensive summer course design workshop, built around L. Dee Fink, Creating Significant Learning Experiences: An Integratted Approach to Designing College Courses (2013), to get ideas on how to fix this course.

Three major changes came out of that experience: First, instead of teaching the course chronologically—with major units on "Ancient Finance", "Medieval/ Early Modern Finance", "Modern Finance", and "Financial Crises", most of the same material was re-arranged and presented as "Building Blocks", "Problems", "Solutions", and "Financial Crises". Both sets of students seemed to prefer the changed presentation.

A second change was to ask students to write graded 'reflections' on the readings. For roughly a third of the readings, students were asked to write a brief (up to 500 words) summary and commentary. For example, after reading about and summarizing medieval debates about 'usury', students might comment on similar debates about modern payday lending. Sometimes I offered suggestions for commentary, but in general, students could go in a variety of directions, such as current events, relation to other classes, or to other concepts. In all, I assigned 14 reflections, roughly one per week. In addition to the reflections, students were expected to write, then critique each other's papers, and then rewrite two 2000-2500 word papers. They also took six (6) short quizzes.

The third change was to invent a game to break up the routine, and draw the students into the readings in a new way. I developed a game based loosely on the spice trade in 14th century Venice. The game was only loosely based on the spice trade—some differences were necessary to support playability. I had introduced the idea of a trading game in the syllabus at the start of the semester. Initially, it was scheduled for 1 day. We ended up using two days. This is the story of that game and our first time experience with it.

Literature Review

The use of games in teaching history or various business disciplines is supported by an extensive literature on computer games, experiments and simulations. For history, see Jeremiah McCall, "Teaching History with Digital Historical Games: An Introduction to the Field and Best Practices" (2016), and, Kevin Kee, "Computerized History Game: Narrative Options" (2011). For business, see H.

P. Womarans, "Business Simulations in Financial Management Courses: Are they Valuable to Learners?" (2005), Precha Thavikulwat, "The Architecture of Computerized Business Gaming Simulations"(2004), and, Marco Greco, Nicola Baldissin and Fabio Nonino, "An Exploratory Taxonomy of Business Games" (2013).

That literature is thinner on in-person games. An exception is Tom G. Geurts and Austin J. Jaffe, "The Property Rights Game: Discovering the Meaning of Private Property" (1996). There is reason to suspect that the difference between computer and in-class games is important. Linda K. Carter and Tisha L. N. Emerson, in "In-Class vs. Online Experiments: Is There a Difference?" (2012), concluded: "The authors found no significant difference in student achievement or overall views of the course or instructor between the two treatments. The authors did, however, find that students exposed to hand-run experiments report more favorable views of the experimental pedagogy and report higher levels of interaction with their classmates."

So: Why base a game on the spice trade centered on 14th century Venice? I chose that period for several reasons: 1) The spice trade was intrinsically interesting, especially to history students; 2) Venice's trading techniques had enough of what might be called 'modern' elements to draw the interest of the finance students; 3) we finished the readings on Early Modern Finance in mid-November, around the time when student interest usually starts to flag, so that the break in the routine might have useful effects; and 4) the period was close to my own fledgling research efforts in financial history, so that I was more than usually familiar with the circumstances. On the latter, see Arthur J. Wilson, GeeTae Kim, "Put-Call Parity, the Triple Contract and Approaches to Usury in Medieval Contracting" (2015).

In the weeks prior to the game, several of the readings set the scene. Students read about the Commenda, articles or chapters on Maritime Insurance, as well as articles on usury, the Bill of Exchange, and on Medieval/Early modern Venice.

These readings included: John H. Pryor "The Origins of the Commenda Contract" (1977), and Ron Harris, "The Institutional Dynamics of Early Modern Eurasian Trade: The Commenda and the Corporation" (2009). Students also read any two of the four readings on maritime insurance. These included part of J. N. Ball, Merchants and Merchandise: The Expansion of Trade within Europe, 1500-1630 (1977), Geoffrey Poitras, "Origins of Maritime Insurance" (2000), Quentin Van Doosselaere, "Third Party Insurance" (2009), and Giovanni Ceccarelli, "Risky Business: Theological and Canonical Thought on Insurance from the Thirteenth to the Seventeenth Century" (2001). Readings on usury included N. Jones, "Usury" (2015), Eric Kerridge, "Usury and Interest" (2002), and Koyama, "Evading the Taint of Usury: The Usury Prohibition as a Barrier to Entry" (2010). Readings on the Bill of Exchange included Adrian Bell, et al., The 'Buying and Selling of Money for Time': Foreign Exchange and Interest Rates in Medieval Europe

(2015), and Marcus Denzel, "The European Bill of Exchange: Its development from the Middle Ages to 1914 (2008). Readings on Venice included Yadira Gonzalez de Lara, "The Secret of Venetian Success: A Public Order, Reputation-based Institution" (2008).

The Game—Roles

A week before game day, a rules document was emailed to the class, describing the game and some possible roles. Students were invited to request specific roles for the game. My hope was that such students would think about the strategies that would work for a given role, given the rules and what they learned from readings about the period. For example, some students could choose to be a "tractor" (a kind of traveling merchant), and others might chose to be "merchant bankers". In so doing, I hoped the students would try to 'get into the heads' of 14th century Venitian merchants in a way that reading chapters or articles only might not be enough to induce them to do. The game rules document (slightly re-edited) is available on request.

On the appointed day, the remaining roles were assigned, supporting materials were distributed, and play began. Initially, most students were surprisingly hesitant—only about half the class had actually requested a role or acknowledged having read the rules document. Fortunately, a few students got things started, and after the initial hesitation, we completed the first round about 40 minutes into the session. A second round took about 20 minutes as students began to understand how to play. At that stage, we decided to recollect materials and resume with the next class session.

I had anticipated a faster start. My sense was that it would take several rounds for students just to get their bearings. So, we scheduled a continuation for the next class, in which, after redistributing materials, we completed 3 more rounds.

Since class size was capped at 25, and some students don't attend on any given day, it was important to plan for a small, but uncertain number of participants. In all, ten (10) types of roles were envisioned, six (6) of which I regarded as especially important. These were: TRACTOR, COMMENDATOR, SHIP OWNER, PEPPER BUYER/SELLERS (in Aleppo, Alexandria), PEPPER BUYER/SELLERS (in Venice), and a Bruges PEPPER BUYER (filled by me, with dice). The other roles: MERCHANT BANKERS, INSURERS, NOTARIES, AND CLERICS, were not strictly necessary, but could be available if enough students were available and interested. Most roles were defined to have some sort of modest comparative advantage in some aspect of that role. For example, the merchant bankers could move money from Bruges to Venice at lower cost than most other players.

While these roles were essentially fluid—in the game as well as in history, any character could take on a variety of roles—my expectation was that tractors

would generally seek funding from commendators, bankers or insurers, or anyone else with investable funds. I expected that students who chose and thought about a given role were likely to mostly stay in that role during the game. By and large, that was the case.

Sequence of Play

After allocating initial cash and supplies to participants, the first step was to determine how much pepper would be available at Aleppo and Alexandria, and how much was purchased by the Aleppo and Alexandria pepper buyer/sellers. These two pepper buyer/sellers were positioned on the far right side of the room, and away from each other, most other participants were 'in Venice' (on the left side of the room).

Potential supply of pepper at Aleppo was determined by dice: Roll 4 dice times 4 for price, roll 2 dice times 2 for available quantity. The Aleppo pepper supplier could then buy at the dice price, up to available quantity. Pepper could be stored at $1/unit/turn. With normal dice, on average there would 14 packets for $56 = $784 supplied to Aleppo.

Potential supply of pepper at Alexandria was also determined by dice: Roll 1 die for any supply (even number means yes). Then roll 3 dice, times 4 for price, roll 2 dice, times 8 for available quantity. The Alexandria pepper supplier could buy at the dice price, up to available quantity. Pepper could be stored at $1/pack. With normal dice, on average, there would 28 packets for $42 = $1176 supplied to Alexandria.

In the second phase, the tractors were expected to negotiate to raise funds prior to going to Aleppo or Alexandria. Tractors would then be expected to hire a ship in order to travel, while the fund providers would decide whether to buy insurance. Blank forms for Commendae, Partnerships, insurance, loans, ship transportation, etc. were provided for these negotiations. If a Notary was available, traders could have agreements notarized, which would aid enforcement in the event of a disputed contract. Notarized transactions can be enforced by Merchant Court (disputes decided by vote among all parties in Venice, excepting the disputants.) The notary would get 2 votes. The loser must accept the ruling or leave the game, bankrupt. So far, no such disputes have arisen.

In the third phase, tractors with ships attempt the crossing to Aleppo or Alexandria and back. For both there and back, dice determined speed of transit and whether pirates attacked or storms struck resulting in shipwreck. For speed, a single die roll determines who among tractors arrives first. For storms or piracy: First roll one die. If its 5 or 6, clear sailing. Otherwise, roll 2 dice—if '2' (snake eyes), ship, tractors, owners, funds and cargo are all lost at sea. If '3', half of tractors and their funds are lost at sea. Players who perish can return to the game

in the next turn as new tractors. With normal dice and average luck, 1/36th of tractors will perish each transit.

At Aleppo or Alexandria, tractors negotiate with the pepper sellers, before returning to Venice. Upon return, they negotiate with the Venitian pepper buyer(s) before deciding whether to offer their pepper directly to the Bruges pepper buyer instead. This last option was not anticipated. The initial rules did not clearly define how to get pepper to Bruges. Once the pepper buyer in Venice claimed a monopoly (see below), I felt constrained to allow direct sales. At this stage, neither party knows what the Bruges price will be.

Once pepper accumulates in Venice, its owners can present it for purchase at Bruges.

In this phase of the game, we ignore transport issues to Bruges, and again used dice to set demand at Bruges. Potential demand for pepper at Bruges was defined as follows: Roll 4 dice times 6 for price, roll 3 dice times 4 for quantity at that price. With average dice, this will imply a price of \$78 for 42 units. The demand curve slope is −0.2, that is price decreases \$1 for each 5 more packets offered. If only 15 units are offered, price will be \$(78 + (42−15)*0.2) = \$83.4. The Bruges buyer (me) will buy as much as possible consistent with demand curve.

In the final part of the round, loan and investment transactions would be settled, including repatriation of funds from Bruges. My clearly unreasonable hope was that we would be able to do 10 rounds in one 75 minute class. Along with play money and toy ships, I provided contract blanks so that students could quickly record whatever they did, and I could reconstruct a record of their activity afterward.

Results

Despite my earlier concern about attendance, 21 of 24 students participated in some capacity over the two days. Within the game, for the most part, tractors did obtain funding from the others, although some of the latter group were not very active. The most aggressive tractors achieved very high rates of return—as high as 200% over 5 rounds. Several of the other investors lost money. Among unexpected developments, one of the merchant bankers was nearly wiped out because the students they invested in did not come to class the second day. The loans were never repaid! A particularly interesting surprise came from the Venitian pepper buyer. Initially, there were to be 2 pepper buyers in Venice—I expected to see a Cournot or Bertrand duopoly scenario play out. Instead, the second pepper buyer skipped class and the first insisted that that gave them a monopoly. They then offered to buy pepper at low-ball prices, only to find that the tractors refused to sell, and instead offered their pepper directly to the Bruges pepper buyer. That rule needed to be clarified in real time—leaving one very frustrated Venitian pepper buyer.

Counting both sessions, we were able to do 5 rounds of this, each time getting faster. The final round took around 10 minutes. The biggest frustration was that students were not very good about recording their transactions on the blank forms, so I do not have a complete record of every transaction. Even so, since we were using play money as well, it was still possible to determine profits and losses.

I made other mistakes too—such as when I forgot to roll the dice for ship wreck in the first round, and when I initially forgot to maintain the distinction between money in Venice and money in Bruges. Both mistakes made the game less active for the bankers and insurers. Both mistakes were rectified the second day.

Still, even before that first class session was over, I knew the experiment had been at least partly successful. Usually, at this stage in the semester (the week before Thanksgiving break), students are harried and pre-occupied. Class participation goes down and stays down. This did not happen to nearly the same extent this time. And on the second day of the game, students were excited, and lingered after class longer than usual. Several of the tractors were almost giddy. I suppose a 200% return can do that.

I also got extensive feedback from the students in the form of one of the reflections. Besides the predictable compliments, probably the single most frequent comment was that there needed to be more risk and more volatility in the game. Perhaps as a consequence, almost as often, students complained about overly idle roles for some—particularly bankers, insurers, notary and cleric. The third most common complaint was that the rules were too complicated, confusing or unclear. Several students were also concerned about attempts to form monopolies—first among Aleppo/Alexandrian pepper sellers, then Venitian pepper buyers, then ship owners, then tractors. At one time or another, most of the participants in the game tried to collude!

At least one student was concerned with each of the following: adhoc real time rule making (my fault!) , feeling rushed, too few products to trade, too many or too few pepper sellers, too many or too few tractors, and a need for more of a role for armed convoys, pirates and commercial scams.

One nice surprise was that my course evaluations were much better. I have never been a very popular teacher, and one longstanding problem with our course evaluation system is that many students do not bother to provide feedback.. In Fall 2015, only 3 History students did so.

In Fall 2016, only 4 of the History and 2 of the Finance students did so. Since Business school students barely participated, and also used a different evaluation instrument, I focus on the History students to make comparisons. In Fall 2015, the overall course rating was 3.7 out of 5. In Fall 2016, the overall course rating was 4.8 out of 5 (see table 1). Of course, given the small sample size, this result should be interpreted conservatively.

Table 1. Course Evaluations, comparing 2015 to 2016 classes

	Course Evaluation	Sample
Fall 2015	3.7 out of 5	3
Fall 2016	4.8 out of 5	4

Ordinarily it would be difficult to make the case that the game contributed to student satisfaction or student learning. Clearly, there were several changes between the two semesters, any one of which could account for the changing course evaluations. Student learning, is similarly difficult to measure in this context. However, there is some evidence that students did learn from the experience. In the Fall 2016 semester, I administered six quizzes to these students. Four of those quizzes took place before the game sessions. Two took place after the game sessions. It would not make sense to compare the 2016 class to the 2015 class. The earlier class had a very different structure, with only 2 quizzes, roughly 1/3 and 2/3rds of way into the semester. Even so, the scores also dropped between quizzes in that semester.

It would not make sense to distinguish between those who participated and those who did not. Since 21 of 24 students participated at some level, the non-participating group is too small and may be idiosyncratic in other ways. However, I can distinguish among them based on the degree of participation. Participation in the game was considered part of class participation. The game component added 1, 2 or 3 points out of 100 possible for the course. The average game participation score was 1.62. After the semester was over, I divided student records into those who scored 2 or 3 (11 students), and those who scored 0 or 1 (13 students). Note that these game scores were determined near the very end of the semester, based on attendance and fragmentary trading records—they could not have affected student quiz preparation earlier in the course.

The low game score students averaged 2.98 out of 4 on the 4 early quizzes. They scored 3.19 out of 4 if we exclude the three non-participants. The high game score students averaged 3.11 on the first 4 quizzes. Standard errors were 0.17 and 0.15 respectively, supporting the interpretation that the two groups scored similarly on the quizzes before the game sessions.

The low game score students averaged 2.31 out of 4 on the two later quizzes. They scored 2.68 out of 4 if we exclude the non-participators. Standard errors were 0.36 with and 0.42 without the non-participators. The high score students averaged 3.11 out of 4 again, with standard error 0.27. Despite the small sample, the high game participating students performed notably better after the game sessions than the low game participating students, with or without the non-participants. When we look at specific quizzes, it appears that roughly 2/3rds of the difference between the early and the later quizzes occurs with the first quiz after the game.

Table 2. Quiz Scores Before Game (quiz 1-4) and After Game (quiz 5-6) (4 point quizzes)

Level of Particpation	Quiz 1	Quiz 2	Quiz 3	Quiz 4	average	Quiz 5	Quiz 6	average
High (n=11)	3.20	2.86	3.32	3.05	3.11	3.18	3.05	3.11
sd	0.55	1.09	0.83	0.74	0.50	0.91	1.12	0.89
Std error					0.15			0.27
Low (n=13)	3.15	2.89	2.77	3.12	2.98	2.08	2.54	2.31
sd.	0.65	0.92	1.19	0.67	0.61	1.49	1.47	1.33
Std error					0.17			0.37

Discussion

Although the sample size is small, it appears that the changes made to the financial history course made it more agreeable to students, and that participation in the trading game in particular is associated with relatively improved student performance on subsequent quizzes. The first result is consistent with the findings of Carter and Emerson, noted above. The second goes beyond them.

Of course this is a preliminary analysis of a small sample. There were also many student suggestions and criticisms to improving the game. If I can effectively address those, next time we may have stronger results.

Some of the student criticisms were symmetrical—too simple and too complicated for example. On the other hand there was a clear sense that there needed to be more risk. I initially calibrated the risk to match what the literature says about Genoan shipping around this time. Somehow I suspect that this criticism came from students who misspent their youth playing games with dice, such as RISK, or MONOPOLY (like the author). I am reminded of what my son's pediatrician said once—"at this age, they tend to feel they are bullet proof." I was also surprised by the problem with monopoly. Partly that is because I thought the game design and the fast pace would, with enough students, make collusion difficult to sustain anyway. The attempted pepper buyer monopoly was an attendance accident—the other pepper buyer did not come to class. The attempted shipping monopoly was more interesting—although had we had more rounds, students could have constructed another ship. The attempted tractor cartel was audacious, but with so many possible members, fragile.

It is less clear how to address concerns about confusing, unclear and overly complicated rules. Up to now, my efforts to address confusion or lack of clarity have resulted in a more complicated, explicit set of rules. The monopoly issue can probably best be managed by 1) more carefully defining any comparative advantage in a role so that outside competition can still arise, and 2) making sure that there are enough players with the more important roles so that collusion takes more effort.

It is also clear from the comments that most of the students actually read many of the readings—and interpreted the game in light of the readings.

On an operational level, I need to find a way to speed up play without students feeling rushed. More extensive pre- game orientation may be warranted. It may also make sense to have at least one more reflection beforehand aimed at making sure students have read the most important articles. I may also want to assign roles ahead of time to students who do not select roles. Once play is underway, it is important to find a way to make sure that transactions and agreements are promptly recorded. Not only might this give the notary something to do, but it will also allow me to construct an audit trail later and to determine more fully what happened.

Conclusion

The changes to the course as a result of the Summer intensive course design institute were generally successful. Students were happier, and course evaluations were much more favorable. We also developed a trading game that usefully captures some aspects of Medieval Trade in a way that is fun and gives students an active role in developing their insights. There is reason to believe that the trading game reinforced that positive impression, and aided in student learning. Quiz scores were better for those who participated in the game the most. While the game is not perfect, it seems clear that efforts to improve it are likely to be worth doing.

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Naïve Diversification: An Investments Class Project on a Shoestring

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Many finance textbooks present a classic chart on naïve diversification showing that average total risk declines quickly and asymptotically to market risk as number of stocks in the portfolio increases. Typically, the curve levels out around 20 to 30 stocks. Hence, the chart appears to suggest that an investor needs only a small number of securities to gain most of the benefits from diversification. This paper presents a class project in which students collect data from free sources on the Internet and then analyze this data in Microsoft Excel. In this project, students extend the classic chart by estimating the dispersion empirically for a large sample of portfolios randomly selected at each portfolio size. By plotting confidence curves determined by percentile statistics, students learn that many portfolios have significantly more risk than the average. To reduce exposure to this risk requires a much greater number of stocks than the average alone suggests. In addition, students learn how to partition total portfolio risk into diversifiable and systematic components. An examination of the cross-sectional diversifiable risk illustrates that even portfolios with hundreds of stocks can have significant risk of large unsystematic shocks.
Keywords: *naïve diversification, class simulation project, finance pedagogy, critical thinking*

Introduction

Many finance textbooks present a chart on naïve diversification showing that average total risk declines quickly and approaches market risk asymptotically as number of stocks in the portfolio increases. The curve levels out around 30 stocks, and authors in the early literature on naïve diversification typically conclude that an investor needs only a small number of securities to gain most of the benefits from diversification. In more recent literature, however, some observe that this conclusion is incorrect, because it does not take into account the cross-sectional dispersion of portfolio risk.

Faculty at smaller colleges and universities often face budget restraints that put research databases out of reach. I illustrate how a teacher can help students better

understand the risk reduction that occurs in naïve diversification without resorting to commercial simulation software or expensive databases. I present a class project in which students collect data from free sources on the Internet and then analyze this data in Microsoft Excel. By working together, even a small class can assemble a database on a large number of stocks.

Students begin by replicating the classic graph of the effect of naïve diversification on portfolio risk. Then they learn how to extend this result by empirically estimating the cross-sectional dispersion of risk at each portfolio size, where the dispersion arises from random draws of portfolios. For a representative selection of portfolio sizes, the class generates a large sample of portfolios at each portfolio size and estimates the variance and standard deviation of total return for each portfolio. This data yields empirical cross-sectional distributions of total risk.

With this data, students calculate statistics for the cross-sectional distribution at each portfolio size. I discuss percentile statistics and how to plot them in order to describe the cross-sectional distribution of total risk. The resulting charts help students not only view the dispersion of risk but also see that the cross-sectional distribution does not follow a normal distribution. Hence, percentile curves represent the dispersion of risk more robustly than confidence bands constructed with the standard deviation.

Finally, students apply their data to partition total risk into diversifiable and systematic risk. This exercise sheds light on why diversification reduces total risk but only up to a point. Students learn that diversification reduces diversifiable risk but not systematic risk, which illustrates the importance of focusing on diversifiable risk. Moreover, students see that the level of diversifiable risk is significant even for large portfolio sizes.

Review of the Literature

A standard paradigm in modern finance is that portfolio risk can be partitioned into systematic and diversifiable risk. As securities are added to a portfolio, company-unique risk is diversified away, leaving only exposure to systematic risk. Whether or not investors are compensated for diversifiable risk is not settled. See, *e.g.*, Goyal and Santa-Clara (2003) and Malkiel and Xu (2004). I do not address that question. An underlying assumption in this paper is that only systematic risk affects security returns. Hence, investors should care about diversifying away company-unique risk.

The earliest papers in the literature on naïve diversification focus on the asymptotic decline of average total risk to market risk. See, *e.g.*, Evans and Archer (1968), Johnson and Shannon (1974), Bird and Tippett (1986), and Statman (1987). They show that diversification (specifically, adding stocks to an equal-weighted portfolio) decreases a portfolio's total risk. Moreover, the marginal reduction in average total risk declines rapidly to that of the market.

More recent papers extend these results by evaluating the cross-sectional dispersion of portfolio risk under naïve diversification (*e.g.*, Newbould and Poon (1996), Surz and Price (2000), and Bennett and Sias (2011)). These authors show that the range of volatility is relatively large even at portfolio sizes as large as 200 or 300 stocks and that this volatility is partly due to the remaining diversifiable risk.

Textbooks focus on the former results but not the latter. Tang (2004) surveys investment and financial management textbooks and finds that they conclude that eight to 40 stocks are sufficient to eliminate most of a portfolio's diversifiable risk. These textbooks cite the early literature. A casual survey of recent editions indicates that not much has changed since Tang. For example, Bodie, Kane, and Marcus (2014, p. 207) display the chart from Statman (1987) showing that average standard deviation of portfolio return levels off at about 20 stocks. Brealey, Myers, and Allen (2014, p. 173) present a chart of the average standard deviation of portfolio return and conclude that most of the benefit from diversification occurs for about 20-30 stocks.

Pedagogical Objectives

This project is designed to help students think about three questions. What do we mean by diversification? Why does diversification matter? How much diversification is enough? By the end of the project, students should be able to do the following.

1. Describe the effects of diversification on total portfolio risk.
2. Apply asset pricing models to partition total portfolio risk into systematic and diversifiable risk in order to explain the behavior of risk as we diversify.
3. Construct and interpret cross-sectional distributions of total and diversifiable risk at each portfolio size and recognize that—by random chance or misjudgment—an investor might select a portfolio whose risk is significantly above average.
4. Estimate unsystematic shocks and explain the implications for total portfolio risk.

Sources of Data

Data for Individual Stocks

We need data for calculating total returns for individual stocks. Yahoo! Finance (https://finance.yahoo.com) offers a readily available source of free historical data.

It provides a daily closing price adjusted for cash dividends and stock splits. Hence, we can calculate total returns directly from Yahoo's adjusted daily closing prices.

The first step is to draw up a list of stocks. For this paper, I compiled a list of stocks from the portfolio composition file (PCF) for the Vanguard Large Cap Exchange Traded Fund (ETF) (Vanguard, 2017). This ETF tracks the CRSP U.S. Large Cap Index, which Philips and Kinniry (2012) report constitutes about 85% of the market capitalization of the U.S. stock market.

Of the 602 stocks on the list, the actual number with usable data depends on how far back in time we wish to examine the data. This list does not include all stocks listed on the U.S. stock exchanges. Nonetheless, it is larger than the data set in many papers in the literature on naïve diversification and suffices for demonstrating how to carry out the analysis. I use the 498 stocks with complete monthly returns data over 2012-2016 plus the previous five-year period. This screen reduces the chance of including stocks with missing data and very low trading volume and thus assures that the stocks were sufficiently liquid that they could have been purchased without causing price impact.

The instructor divides the list of stocks among students in the class. For example, with a class of 20 students, each student could be assigned 30 stocks if the master list is based on the CRSP U.S. Large Cap Index. Each student collects the data independently; students assigned to the same subset compare their results to verify accuracy and completeness.

In order to collate the data in a manner easy to analyze in Excel, the instructor creates a template Data Check Worksheet for flagging common data anomalies in Yahoo! Finance. (Please contact the author for suggestions on setting up this worksheet.) Students set up a Data Check Worksheet for each stock assigned to them. Once students have collected the price data, cleaned it up for data anomalies, and organized the price series in a standardized format, the instructor collates the data. For this project, the only price series needed for each stock is the adjusted close. From this data we can calculate daily total returns and hence construct monthly total return series for each stock.

Market Data

To decompose total risk, we must choose a proxy for the market. In the naïve diversification literature, authors frequently assume that weights and rebalancing of the market portfolio must match the weights and rebalancing applied to the N-stock portfolios in their studies. However, the market is a value-weighted portfolio of all traded securities. Hence, the factor models for decomposing total risk into market risk and company-unique risk apply to any portfolio, *regardless of how that portfolio is weighted or rebalanced*.

In the literature on naïve diversification, the most common choice of a proxy for the market is the set of securities available for sampling. However, if we use

a one-factor market model to partition total risk, then the total market index in *Current Research Returns* (2018) is a better proxy for the U.S. stock market. This value-weighted index is formed from all CRSP firms incorporated in the U.S. and listed on the major U.S. stock markets. Moreover, French's total market index is constructed from high-quality CRSP data, is screened to assure good returns data, and does not suffer from the survivorship bias present in a market index constructed using all stocks in a study's sample.

I illustrate this project with time series of monthly returns for the five-year period 2012–2016. I derive the monthly returns from the daily adjusted price data for individual stocks and use monthly market returns from the *Current Research Returns* (2018). Monthly is the most common choice in the literature on naïve diversification.

Analysis of Total Risk: First Pass

Each student calculates returns for his or her stocks from the adjusted closing prices on the last trading day of the previous month and the current month, *e.g.*, as $r_t = P_t/P_{t-1} - 1$, where P_t is the adjusted close for month t. Students then submit their adjusted closing price time series and returns time series to the instructor, who collates the data and returns it to the class.

Analytical Approach to Estimating Average Cross-sectional Total Risk

Elton and Gruber's (1977, p. 418) analytical formula for expected variance of total portfolio return is a function of N, the number of securities in an equally weighted portfolio:

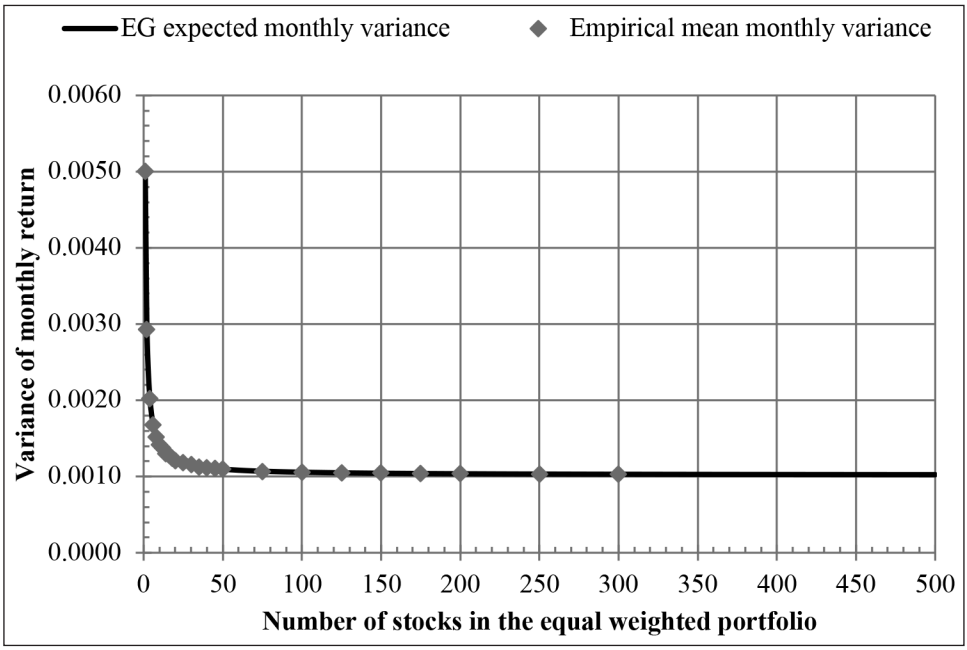
$$E(\sigma_p^2(N)) = \frac{1}{N}\overline{\sigma^2} + \frac{N}{N-1}\overline{cov(l,j)} \quad (1)$$

where $\sigma_p^2(N)$ is the variance of return for the portfolio, $\overline{\sigma^2}$ is the average variance of return for all stocks in the population, and $\overline{cov(l,j)}$ is the average covariance of returns for all pairs of stocks in the population. In Equation (1), expected variance is with respect to a simple random draw from the population of all possible portfolios. The expectation is over the cross-sectional distribution of total risk, ***not*** with respect to the probability distribution for total return.

To apply Equation (1), each student estimates variance of total return for his or her stocks, *e.g.*, using Excel's VAR.S function. The instructor collates results and then delivers them to the class so that each student may calculate the average variance. Estimating covariances is tedious, however, because it requires M(M-1)/2 computations, where M is number of stocks in the study. In order to estimate the covariances for all pairs of stocks, it may be more efficient for the instructor to provide students with the average covariance.

Next, students set up an Excel spreadsheet to apply Equation (1), where N is in the first column and the estimate of the expected variance for a portfolio with N securities is in the second column. They construct a chart showing the effect of naïve diversification on total portfolio risk. See Figure 1 for an illustration. As in previous studies, the estimate of expected portfolio variance declines rapidly and levels off at about 30 to 40 stocks.

Figure 1. Comparison of Elton &Gruber (EG) Formula for Mean Variances with Empirical Estimates; Equal-weighted Portfolios Formed from U.S. Large Cap Stocks, 2012-2016



At this point, it is helpful to guide a class discussion in which students discuss the assumptions and limitations of Figure 1.

- A key assumption is that the population of securities on hand is a good proxy for the U.S. stock market. The large cap index is a good proxy, because it accounts for roughly 85% of total market cap. Nonetheless, a large cap index omits more risky and hence more volatile small caps. Thus, the curve in Figure 1 is biased optimistically, *i.e.*, is lower than it would be if we included small caps as well as large caps.
- The results assume that portfolios are equal weighted and rebalanced monthly. What might we might observe under other assumptions about weighting and rebalancing? Students could be directed to Bennett and Sias (2011), who address this point.

- The results are in terms of variance of returns. These are not intuitive nor easily compared to commonly available performance information. Unfortunately, due to Jensen's Inequality,

$$E\left\{\sqrt{\hat{\sigma}_p^2}\right\} \leq \sqrt{E\{\hat{\sigma}_p^2\}}, \tag{2}$$

with strict inequality if returns are not constant. Hence, estimating standard deviation by taking the square root of the variance estimator introduces a downward bias. However, for sufficiently large sample sizes of returns, the bias is likely to be small (*e.g.*, see Brugger (1968) and Cureton (1968)).

Empirical Approach to Estimating Average Cross-sectional Total Risk

In the next stage, the class performs an empirical analysis of the cross-sectional distribution of total portfolio risk. Students draw samples of portfolios of N stocks. Analysis up to $N = 300$ is sufficient to observe the key results.

Sampling the Portfolios at Each Size N

The general steps for the sampling at each size N are the same with one exception. When $N = 1$, we can analyze all possible one-stock portfolios; no sampling is required. For each $N > 1$, students perform simple random sampling without replacement (SRS) from the set of available stocks for the project.

For $N > 1$, the larger the sample size, the more stable the estimates will be for extreme percentile statistics. In this project, the sample size is dictated by the ease of computation in Excel. Excel spreadsheets for versions 2007 and later are large. Hence, our primary constraint is speed at which Excel recalculates the values in the spreadsheet. Speed slows down noticeably for sample sizes of 100 portfolios or more. Thus, we might assign each student the task of generating 100 portfolios for one or more portfolio sizes. For each portfolio size N, the instructor collates the separate student-generated samples to form a combined sample. In this paper, I report results for a combined sample of 1,000 portfolios at each size $N > 1$.

Excel Workbook for Drawing Samples of Stocks

To facilitate the large-scale calculations, the instructor should construct a template Excel workbook for each size N. (For a detailed description of how this workbook could be set up, please contact the author.) In this workbook, the instructor provides each student with all of the price data collected by the class. The template workbook is set up to calculate portfolio monthly returns for the selected historical period once the student loads a table of random numbers

generated in a separate workbook; the workbook performs an SRS using these random numbers.

Once the portfolio monthly returns are calculated, students apply VAR.S and STDEV.S to calculate estimates of the sample variance and sample standard deviation, respectively, when N is greater than 1. (For N = 1, apply VAR.P and STDEV.P.) Each student reports the results to the instructor, who compiles a table of variances and standard deviations for all portfolios in the sample at each portfolio size and then returns these results to the class for further analysis.

Analysis of Empirical Cross-sectional Distribution of Total Risk

Students overlay empirical estimates of average variance of total return on the curve constructed from the Elton and Gruber (1977) formula. See Figure 1. For a sample size of 1,000 portfolios at each $N > 1$, the empirical estimates are virtually the same as the estimates from the formula. This exercise assures students that empirically generated estimates can be as informative as analytical estimates.

Astute students recognize that some portfolios at each size N must have variance above the average. Hence, the average is an incomplete description. Moreover, if the cross-sectional distribution of total risk at each N is not symmetric, then the average and standard deviation of the cross-sectional distribution are not helpful in making probability statements about the likelihood that total risk of a randomly selected portfolio is above the average. Students can evaluate the departure from symmetry by applying Excel's SKEW function to the cross-sectional distributions at each portfolio size.

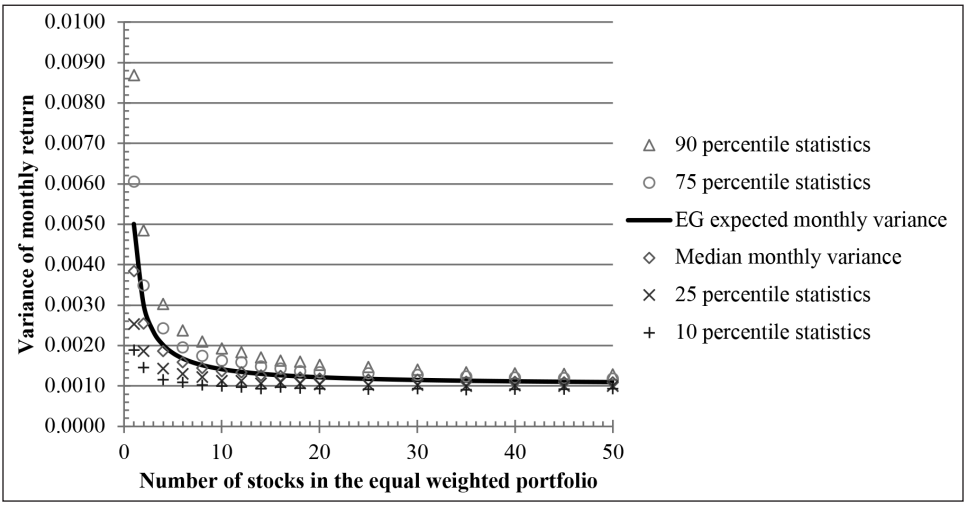
For just about any large set of stocks, the class is likely to observe the departures from a normal distribution for the cross-sectional distributions of variance (or standard deviation). When discussing these results, instructor should elicit two implications. First, the median total risk will be more informative than the average, especially at smaller portfolio sizes. We know that half of the portfolios have total risk greater than the median, whereas we cannot make a similarly precise probability statement based on the average. Second, given that some portfolios have greater than average risk, we need some way to measure this dispersion other than standard deviation when the cross-sectional distribution is not normal.

To examine the dispersion of portfolio risk, the most informative approach may be to construct a chart of the median and selected percentile statistics at each portfolio size N. Students can easily calculate these statistics based on the samples of variances and standard deviations.

Figures 2A ($N \leq 50$) and 2B ($N \geq 50$) illustrate the types of charts that the students could be asked to construct to help them visualize the cross-sectional dispersion of total risk. These figures show the Elton and Gruber (1977) estimate of average variance of total risk along with the empirical estimates of the median,

the 25 and 75 percentile statistics, the 10 and 90 percentile statistics, and the 98 percentile statistics.

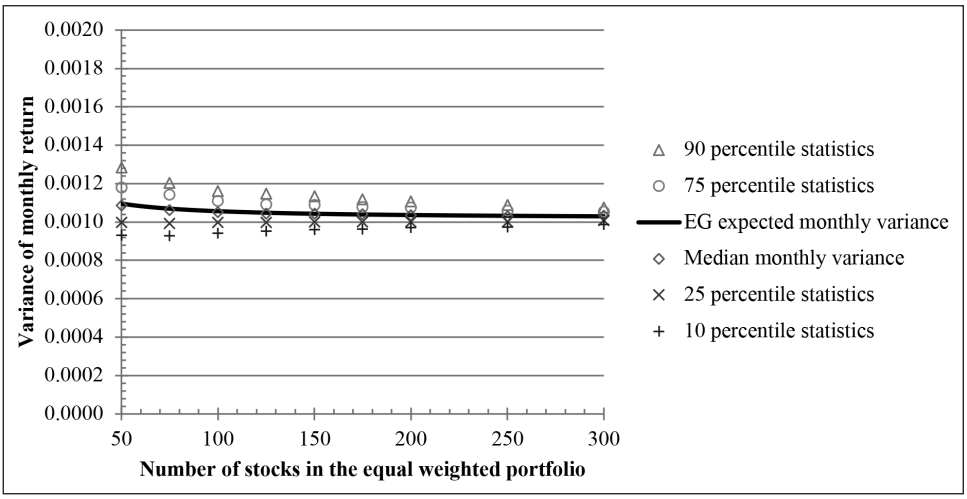
Figure 2A. Comparison of Elton and Gruber (EG) Formula for Mean Variance of Total Portfolio Return with Empirical Estimates of the Median and Selected Percentiles; Equal-weighted Portfolios Formed from U.S. Large Cap Stocks, 2012-2016 (N ≤ 50 stocks)



Total risk drops off rapidly and then levels off as N increases. The pattern holds whether we observe the cross-sectional average variance of total return or the cross-sectional median. Moreover, the median is substantially less than the mean for small values of N. However, above N = 30 stocks, the two statistics are approximately the same. This convergence coincides with the reduction in skew and indicates that the cross-sectional distribution of portfolio variances becomes approximately symmetric for N > 30. Thus, students can see that *somewhat less than half* of all *small* portfolios have total risk greater than the average, but approximately half of all large portfolios have total risk greater than the average.

The percentile statistics in Figures 2A and 2B show the dispersion of the cross-sectional distribution of the variance of total portfolio return at each portfolio size N. Students can see that a chart displaying only the median or average omits important information about the chance of selecting a portfolio with greater than the median or average risk. If each portfolio of size N has an equal chance to be selected, then the investor has a 50 percent chance that total risk will be *greater* than the median. In principle, we could plot the cross-sectional distributions in a single chart. However, the scale of the dispersion for one-stock portfolios leads to a visual compression of the dispersion when N is large. As a result, it appears that this dispersion is virtually zero when N is large. By splitting the chart between relatively undiversified portfolios (N ≤ 50 stocks) and more diversified portfolios,

Figure 2B. Comparison of Elton and Gruber (EG) Formula for Mean Variance of Total Portfolio Return with Empirical Estimates of the Median and Selected Percentiles; Equal-weighted Portfolios Formed from U.S. Large Cap Stocks, 2012-2016 (N ≤ 50 stocks)



it is easier to see the dispersion of total risk when N is large. Figure 2B illustrates that dispersion still is present at larger portfolio sizes.

Explaining the Effects of Diversification on Risk

In the first part of the project, students learn how to verify the claim that total portfolio risk falls, on average, as number of stocks in the portfolio increases. They also learn how to describe the dispersion of cross-sectional total risk.

Two related questions should arise in class discussion. Why does total risk not fall to zero for a sufficiently large number of stocks? How can we characterize the level to which total risk converges asymptotically? Intuitively, the answers are that total risk converges to market risk when the number of stocks in the portfolio approaches that of the market itself. But it cannot fall to zero, because the market as a whole is risky. In the second part of the project, students learn how financial economists support these intuitive propositions by applying asset pricing models.

Asset Pricing Model

In the next part of the project, we apply the single index market model (SIMM):

$$\tilde{r}_{it} = \alpha_i + \beta_{mi}\tilde{r}_{mt} + \tilde{e}_{it} \quad (3)$$

where $\tilde{r}_{it}$ is the total return on stock i in period t, in excess of the one-month T-bill return, with standard deviation σ_i; $\tilde{r}_{mt}$ is the total return on the market index m in period t, in excess of the one-month T-bill return, with standard deviation σ_m; and

$\tilde{e}_{it}$ is the error term for stock stock i in period t, with mean zero and finite standard deviation σ_{ei}. We make the standard assumptions, *e.g.*, see Elton, Gruber, Brown, and Goetzmann (2010, pp. 132-134). In particular, assume that the error terms are uncorrelated with the market index, and the error terms for different stocks are uncorrelated. The SIMM is a reasonable model for this project, because it performs well relative to alternative asset pricing models. See, *e.g.*, Bennett and Sias (2011), Chan, Karceski, and Lakonishok (1999), and Elton and Gruber (1973).

We can show that the partition of total risk for stock i is

$$\sigma_i^2 = \beta_{mi}^2 \sigma_m^2 + \sigma_{ei}^2, \tag{4}$$

where we label the first term on the right-hand side as systematic risk and the second as diversifiable risk. In the context of the SIMM, labeling these risks as "market risk" and "company-unique risk," respectively, is a common practice that we also follow. For an equal-weighted portfolio of N stocks, the partition of total risk takes a form analogous to Equation (4):

$$\sigma_p^2 = \beta_{mp}^2 \sigma_m^2 + \sigma_{ep}^2, \tag{5}$$

where

$$\sigma_{ep}^2 = var(\tilde{e}_p) = \left(\frac{1}{N}\right)^2 \sum_{i=1}^{N} \sigma_{ei}^2 \tag{6}$$

Estimating Single Index Market Model Parameters

In principle, we could estimate the parameters for the individuals stocks and then calculate the corresponding portfolio parameter estimates as averages of those estimates. However, earlier in the project we generated the monthly portfolio returns. Hence, at this stage, it is more computationally efficient to calculate the excess monthly portfolio returns and then apply least squares regression directly to these returns.

For one-stock portfolios, each student has a table of 60 monthly total returns for each of the 498 stocks for 2012-2016. For N-stock portfolios, N > 1, students have a table of the time series of monthly returns for each portfolio in their samples. Students collect the time series of one-month T-bill yields and market excess monthly returns from the *Current Research Returns* (2018) for the 60-month period. Then they calculate the excess monthly returns for each portfolio (all N-stock portfolios in their samples). Next, they estimate the systematic risk and diversifiable risk for each portfolio. Finally, students submit their work to the instructor to verify that they have carried out the calculations correctly. The instructor collates these results and distributes them to the class.

Basic Results

How to Present the Results of Naïve Diversification

Here, I illustrate the types of charts that we might ask students to construct. In the first set of charts, we compare presentation in terms of variance versus standard deviation. Figures 3 and 4 both show the median values of total risk, market risk, and company-unique risk at each portfolio size. The additivity of the partition is easy to see in Figure 3, where risk is displayed in terms of variance of return. Company-unique risk declines asymptotically to zero as total risk declines rapidly and asymptotically to market risk. The chart appears to show that most of the company-unique risk is diversified away for portfolios of 50 or more stocks. At 50 stocks, the median company-unique risk is about 3.7% of the median company-unique risk for one-stock portfolios. This chart appeals to our intuition that increasing the number of stocks should diversify away the company-unique risk. Moreover, it is consistent with the conventional interpretation that most company-unique risk is diversified away at small portfolio sizes.

Figure 4 tells a somewhat different story. Median total risk still declines and converges quickly to median market risk. However, when risk is expressed in terms of standard deviation of returns, the median company-unique risk declines but remains visibly different from zero even at

Figure 3. Partition of Total Risk In Terms of Variance of Portfolio Return: Median of Each Type of Risk (partition based on 1-factor market model; 2012-2016 data)

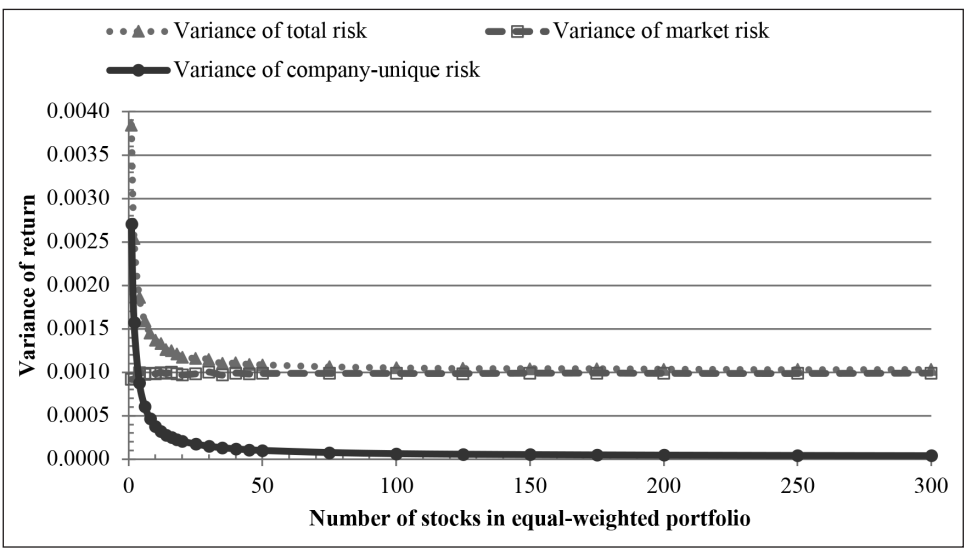
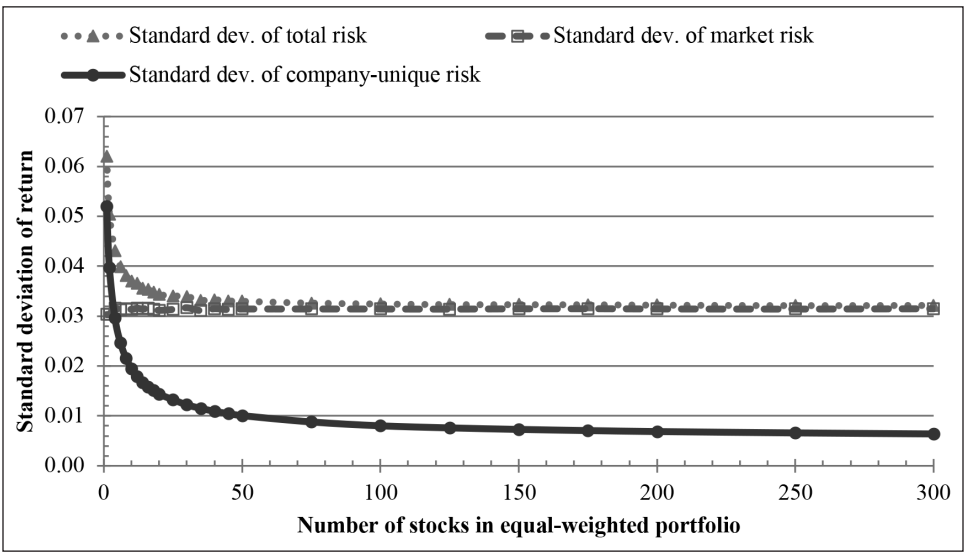


Figure 4. Partition of Total Risk In Terms of Standard Deviation of Portfolio Return: Median of Each Type of Risk (partition based on 1-factor market model; 2012-2016 data)



a portfolio size of 300 stocks. At 300 stocks, the median company-unique risk is about 12.3% of the median company-unique risk for one-stock portfolios; the absolute level of the median is about 0.64% per month (when annualized, about 2.2%). Figure 4 shows that company-unique risk has not been "almost completely" diversified away for the majority of 300-stock portfolios.

Figures 5A and 5B illustrate a more informative way to present the effects of naïve diversification by showing the cross-sectional dispersion of total risk. Also, they illustrate the importance of scale when reading a chart. The scale for Figure 5A is determined by the wide dispersion of total risk for individual stocks. By splitting the chart into two parts, we are able to better examine dispersion when N is greater than 50 stocks. Otherwise, the impression based on Figure 5A is that dispersion is close to zero for $N \geq 50$.

From these charts, students can draw two important conclusions about cross-sectional total risk that cannot be made from the median alone. First, Figures 5A and 5B show that cross-sectional dispersion steadily decreases as N increases. Table 1 supplements the visual impression. In particular, the upside *dispersion* of risk (last column in Table 1) is not negligible for 50-stock portfolios (0.35% per month) but does become very small as N reaches 300 stocks. Thus, the observation that the *median* cross-sectional risk converges to the market risk is complemented by the conclusion that, *for most portfolios* (not just the portfolio at the median), the total portfolio risk approaches market risk as N increases. Second, the range of cross-sectional risk shifts downward. We intuitively expect that total portfolio risk

for all portfolios decreases as diversification improves. However, from Figure 5A and Table 1, students can observe a more subtle point: *most* (at least 80 percent of) relatively undiversified portfolios (50 stocks or less) have total risk greater than that of the total stock market (monthly standard deviation of 3.12%). This point gets lost when we only show the median.

Figure 5A. Dispersion of Total Risk In Terms of Standard Deviation of Portfolio Return, N ≤ 50 (partition based on 1-factor market model; 2012-2016 data)

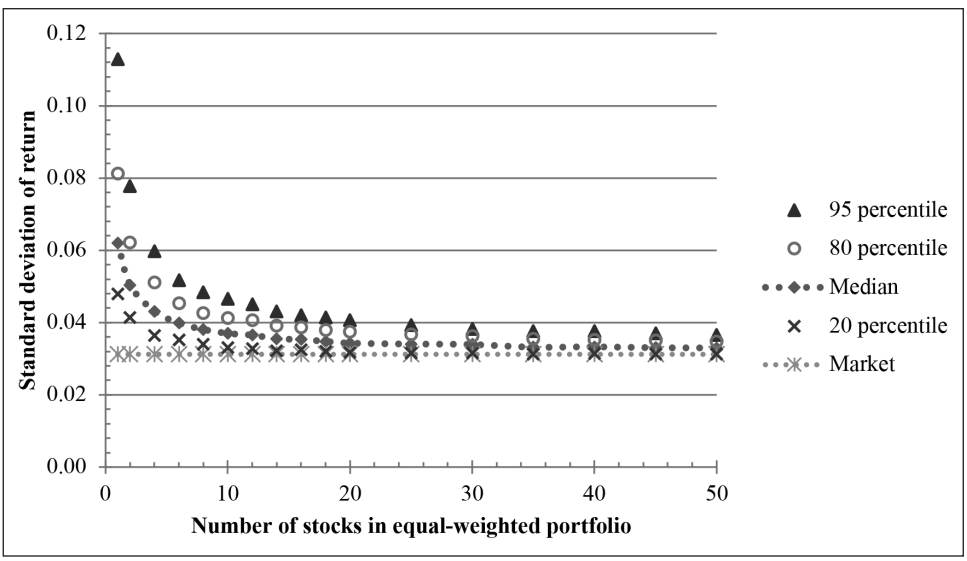


Figure 5B. Dispersion of Total Risk In Terms of Standard Deviation of Portfolio Return, N ≥ 50 (partition based on 1-factor market model; 2012-2016 data)

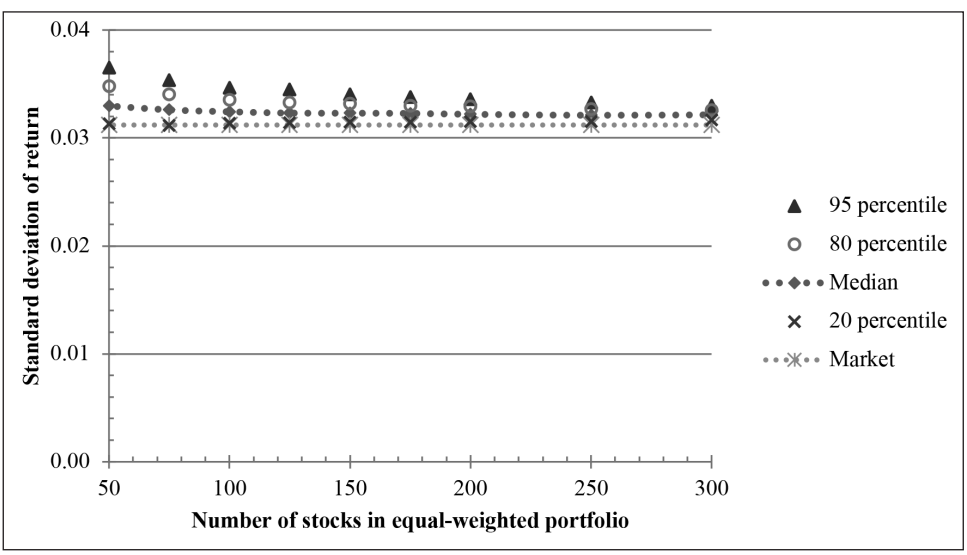


Table 1. Cross-sectional Dispersion of Monthly Total Portfolio Risk At Different Portfolio Sizes

Portfolio size	Standard deviation of excess monthly portfolio total return					
	5%-tile	20%-tile	Median	80%-tile	95%-tile	Difference between 95%-tile and median
1	4.04	4.80	6.20	8.12	11.29	5.09%
10	3.05	3.31	3.70	4.12	4.66	0.96%
20	2.96	3.17	3.43	3.74	4.06	0.63%
30	2.99	3.16	3.39	3.63	3.82	0.43%
50	2.99	3.13	3.30	3.48	3.65	0.35%
100	3.02	3.13	3.24	3.35	3.46	0.22%
300	3.12	3.17	3.21	3.26	3.30	0.09%

Note. Total portfolio risk is calculated for the excess portfolio total return, given portfolio size N (*i.e.*, number of stocks) and an equal-weighted portfolio rebalanced monthly. The population of stocks consists of 498 U.S. common stocks in the Vanguard Large Cap ETF as of May 15, 2017. The results are based on monthly total returns over the 60-month period, 2012-2016. The market proxy is the total stock market index. Monthly returns for this index are excess returns for the CRSP total U.S. stock market index. Sample statistics are for the cross-sectional distribution of risk measured as standard deviation of monthly return.

Figures 6A and 6B illustrate how students might chart diversifiable risk. Range of cross-sectional company-unique risk narrows at a decreasing rate as number of stocks in the portfolio increases. Although not illustrated here, we observe a similar narrowing of range for the cross-sectional portfolio market risk. Thus, the narrowing range of total risk is due to decreasing cross-sectional dispersion of *both* the portfolio market risk and company-unique risk.

Figures 6A and 6B also show students that the cross-sectional range of unique risk *shifts downward*. The cross-sectional distribution of the market risk, on the other hand, narrows but does not shift downward. Hence, the downward shift in the *range* of total risk observable in Figures 5A and 5B is entirely due to the downward shift in the range of company-unique risk.

By constructing these charts, students observe important features of company-unique risk under naïve diversification. Level and range decline as number of stocks increases. However, the decline to zero occurs much more slowly than conventional charts suggest. For 80% of portfolios of 300 stocks or less, diversifiable risk is above 0.61% per month, or about 2.11% annualized.

These charts enable students to see another subtle feature. The downward shift in risk is greatest for small values of N, but the range also falls significantly for larger values of N. For example, the 20th percentile of company-unique risk is 1.09% for 30-stock portfolios. But increasing the number of stocks to 75 reduces the 80th percentile to 0.97%. In other words, 80 percent of the 75-stock portfolios have *less diversifiable risk than over 80 percent of the 30-stock portfolios*.

Figure 6A. Dispersion of Company-unique Risk In Terms of Standard Deviation of Portfolio Return, N ≤ 50 (partition based on 1-factor market model; 2012-2016 data)

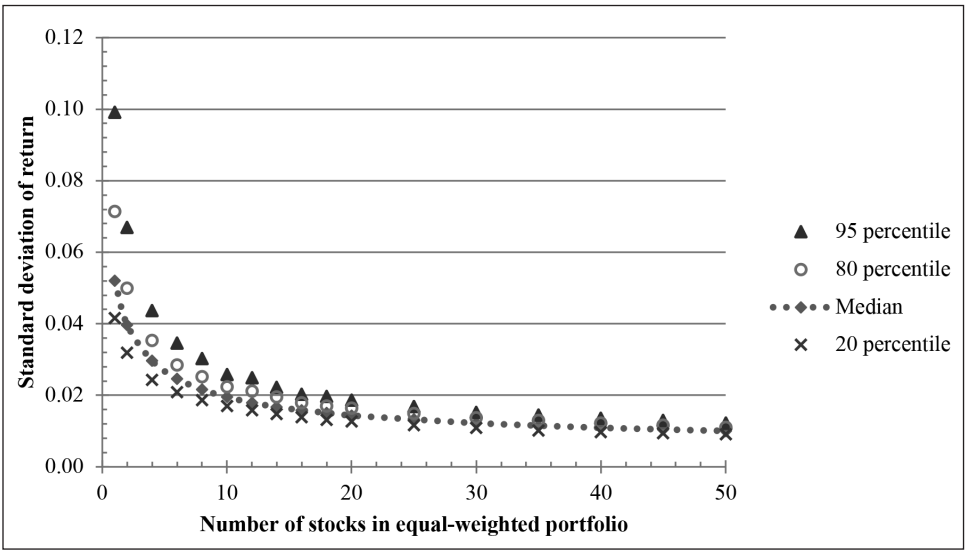
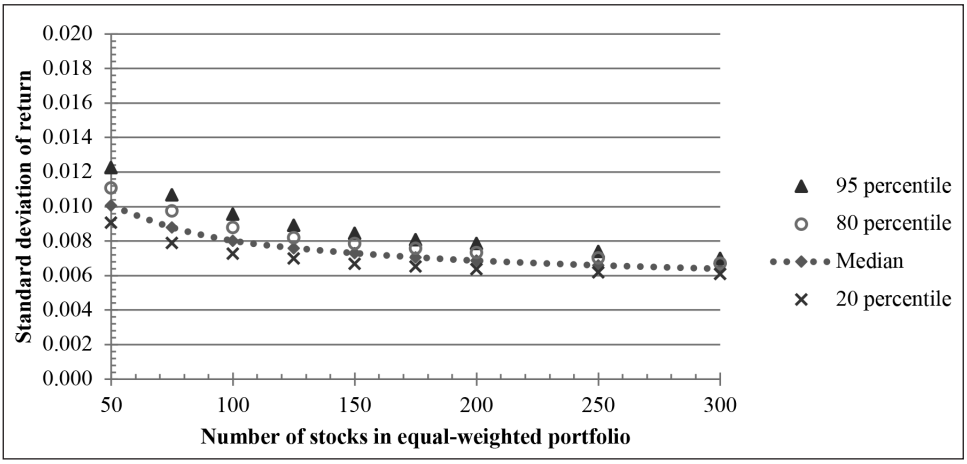


Figure 6B. Dispersion of Company-unique Risk In Terms of Standard Deviation of Portfolio Return, N ≥ 50 (partition based on 1-factor market model; 2012-2016 data)



Implications of Diversifiable Risk in a Portfolio

The cross-sectional distributions at each portfolio size provide information about the effectiveness of diversification in protecting the investor from **security selection risk**, *i.e.*, the odds of selecting a portfolio with risk that could have been diversified away. An important question not yet answered is the significance of the level of diversifiable risk in portfolios with large numbers of stocks. What exactly

does it mean if company-unique risk is 0.5% to 1.0% per month, and is this level large enough to matter in a practical sense?

We turn now to the question of how to define "negligibly different from zero" for diversifiable risk. Bennett and Sias (2011) argue that what should matter is not how much has been eliminated ***but how much remains***. Any measure of the effect of diversification that does not do so may not be a good tool. For example, Fisher and Lorie's (1970) dispersion ratio measures relative reduction in total risk, and Surz and Price's (2000) R^2 statistic measures how much of cross-sectional variation in total risk is explained by the market. Neither measures the magnitude nor significance of remaining company-unique risk.

The final stage of the project focuses on the **unsystematic shocks** defined in terms of the left tail of the returns distribution. These shocks arise from the portfolio error terms, σ_{ep}, in the single-index market model. Hence, they are realizations of remaining company-unique risk in a portfolio of N stocks. By assumption, the means are zero. Students estimate σ_{ep}, the portfolio's company-unique risk in terms of standard deviation.

In order to make probability statements about unsystematic shocks, we must assume a probability model for the error terms. Assume that the $\tilde{e}_{pt}$ follow a normal distribution and are independent over time. Let $\hat{\sigma}_{ep\,(N,q)}$ be the estimate of the company-unique risk (a property of the returns distribution) for the portfolio at the q-th percentile (a property of the cross-sectional distribution) among portfolios of size N. Then the following probability statements hold.

- There is about a 16% chance that portfolios with company-unique risk at the q-th percentile will have a monthly unsystematic shock of $-\hat{\sigma}_{ep\,(N,q)}$ or worse. For portfolios at higher percentiles, say $q^* > q$, we have $\hat{\sigma}_{ep\,(N,q^*)} > \hat{\sigma}_{ep\,(N,q)}$. For these portfolios, the probability is greater than 16% that the portfolio will experience a monthly unsystematic shock of $-\hat{\sigma}_{ep\,(N,q)}$ or worse.
- Assuming independence of the monthly returns, there is approximately a 16% probability that portfolios at the q-th percentile will have an annual unsystematic shock of $\sqrt{12}\hat{\sigma}_{ep}(N,q)$ or worse. For portfolios at higher percentiles, say $q^* > q$, the probability is greater than 16%.

We need a frame of reference for evaluating the unsystematic shocks. Stocks in this project are U.S. large caps, so a good benchmark is the S&P 500 index. Ibbotson (2017) reports that the historical average annually compounded total return on this index is 10.0% for 1926-2016. Thus, students can interpret the unsystematic shocks as deviations from the return that they might have earned on an S&P 500 index portfolio. (A given portfolio might have market beta different from one. Hence, this approach is not quite correct but is good enough to get a sense of perspective on the magnitude of the shocks.)

Table 2. Unsystematic Shocks: Upper End of Range of Shocks That Have an Approximately 16% Chance of Occurring; Equal-weighted Large Cap Portfolios, 2012-2016

Size of portfolio	50th percentile of company-unique risk (standard deviation in %)	Monthly unsystematic shock (standard deviation in %)	Annualized unsystematic shock (standard deviation in %)
1	5.20	−5.20	−18.03
2	3.97	−3.97	−13.74
4	2.96	−2.96	−10.26
6	2.47	−2.47	−8.54
8	2.16	−2.16	−7.48
10	1.95	−1.95	−6.76
20	1.43	−1.43	−4.97
30	1.22	−1.22	−4.23
50	1.01	−1.01	−3.48
75	0.88	−0.88	−3.04
100	0.80	−0.80	−2.78
200	0.69	−0.69	−2.38
300	0.64	−0.64	−2.21

Notes. Unsystematic shocks in this table assume a single index market model with error terms that have a normal probability distribution with mean of zero. (When we assume a lognormal model, the results are nearly the same.) Size of portfolio is the number of stocks in an equal-weighted portfolio.

When discussing the unsystematic shocks in Table 2, the class should address three questions. First, to what portfolios do these results apply? Table 2 displays shocks for portfolios with company-unique risk at the 50th percentile of the cross-sectional distribution at each portfolio size N. Second, how do these results compare to the benchmark? As a first pass, students don't require statistical analysis to answer this question, because the unsystematic shocks are relatively large in magnitude. A simple percentile calculation suffices, *e.g.*, for 300-stock portfolios, the annual unsystematic shock that could occur in about one out of six years is at least 22% (2.21%/10%) relative to the market return. (A 20% decline in the stock market is a common definition of a bear market.) For relatively undiversified portfolios, the shock is greater.

Third, could the shock be worse than the values listed in Table 2? The statistics are the *upper endpoint* of the left-hand tail of the error term that represents return due to company-unique risk. Thus, for a given portfolio of size N with company-unique risk at the 50th percentile, the unsystematic shock could be much greater in magnitude. Moreover, for portfolios with company-unique risk *above* the

50th percentile, the corresponding unsystematic shock will be ***greater than the magnitude listed in Table 2***.

Conclusions

The general objective of this project is to give students a sense of the formal analysis necessary to evaluate questions in finance. This project illustrates that a quick and facile analysis can easily lead to wrong conclusions. This lesson is a hard one to convey in the age of the Internet with its expectations of instantaneous results, but it is important if our finance students are to become thoughtful professionals. This project illustrates how to organize a comprehensive approach to answering a question: how does naïve diversification affect risk? The project also shows that one can evaluate many questions deeply with relatively basic tools.

This project may lead to a general discussion about how investors *should* diversify. Typically, investments textbooks use the topic of diversification as a lead into modern portfolio theory. However, students may wonder why we discuss naïve diversification in the first place if investors do not select securities at random in practice and, per modern portfolio theory, should not select securities at random. One objective of the project is to help students recognize that if they don't diversify adequately, then they are exposed to considerable risk for which they are unlikely to be compensated. Moreover, even an apparently well-diversified portfolio still may expose the investor to nontrivial unsystematic shocks.

We also could point out that naïve diversification shows what could happen (at least in terms of risk exposure) if you mess up your security selection and, in particular, include too few stocks in your portfolio. An important lesson from behavioral finance is that investors tend to be overconfident in their abilities. For example, Goetzmann and Kumar (2008) report that over 90 percent of the investors hold only ten stocks or less in their portfolios, and more than half hold three stocks or less. They also find that investor's choices of stocks are consistent with overconfidence, trend-following, and local bias. This project may help students better understand how diversification can protect them from their own worst instincts.

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Retirement Planning with Spreadsheets: Monte Carlo Simulations without Third Party Software

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A shortcoming of a simple retirement planning spreadsheet exercise is the false sense of certainty that a student may feel when using expected rates of return with no variability. This article presents a pedagogical exercise that simulates annual returns using random draws from appropriate probability distribution(s) and storing those results to provide summary statistics for analysis. This is done using an off-the-shelf version of Excel without costly third party software, such as @Risk or Crystal Ball. This exercise also allows students to see the drawbacks of using distributional assumptions compared with bootstrapping results generated from historical market returns.
Keywords: *Retirement planning, risk, simulation, pedagogy, Excel*

Introduction

Many introductory finance courses use financial planning assignment to support instruction on time value of money (retirement planning in particular). A fundamental drawback to such assignments is the absence of realistic random shocks, leaving students with a limited and misleading understanding of the effects of risk on financial planning. In this article, we propose an assignment that not only illustrates the impact of risk in retirement planning, but also demonstrates two methods for modeling theoretical and actual distributions of outcomes. These approaches can be demonstrated without third-party software like @Risk or Crystal Ball. Both of these tools allow for more robust distributional assumptions than the relatively simplistic models presented here. However, such third-party software products come at the cost of higher licensing fees (that would be passed on to students) as well as technical challenges associated with installation and trouble-shooting. These trade-offs typically do not favor the additional cost and complexity in an introductory business course. For the types of simple simulation

necessary to impose risk in a financial planning exercise, third-party software is not necessary. Furthermore, even if third-party software would add value, these exercises help the student better understand what is happening inside the "black box" of the third-party solutions. The assignment frameworks provided here can be implemented with an off-the-shelf installation of a spreadsheet product such as Microsoft Excel. Formulas presented in this article are related to Excel; other spreadsheets should be able to accomplish the same outcome, but the procedures may differ slightly.

This assignment harnesses the built-in statistical functions of most modern spreadsheets, including a pseudo-random number generator and the most common statistical distribution functions. While it is positioned as a retirement planning exercise, it could easily be modified for any other Monte Carlo or bootstrapping exercise in settings that may range from project selection, portfolio construction or operational applications.

Supporting Files

Two files are available to assist with understanding the pedagogical innovation. The first is an example of a spreadsheet that illustrates the principles outlined in the assignment. This file is available at http://bit.ly/2gQ2IqC.

The second file is a brief video describing the data tables mechanism. It provides a brief overview of data tables as ordinarily used, and then demonstrates their additional use for simulation. This file is available at http://bit.ly/2fX15Yn.

Literature Review

The importance of early exposure to retirement planning principles is well-documented. As employers continue to move away from defined-benefit plans in favor of defined-contribution plans, employees are given more latitude in both participation decisions (both the decision to enroll and level of participation) as well as control over their investment portfolio(s). While this level of employee control is beneficial when participants understand the risk-return trade-offs and portfolio selection choices available to them, it can be deleterious when they do not understand the importance of a deliberate portfolio selection process. As shown by Lusardi and Mitchell (2007), financial literacy and planning is an important predictor of post-retirement wealth levels.

The use of Monte Carlo simulation in retirement planning is not new. Articles ranging from Ervin, Faulk, and Smolira (2009) to Chen and Chang (2010) documented various strategies for using simulation techniques to model the potential results of various retirement strategies. TIAA-CREF advisers, for example, can provide participants with simulation-based estimates of retirement

wealth under certain assumptions about portfolio risk, contributions, and expected retirement age. Schleef and Eisinger (2007), in particular, demonstrated the superiority of a Monte Carlo approach in generating reasonable expectations about portfolio performance in a retirement context, while Bajtelsmit, Foster, and Rappaport (2013) identified the importance of factoring mortality in one's estimates of required retirement wealth.

Findley (2014) provided one approach to retirement planning, but his approach required a basic assumption of algebra and some calculus. The assignment presented in this article imposes no such requirement. While Findley (2014) may have provided additional insights, its reliance on even basic mathematical skill exempts a subset of the population who may benefit.

The first model presented in this article follows standard Monte Carlo simulation principles, drawing random numbers from a familiar statistical distribution used to model investment returns in equity and fixed income assets, adjusted for recommended asset proportions over time. However, as noted by Affleck-Graves and McDonald (1989), such distributional assumptions can severely skew the predicted results compared to what actually occurred historically. Thus, we propose a second model that allows students to learn bootstrapping procedures – sampling from actual investment returns realized over the past century. While such assumptions may limit the range of outcomes available to retirement planners, they are more conservative and provide a more reasonable range of up-side potential.

Data

Our assignment instructs students first to assume distributional assumptions typically thought to reflect asset returns related to well-diversified funds of equity and fixed income instruments. The model allows students to adjust their assumptions if they would consider assuming a higher level of risk in exchange for a higher level of return. Initially, we ask students to create a static model with the assumptions listed in Table 1. These assumptions are based on historical returns from S&P 500 returns for equity holdings and assumed bond index returns for fixed income holdings.

After instructing the students to create a retirement plan based on these assumptions, along with their own choices for equity/fixed income portfolio allocations, we have them check their answers to determine whether they expect to have enough assets to last for their anticipated (relatively conservative) life expectancy. We then instruct them in basic Monte Carlo principles (described below) and ask them to impose additional distributional assumptions, namely, volatility in inflation rate, salary growth rate, equity volatility (standard deviation), fixed income volatility (standard deviation), and risk-free rate (standard deviation). The initial distributional assumptions we suggest are listed in Table 2. The moments

Table 1: Initial Model Assumptions

Demographics	
Current Age	22
Expected Retirement Age	65
Life Expectancy	80
Inflation	
Expected Annual Inflation Rate (%)	2.1
Salary	
Starting Salary	$45,000
Expected Salary Growth Rate (%)	3.5
Savings Behavior	
Employer contribution (%)	6
Employee contribution (%)	9
Current retirement savings	$1,000
Asset Return	
Expected Stock Return	8.03
Expected Bond Return	5
Expected risk-free rate	2.5
Retirement Needs	
% of final salary required	75

Note: Expected stock returns represents the expected annual return on the S&P 500 Index from 1926-2014.

for equity returns are calculated as the mean and standard deviation on the S&P 500 Index from 1926-2014. For this exercise, we assume that equity and fixed income returns are normally distributed with the moments specified in Table 2. Students can experiment with other distributions that may explain asset returns, but we have found that most students have basic familiarity with the normal distribution.

Once the students have created a dynamic model using these distributional assumptions, we discuss whether the results are reasonable. Most students who monitor financial markets will know that they typically are not. We then demonstrate bootstrapping techniques in which we use actual monthly returns on the S&P 500 Index for the period from 1926-2014. For each month, we calculate the holding period return for the previous 12 months, giving a universe of 1,057 annualized returns from which to draw.

Table 2: Initial Distributional Assumptions

Demographics	
Current Age	22
Expected Retirement Age	65
Life Expectancy	80
Inflation	
Expected Annual Inflation Rate (%)	2.1
Standard Deviation of Inflation Rate (%)	1
Salary	
Starting Salary	$45,000
Expected Salary Growth Rate (%)	3.5
Standard Deviation of Salary Growth Rate (%)	1.5
Savings Behavior	
Employer contribution (%)	9
Employee contribution (%)	6
Current retirement savings	$1,000
Asset Return	
Expected Stock Return (%)	8.03
Stock Return Standard Deviation (%)	20
Expected Bond Return (%)	5
Bond Return Standard Deviation (%)	2.5
Expected risk-free rate (%)	2.5
Risk-free rate Standard Deviation (%)	1
Retirement Needs	
% of final salary required (%)	75

Note: Expected stock returns and volatility represent the expected annual return and standard deviation on the S&P 500 Index from 1926-2014.

Application

The assignment is straight-forward for students with an intermediate knowledge of spreadsheets such as Excel. It requires little additional programming, but some students will need to be introduced to the formulas used to generate the hypothesized returns. The basic formula is **=RAND()**, which generates a pseudo-random number from a uniform distribution in the range of [0,1]. By itself, this uniformly distributed random variable has limited use for an application such as this, but when combined with other statistical formulas, it becomes particularly powerful. In our application, where we suggest that students assume normal distribution of asset returns (an assumption that may be relaxed if the student

is familiar with other distributional forms), a random number can be generated from a normal distribution with mean **X** and standard deviation σ with the formula =**NORM.INV(RAND(),X, σ)**, where **X** and σ point to spreadsheet cells containing those inputs .

Replacing the appropriate formulas from the static model with the dynamic formulas above will generate one random draw accumulating returns for the plan participant over their life. Since the nature of Monte Carlo Simulation is to collect a large number of random draws, we need to use an additional, undocumented feature of the spreadsheet to accumulate data from multiple draws. Data Tables is a documented function that is typically used for sensitivity ("what-if") analysis, showing the result of a formula with multiple different inputs. The undocumented feature is that when we use randomly generated numbers, we do not need to provide the input; the spreadsheet will accumulate as many draws from our sample as our CPU power and personal patience will permit. Thus, creating a data table using a value generated from a random variable will collect potentially thousands of observations and permit statistical summaries of those data. For example, we can run the simulation 1,000 times and note the average portfolio value at the presumed mortality age of 80, the average age at which assets are fully expended, the average portfolio value at retirement, and the minimum and maximum age of asset exhaustion. Not only does this exercise give students an appreciation for the importance of early retirement planning (as any static exercise can), it builds in an understanding of the risk associated with risky investments.

As shown below numerically, our Monte Carlo results routinely generate an unrealistically wide range of results. This is expected, since most published analyses do not suggest that stock market returns are normally distributed. However, modeling with normally distributed stock market returns gave students a basic understanding of the spreadsheet mechanics necessary to generate simulation results. This baseline allows us to teach bootstrapping, an alternative approach that would also show students a method for estimating returns based on actual historical data, rather than imputed distributional assumptions.

This approach required gathering actual equity returns from the S&P 500 Index. Since the imputed variability of fixed income returns was relatively small, we did not bootstrap bond returns. However, bootstrapped bond returns would not make the analysis appreciably more complex. After collecting S&P 500 returns, we calculated annual holding period returns for each month in our sample beginning 12 months prior to the month of observation (thus, our first observation of annual holding period returns was in 1927). This gave us a sample of 1,057 unique months of trailing annual returns.

Given this sample of returns, we used the =**RANDBETWEEN(A,B)** function to choose a random month within our sample, with replacement, and impute that month's annual return as the annual return for a given observation . Following

the same procedure as the Monte Carlo simulation described earlier, we collect observations and compute summary statistics.

Results

Monte Carlo Simulation

Our Monte Carlo simulation results typically generated very wide ranges of outcomes. In one run of 1,000 iterations, we saw final wealth values at age 101 ranging from less than −$2,917,730 to $67,035,373 and an inter-quartile range of $5,790,859. The average age of insolvency was approximately 89, but some assets were insolvent by age 68 (with a retirement age of 65). These results seemed to predict both unusually optimistic results as well as unusually dire results.

Bootstrapping Simulation

The bootstrapping method, relying on historical data rather than distributional assumptions, generated more stable results overall. In one run of 1,000 iterations, the results suggested wealth at age 101 ranging from −$2,533,247 to $41,195,460. While these extreme values are still quite wide, they are more constrained than the results suggested by the Monte Carlo simulation. Similarly, the inter-quartile range in this run was $2,299,424—less than half that of the Monte Carlo simulation.

Conclusion/Transferability

We have provided the outlines of a retirement planning assignment for early-level finance courses. This assignment achieves several objectives:

1. Get students thinking about retirement planning early
2. Introduce students to time value of money concepts in a long-term, personally applicable assignment
3. Teach students to use statistical functions available in most spreadsheet software
4. Illustrate the sensitivity of wealth outcomes to risk
5. Demonstrate various method for incorporating risk into planning and estimation
6. Show the techniques for Monte Carlo simulation and bootstrapping in an accessible way that does not require investment in third-party software
7. Give students a sense of the power available using more robust techniques

A spreadsheet created by the authors to illustrate the assignment is available at http://bit.ly/2gQ2IqC. Sample assignment documents used by the authors,

including grading rubrics and learning outcome alignments are included in the appendix. The authors welcome questions potential users may have.

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Appendix 1

Example Assignment

Introduction: This assignment is intended to use basic personal financial tools to illustrate concepts of compounding, time value of money and risk. The assignment has four separate parts, intended to be completed prior to four separate class periods. The class periods do not need to be consecutive, though not too much time should elapse between them so that the ideas do not become stale. The entire assignment will typically be completed within a month for a standard semester-long course.

Part I: Assumption Development

This portion of the assignment will be completed early in the course, with a focus on estimating annual income and expected retirement expenses.

1. Demographics and justifications:
   - Assume you are beginning full time work this year.
   - State the age at which you plan on retiring. How many years do you have to accumulate the dollars necessary to commence retirement?
   - Report the age at which you expect to die and how much money (if any) you want to have upon death to leave to someone or some organization. How many years will you be spending money in retirement?
   - Show these assumptions and their justifications on your spreadsheet.
2. Expected Retirement Spending
   - Create an annual expense budget for your needs in your first year of retirement using today's dollars. For example, you may have no mortgage payment due in retirement. Note that if you retire prior to being eligible for Medicare (age 65 under current law), you will also need to budget for medical insurance. There are sources online available to help you find an estimate of this. Recognize that this figure could vary widely based on your future health.
   - Note that it is not necessary to establish a budget that varies from month to month. The focus of this assignment is your annual needs rather than your expected monthly cash flows.
   - Using your estimate of expenses in today's dollars, the number of years before retirement and a rate of inflation assumption of 2.1% , report how much money you expect to spend in your each year of retirement in future dollars. Remember to continue to adjust for inflation to account for the impact of inflation during retirement.

3. Earnings and Savings Behavior

Report the following assumptions in Excel:

- Your actual current retirement savings
- Average annual salary growth rate
- The percentage of salary you expect to contribute each year between now and retirement toward work-sponsored retirement accounts (e.g., 401(k)), including the assumed employer contribution percentage. This can vary from year to year if you wish, either increasing or decreasing over time.

If you do not use a linear salary growth rate, please bold the figures that use a different assumption. For example, if you give yourself a flat $10,000 raise at age 30 because you predict a promotion that year, bold the salary of the year in which the $10,000 raise applies. If you see yourself leaving the workforce to return to school, bold the reduced student salary you expect during those years.

Part II: Static Analysis

This portion of the assignment gives students an opportunity to use time value of money principles to calculate the impacts of both inflation and portfolio growth on retirement accumulations.

1. The Work/Accumulation period
   - The retirement spreadsheet should calculate, on a year-by-year basis, the accumulation of retirement savings. This means you will have a series of time value of money calculations. Each year will, therefore, be a future value calculation for the year. You must state, for each year, the proportion of your portfolio you want to invest in equities (with an expected return of *xx*%) vs. bonds (with an expected return of *aa*%)
   - Assume annual contributions are split into equal monthly installments made at the end of each month, coincident with the receipt of your paycheck.
   - For simplicity, assume your account compounds on a monthly basis.
   - Repeat the calculation for each year you are working to determine your account balance at retirement.
2. The Retirement/Spending Period
   - In your first year of retirement, there will be no further cash inflows into the retirement account. Since you are no longer working, you are only drawing from the principal you have accumulated and not earning a salary. Your job is to calculate how much money will be left in your account at the end of the year after drawing out your retirement income. Remember, your principal will still earn the risk-free rate of return of *ww*%. You aren't pulling out all the money at once. The annual draw on your savings will (a) be split into equal monthly withdrawals, (b) should be based on your budget and (c) be reported in the "withdrawal" column.

- Continue the calculation for future years. Increase your withdrawal each year by 2.1% so your retirement income keeps pace with inflation. Remember, your principal will still be earning the risk free rate of interest.

3. Results
   - Report how old you are when (or if) you run out of money. Were your savings sufficient to fund your retirement until your expected date of death? Based on this analysis, would you change anything about either your pre-retirement contributions or your post-retirement withdrawal patterns? Would you change your asset mix?
   - Make appropriate changes to your assumptions to ensure that your retirement income lasts to age 100, and use this model in Part III.

Part III: Monte Carlo Simulation

This portion of the assignment introduces the impact of risk using standard Monte Carlo simulation, with draws from the normal distribution. The normal distribution is used to make the analysis tractable for undergraduate students, but is not intended to illustrate any theoretical or empirical distributional assumptions.

1. The Work/Accumulation period
   - As in the static analysis, you will need to build a spreadsheet that calculates a year by year accumulation of retirement savings. As before, you will also decide your split between equity and bond investment on an annual basis. In this analysis however, each year's returns for equity and bonds will be random draws from a normal distribution with the following characteristics:
   - Equities: Expected return of *xx*% with a standard deviation of *yy*%
   - Bonds: Expected return of *aa*% with a standard deviation of *bb*%
   - Since annual returns are random, the final balance at retirement will be randomly determined as well. We are not acutely interested in the final balance for any single set of random returns but rather the distribution of final balances for 1,000 sets of random returns.
   - Using the data table technique described in class, capture the final balance for each of your 1,000 trials. Calculate the average, median, min, max, 10th, 25th, 75th and 90th percentiles among your trials.
2. The Retirement/Spending Period
   - As in the static analysis, you will be using your projected retirement need (the future value calculated in Part I – 2) as your first year's draw in retirement split into monthly withdrawals. Each year, this draw will need to increase by a randomly drawn rate of inflation (normally distributed with mean *xx*% and standard deviation *yy*%). Your unspent retirement balance will earn a randomly drawn risk-free rate (normally distributed with mean *ww*% and standard deviation *zz*%).

- Expand your data table to capture the age at which your retirement balance drops below zero for the first time. Report the same sample statistics from among your trials. What is the average age at which you run out of money? The minimum age? What is the inter-quartile range? What is the maximum amount of money remaining at age 99?

Part IV: Dynamic Analysis – Bootstrapping

This optional portion of the assignment relaxes the distributional assumptions and allows the model to draw return numbers from an array of actual historical returns.

1. The Work/Accumulation Period
   - You will set up your spreadsheet similarly to Part III, however your equity returns will now be randomly drawn from the universe of actual returns from the S&P 500 rather than a theoretical probability distribution.
   - Use the **=VLOOKUP** technique to draw returns into your analysis from the historicalreturns.xlsx file provided to you on the course management system.
   - As with the Monte Carlo analysis, the final balance will change among trials. Use the data table technique to again capture final balances for 1,000 trials and report the aforementioned sample statistics.
2. The Retirement/Spending Period
   - Use the same technique as in the Monte Carlo dynamic analysis to calculate your annual draw.
   - Expand your data table to capture the age at which your retirement balance drops below zero for the first time. Report the same sample statistics from among your trials.

Part V: Interpretation of Results

This portion of the assignment allows the student to reflect on the impact of the various forecasting methods.

1. Contrast the average age at which your retirement balance went negative among the three techniques. Which model appeared to be most favorable? Which was the least?
   - Looking at the results of each model (paying particular attention to year-by-year returns), which do you feel is more reflective of what reality might bring? Why do you feel that way?
   - Explain why the normal distribution used may not be appropriate for modeling a retirement savings plan. How might you improve upon the model using your knowledge or research about continuous probability distributions?

Appendix 2. Example Grading Rubric

	Excellent	Good	Fair	Poor
Part I-1: Demographics and Justifications	All required demographic assumptions are stated, reasonable and well-justified.	All required demographic assumptions are stated, but their reasonableness and/or justifications may be weak.	All required demographic assumptions are stated but reasonableness is suspect. Justifications are missing.	Not all required demographic assumptions are laid out.
Part I-2: Expected Retirement Spending	Retirement budget clearly presented with only monthly expenses. Future value calculated correctly given stated assumptions about retirement age.	Retirement budget may be incomplete or include extraneous information. Future value calculated correctly given stated assumptions about retirement age.	Retirement budget may be incomplete or include extraneous information. Future value incorrectly stated given assumptions about retirement age.	Budget missing. Future value missing or incorrect.
Part I-3: Earnings and Savings Behavior	All required assumptions are stated and reasonable. Any discrete changes in salary are bolded.	All required assumptions are stated and reasonable. Discrete changes in salary are not bolded.	All required assumptions are stated but may not all be reasonable.	Some assumptions are missing.
Part II-1: Static Work/ Accumulation Period	Future account values are calculated annually and correctly using monthly contributions/ compounding.	Future account values are calculated annually but are not calculating future values correctly based upon incorrect compounding frequency or payment frequency.	Future account values are calculated incorrectly based upon something other than just incorrect compounding frequency or pay frequency.	Future values are calculated incorrectly using something other than the future value function.
Part II-2: Static Retirement/ Spending Period	Future account values are calculated annually and correctly using monthly draws/compounding.	Future account values are calculated annually but are not calculating future values correctly based upon incorrect compounding frequency or payment frequency.	Future account values are calculated incorrectly based upon something other than just incorrect compounding frequency or pay frequency.	Future values are calculated incorrectly using something other than the future value function.

Appendix 2. (*Continued*)

	Excellent	Good	Fair	Poor
Part II-3: Results	Results are reported in full.			Results are incomplete.
Part III-1: Monte Carlo Work/Accumulation Period	Future account values are calculated annually and correctly using monthly contributions/ compounding. Rates of return are correctly calculated using **=RAND()** and **=NORM.INV().**	Future account values are calculated annually but are not calculating future values correctly based upon incorrect compounding frequency, payment frequency or incorrect usage of **=RAND()** and **=NORM.INV()**.	Future account values are calculated incorrectly based upon something other than just incorrect compounding frequency, pay frequency or incorrect usage of **=RAND()** and **=NORM.INV()**.	Future values are calculated incorrectly using something other than the future value function or no attempt is made at drawing returns from the normal distribution using **=RAND()** and **=NORM. INV()**.
Part IV-1: Bootstrapping Work/Accumulation Period	Future account values are calculated annually and correctly using monthly contributions/ compounding. Rates of return are correctly drawn using **=RANDBETWEEN()** and **=VLOOKUP()**.	Future account values are calculated annually but are not calculating future values correctly based upon incorrect compounding frequency, payment frequency or incorrect usage of **=RANDBETWEEN()** and **=VLOOKUP()**.	Future account values are calculated incorrectly based upon something other than just incorrect compounding frequency, pay frequency or incorrect usage of **=RANDBETWEEN()** and **=VLOOKUP()**.	Future values are calculated incorrectly using something other than the future value function or no attempt is made at drawing returns from historical returns using **=RANDBETWEEN()** and **=VLOOKUP()**.

Appendix 2. (*Continued*)

	Excellent	Good	Fair	Poor
Part IV-2: Bootstrapping Retirement/Spending Period	Future account values are calculated annually and correctly using monthly draws/compounding. Rates of return are correctly drawn using **=RANDBETWEEN()** and **=VLOOKUP()**.	Future account values are calculated annually but are not calculating future values correctly based upon incorrect compounding frequency, payment frequency or incorrect usage of **=RANDBETWEEN()** and **=VLOOKUP()**.	Future account values are calculated incorrectly based upon something other than just incorrect compounding frequency, pay frequency or incorrect usage of **=RANDBETWEEN()** and **=VLOOKUP()**.	Future values are calculated incorrectly using something other than the future value function or no attempt is made at drawing returns from historical returns using **=RANDBETWEEN()** and **=VLOOKUP().**
Part V: Interpretation of Results	Part 1 answered correctly. Thoughtful and complete analysis of why differences in variance may lead to different results as well as thorough discussion of the shortfalls of the normal distribution with a justified suggestion for an alternative distribution.	Part 1 answered correctly. Thoughtful and complete analysis of why differences in variance may lead to different results as well as some discussion of the shortfalls of the normal distribution.	Part 1 answered correctly. Superficial discussion of how results may vary among models. Minimal discussion regarding the normal distribution	Part 1 answered incorrectly or no discussion regarding differences in models or the normal distribution.

A Self-Directed Learning and Demonstration Test Approach to Spreadsheet Skill Development

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Numerous studies have documented the increasing importance and utility of spreadsheet proficiency for business. Business programs in general and finance and accounting programs in particular struggle with how to best teach students either the basics of spreadsheet use or advanced skills.

In 2015, after several years of observing that students in accounting and finance courses were exhibiting little practical knowledge of spreadsheet use, our faculty agreed on a new approach that we refer to as "Self-Directed Spreadsheet Skill Acquisition," accompanied by an inflexible testing requirement for all students in basic accounting and finance courses to pass a series of spreadsheet skill "demonstration" exercises with a 100% score.

The test is designed as a "self-assessing" instrument, as it demonstrates the required skill rather than testing a subset of a body of knowledge. The design further encourages "incidental learning" through student sharing of targeted skills, and is immune from attempts to cheat. Despite concerns that the 100% requirement would result in widespread student failure, the results have demonstrated that when students are presented with an achievable but rigorous target standard they will meet the standard and develop self-study skills to do so.

Keywords: *finance, spreadsheets, Excel, testing, pedagogy*

Introduction

If you walk through the finance or accounting department at any major corporate office, you will see computer screens filled with Excel spreadsheets outlining financial results, budgets, forecasts, and plans used to make big business decisions.

—Investopedia

Review of Literature

Numerous studies have documented the increasing importance and utility of spreadsheet proficiency for business applications (Zhao, 2016; Baker, 2007; Holtzman 2010; Dudley, 2010; Usha, 2016; others), with the disciplines of finance, accounting and engineering making heavy use of spreadsheets. Business programs in general, however, and finance and accounting programs in particular, struggle with how best to teach students either the basics of spreadsheet use or advanced skills such as financial modeling and data manipulation (Davies et al, 2013; Hannafin n.d. & Hannifin 2010).

Business schools have for years asked themselves how much in the way of technical computer skills is appropriate for inclusion in the standard business curriculum. At the time that spreadsheets were first introduced (in 1979 with the introduction of VisiCalc) computer instruction primarily took the form of teaching programming skills, particularly Fortran and COBOL. For most of the 1980's "students had to learn a programming language in order to benefit from computers" (Baker, 2007, p. 19). Spreadsheets (Lotus 1-2-3, Quattro, SuperCalc, VP-Planner, and ultimately Excel) changed that paradigm. Morishita (2001, p 294) et al observe

> *Our experience in computing was that it took a very long time to learn computer languages and it was sometimes hard to obtain proper results in a limited time. The spreadsheet, however, is rather easy to use and almost instantaneous numerical simulations are possible.*

In effect, learning spreadsheet use has over the past 15 years largely replaced curricular requirements in both business and engineering programs to learn a programming language. "There is no longer a need to question the potential for spreadsheets to enhance the quality and experience of learning that is offered to students." (Baker & Sugden 2007, p. 32)

The recognition that the acquisition of spreadsheet skills is a valuable component of a business education appears to have become widespread since the turn of the century, but the actual incorporation of spreadsheet skills into the learning environment has been slow to materialize. As of 2011, Payne and Tanner could report from her survey of finance coursework that

> *The model finance professor determines 100% of the students (sic) overall grade through individual in-class tests…In-class tests comprise 34% to 65% multiple-choice questions and 34% to 65% open-ended problems. Students can use financial and non-financial calculators and financial tables for the exams. (Payne & Tanner 2011, p. 83)*

Payne's recommended solution for the problem of inadequate attention to spreadsheet instruction was that business schools should offer a "dedicated technology-oriented finance (course) and…require a tech finance course as part of their undergraduate finance major." (Payne and Tanner 2011, p. 83). Based on a study of program requirements and syllabi at 469 AACSB schools, she had found that "fewer than 1% of AACSB-accredited business school offer a dedicated course in financial technology applications" let alone require such a course as part of their finance curriculum. (Payne and Tanner 2011, p. 82) It is probably not a stretch to extrapolate from Payne's findings for finance majors, where spreadsheet skills have a heightened import, to conclude that business schools for non-finance majors (marketing, management, etc.) are likely to incorporate spreadsheet instruction to an even lesser extent.

Payne's research reviewed such courses where they existed at just 34 schools, and identified a set of "Finance objectives" and a parallel set of "Excel learning objectives" common to such dedicated courses. Those objectives reflected the higher-level Excel skills most finance professors would find appropriate for finance students, among them: LOOKUP functions, Solver, pivot tables ,and regression analysis. Unmentioned in her study is whether students are expected to come to such a dedicated class already equipped with more basic Excel skills, or whether such basic skills are to be more generally expected of non-finance business majors. Do students in these courses start from ground zero, or is there a prerequisite set of basic spreadsheet skills that they are expected to enter the class having already acquired?

Development of the Program

At the University of Nebraska/Kearney, our concern has been primarily that business students (not just accounting and finance students) should have at least basic Excel skills by the time they graduate, and we have run the gamut of pedagogical approaches to spreadsheet instruction. Over the past 20 years we have tried (initially) ignoring the issue under the assumption that today's high school graduates are computer literate when they come to us, have required all business students to complete a dedicated class addressing spreadsheet and word processing skills, have attempted to infuse spreadsheet instruction into the curriculum by encouraging faculty to embed it in their courses, and have used commercial testing products to assess student skill levels in spreadsheet use.

As of 2015 other departments in our College of Business were using both a standardized commercial test (both the Certiport Microsoft Proficiency Exam and the GMetrix Multi-Project 3 Excel Exam) to assess spreadsheet skills and requiring students to complete a basic computer proficiency class, but our Accounting and Finance (hereafter "A&F") department was still anecdotally observing that despite

all our efforts students in accounting and finance courses were still coming into our courses exhibiting little practical knowledge of spreadsheet use. Without belaboring the point, academicians probably need little explanation of the internal politics involved in attempting to influence the testing and grading standards employed by other departments; but after several years of attempting to do so our A&F department decided to utilize its unique position in the curriculum to address the issue directly. The A&F department offers the only three-course sequence in our curriculum that all business students regardless of major must complete in order: Accounting I, Accounting II, and Principles of Finance. That course sequence enabled us to implement a staged series of spreadsheet skill expectations and exam requirements with successively-higher levels of skills built into a series of "demonstration" exams, and to do so without needing the sometimes-reluctant cooperation of our sister academic units. For a variety of reasons, we decided to implement the Level I exam in the second accounting course (Accounting II), the Level II exam in the Principles of Finance course, and to then defer to future semesters the options of dropping the sequence down to Accounting I and/or incorporating higher-level exercises into advanced accounting and finance courses for our respective majors. The requirement was implemented within the A&F department for the Spring, 2015 semester. This paper describes the testing process that we implemented along with the basic parameters of the program and our assessment of its effectiveness.

Description of the Instructional Methodology

Self-Direction and Inflexible Standards

Our faculty agreed on a new approach that we refer to as "Self-Directed Spreadsheet Skill Acquisition," accompanied by an inflexible testing requirement for all students in basic accounting and finance courses to pass a series of spreadsheet skill "demonstration exercises" (tests) with a 100% score. Every student had to complete the exercise flawlessly in order to pass the course to which the exercise is "attached" (Accounting II for the Level 1 test and Principles of Finance for the Level 2 test). All students in our business programs, regardless of major (Marketing, Management, Accounting, Finance, Supply Chain management, Human Resources) must successfully complete both Level 1 and Level 2 exams. The Finance Department is now implementing a Level 3 exam in its upper-division Corporate Finance course (taken by majors only following the "Principles of Finance" course required of all business students), and within the next year will implement a Level 4 exam in our senior finance Case Studies course, required of all finance majors.

We left no room for instructor judgment, excuses, delays or exceptions. Students are not tested over abstract concepts, but instead must sit at a computer that has been disconnected from the internet and create a spreadsheet that demonstrates

each of a lengthy list of spreadsheet techniques. In perhaps our most remarkable feat of political legerdemain within the context of individual instructor academic freedom, all faculty teaching those courses in the A&F department agreed to fail any student who did not meet the skills test requirement.

What is more, no spreadsheet skills are taught in any of the targeted courses. Instructors, in fact, are admonished to refuse to teach the skills and when asked for help refer the student to a website with tutorial video links. No class time in either finance or accounting courses, in other words, is redirected to the teaching of spreadsheet skills (though of course those courses may and do make content assignments that call for the use of spreadsheets).

Key Program Elements

Seven key elements of the program are, we believe, essential to its success:

1. **A minimum score of 100%:** As explained above, students are advised of the list of techniques they must master, and they may not "cherry pick" the list to pass at 60%. A single missed technique results in failing the attempt.
2. **Tying the Requirement to a Required Course:** All full-time faculty in the A&F department agreed that successful completion of the Excel exam would be listed in their syllabi as a "necessary but insufficient requirement" for passing their course. In other words, passing the spreadsheet exam does not affect their course grade, but failure to pass it means failing the course. In practice, we did allow faculty at their discretion to issue an "incomplete" (I) grade for students who had not passed the test by the end of the semester. Our grade recording system automatically turns an "I" into an "F" if it is not upgraded to a passing mark within one calendar year.
3. **Multiple Attempts:** Students may attempt different versions of the exam as many times as they want until they achieve a 100% score, with no penalty for multiple attempts.
4. **Transparent Technical Requirements:** The entire list of technical Excel skills that students must demonstrate are published and distributed to all students in the target courses. There are no "hidden" requirements.
5. **No Instructor Pedagogy:** F&A instructors have agreed that **zero class time and zero instructional assistance** will be provided to students to acquire the targeted skills. Students must acquire the skills on their own, and no class time or instructor time is devoted to assisting them to do so.
6. **Blackboard/Canvas Instructional Video Links:** Every student registered for a target course is given access to a special "ersatz" Blackboard/Canvas "course" link. (Our institution transitioned from Blackboard to Canvas in the fourth year of program implementation). The Blackboard/Canvas "course" provides two critical elements:

a. Every required spreadsheet skill is listed, and for each a series of links is provided to YouTube or other online-available instructional videos demonstrating the spreadsheet technique. The videos run from 2 to 15 minutes in length, and multiple links are provided for each required skill. 90% of the videos are from sources on YouTube, perhaps 5% from Vimeo, and the remainder are occasional videos available on the Internet and produced by faculty/instructors on other campuses. None were produced in-house. Every semester the program director reviews all the video links to be sure they are still operative, replaces any inactive links with an alternative video, and adds a few new links to the mix. Planned for the future is a mechanism for students to provide feedback on which videos were most helpful, but that system is not yet in place. We avoided videos produced in foreign countries with heavily-accented presenters. Uniformity of presentation style does not appear to have been a problem. To the contrary, for most individual Excel skills we made an effort to provide several different videos with different presentation styles and explanatory approaches.
b. After each student attempt, the result is posted on Blackboard/ Canvas under the grading section. If the student passes (at 100%) the attempt is merely listed as a "PASS." If "FAILED," the specific Excel techniques missed are listed under the grade comment section, affording the student an opportunity to re-view instructional videos and prepare for another attempt at another version of the test.

7. **Multiple completion venues:** Four different delivery channels are offered to students to complete the exams:
   a. The Program Coordinator conducts periodic "open lab" sessions in one of our computer labs, where students may walk in, show their photo ID, and sit for any level of the exam. The open lab sessions typically last for six hours, are conducted at least twice each month during the semester in the morning and in the afternoon, and are available without appointment ("walk-in"). During the open lab sessions all of the computers in the lab are disconnected from the internet to avoid students looking up the required skills.
   b. One computer disconnected from the internet was installed in the hallway outside each finance professor's office, and all finance professors agreed to proctor exams during any of their office hours.
   c. The A&F departmental secretary was made available to proctor the exam for any student by appointment with her. After completing the exam, the resulting Excel file is saved to a flash drive and sent to the Program Coordinator for grading.
   d. During the first semester online students were required to identify a local proctor, but that system proved too cumbersome and time

consuming. During subsequent semesters, all versions of all levels of the exam were made available through the ProctorU examination proctoring system. The university e-campus office initially offered to pay the $25 fee for online students, but that offer was rejected in favor of requiring online students to pay $10 of the $25 fee in order that students would take multiple attempts seriously. To date, a total of 58 students have taken the exam through ProctorU. Of that number, one was caught cheating by the ProctorU system.

Exam Content

The premise of the exams is that students should not be asked questions about spreadsheets, but rather should actually demonstrate the use of specific skills by creating a spreadsheet. For the exam, students must open up Excel, create the spreadsheet file, name it according to instructions, and then follow a series of instructions calling for specific skills. The first several instructions call for the student to enter certain textual and quantitative data in designated cells. Subsequent instructions call on the student to access, copy, display, or mathematically manipulate that data. For the Level 1 exam, for instance, example instructions include:

In cell C2 of the second worksheet, use the =AVERAGE function to calculate the mean of the entries in cells A1 thru A7. Display as currency to the penny.

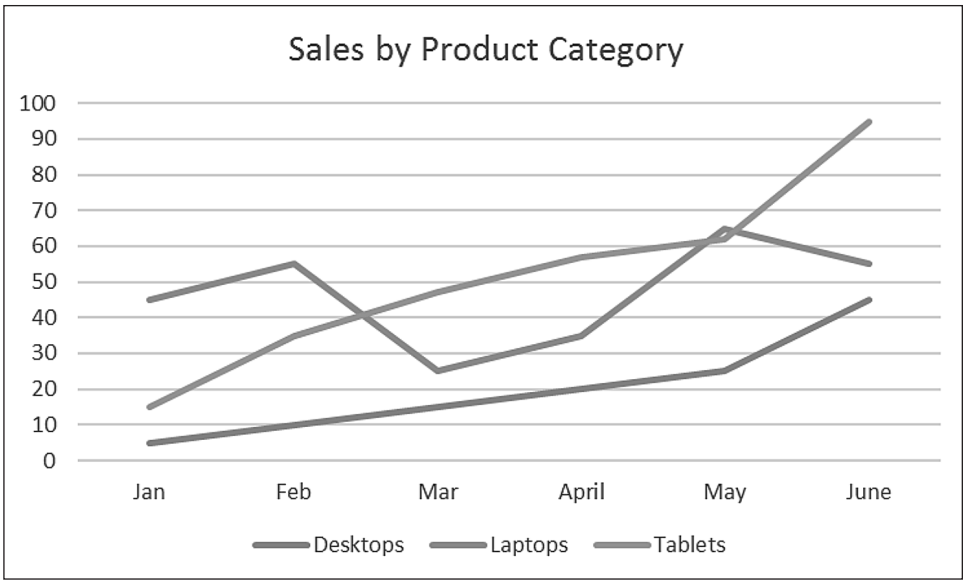
In cell C4 of the second worksheet, use the =IF logic function to test whether the total in C3 is greater than 5. If greater, display the word "YES" in cell C4. If less, display the word "NO" in cell C4. RIGHT justify the displayed word in the column.

Being careful to utilize proper algebraic order of operations for Excel, in cell C5 of the second worksheet, raise the number in cell A5 of the second worksheet to a power of 1/3 rounded to the nearest dollar. Format the column so that the full answer displays within the column. Perform this instruction without using the =POWER function. Construct the formula as an algebraic expression. Do not use 0.333 as an approximation of 1/3.

Starting in cell C20 on the Output page for upper-left-hand corner of the table create the following:

	Desktops	Laptops	Tablets
Jan	5	45	15
Feb	10	55	35
Mar	15	25	47
April	20	35	57
May	25	65	62
June	45	55	95

Starting in cell H20 on the Output page and using the data from the table you just created, insert a line graph displaying the data. Label the graph "Sales By Product Category" and be sure that each axis on the graph is labeled to reflect the correct measurement. If you do it correctly, your line graph will look like this:



It should be noted that students are assessed only over the actual spreadsheet skills. Although, for instance, the Level 1 test has the student enter data in a format similar to a P&L, there is no assessment of the accuracy of the statement as an accounting statement. Only spreadsheet skills are assessed.

Exam content was determined by a committee comprised of all of the finance professors at our institution after reviewing published Excel syllabi at five other institutions and reviewing the subjects tested over by both the Certiport Microsoft Proficiency Exam and the GMetrix Multi-Project 3 Excel Exam. Copies of the exams are available to any instructional faculty at other institutions by contacting the author of this article.

Program Outcomes

Since the initiation of the requirement during the Spring, 2015, semester a total of 1,218 students have been subject to the requirement and considerable data has been accumulated on their experience. Of those subject to the test, 14.2% never took it during the semester that they were in a course requiring it (13.0% for Level 1; 15.2% for Level 2). Those 14.2% are comprised of course withdrawals, no-shows, and students who simply didn't bother. Withdrawals were automatically awarded a "W" by the registrar's office, and course no-shows received an "F" irrespective of their non-performance on the test. Of the remaining non-performers, all but 6 of a total of 1,218 (0.49%) were poor performers who (as reported by the course instructor) would have received an "F" regardless of their failure to pass the test. The statistics reported below and in Table 1 represent the 1,044 students who actually took the test. In the case of those 6 students who would have passed the course save for the test, all 6 received an "I" in the target course and completed the test within the following academic year. In other words, we remove from the base number of students those whose failing course grade resulted from poor course performance rather than failure on the test.

Table 1. Percent of Active Students who Passed the test with "X" Attempts

	1 Att	2 Att	3 Att	4 Att	5 Att
Level 1	**40.65%**	**24.07%**	**7.01%**	**1.40%**	**0.47%**
Level 2	**57.63%**	**21.92%**	**5.03%**	**0.81%**	**0.16%**
Overall	**50.67%**	**22.80%**	5.84%	1.05%	0.29%

n=1,044

Table 2 details the performance of the remaining 85.8% of students subject to the test. Of the total of 1,044 who took the test, only 5 (0.48%) were unable to pass it after repeated attempts (3 at Level 1; 2 at Level 2), with the highest number of tries at 5 attempts for Level 1 and 4 attempts for Level 2. All of those students received an "F" in the course, and all would have passed the course had they succeeded on the test.

Table 2. Percent of Registered Students who Never Took the Test

Level 1	13.01%
Level 2	16.15%
Overall	14.20%

n = 1,218

Overall, just over half of all students who took the test passed it on the first attempt., and almost three quarters passed it in two attempts. Blackboard and Canvas "hit

counts" suggest that about half of those passing on the first attempt accessed the tutorial videos to prepare for the test, and over 90% of those failing on the first attempt accessed the videos to prepare for subsequent attempts. We consider this a great success in terms of the "self-directed" approach to student learning.

Observations and Conclusions

Failure Rates

The spreadsheet skills test program was the result of action by a single (A&F) academic department, but could not have been attempted without the (admittedly reluctant) agreement of our college Dean. A major concern of his and of faculty in other departments was that large numbers of students ("large" being undefined beyond simply "large") would fail to achieve a perfect score and drop out of our programs of study. That concern has proven entirely unfounded. Likewise, the "100%" requirement was initially viewed by many faculty (not just the Dean) as extreme, unreasonable and likely to lead to multiple failures. Faculty concern has likewise proven unfounded.

Self-Directed Learning

Several faculty in other departments (none in A&F} believed it to be "unfair" and even unethical for us to require students to learn subject matter without direct faculty instruction. Such a perspective strikes us (in the A&F department) as an excessively narrow perspective on our pedagogical role. Learning takes place in many contexts and venues on a college campus, from the classroom to the dormitory to the athletic fields to social clubs, and creating an environment where students are expected to develop self-reliant learning skills and attitudes strikes us a perfectly consistent with our function as an institution of higher education

In fact, one of the most gratifying elements of this project has been to see the extent to which students start taking responsibility for their own learning behaviors. That's not to say there isn't considerable grumbling, and the Program Director encouraged the course instructors in target courses to place the "blame" for both the requirement and the process on him rather than have it affect their own teaching evaluations. But anecdotally, many students clearly demonstrated post hoc satisfaction at having mastered the required skills.

Grapevine Learning

One very interesting and totally unanticipated element of the program was the utility of the student grapevine as an instructional medium. Actual cheating

on the test is virtually impossible for those who take it in person (those who are proctored are in a less controlled environment). At least, if cheating is possible we haven't yet figured out how. The "test" is actually a demonstration of the required skills, and all requirements are published in advance. No internet access or other materials are allowed. We have noticed, however, that certain required skills that at the beginning of the project were common causes of failure, are over the past few semesters virtually disappearing as "problem" skills.

A prime example of this is the ability to construct an Excel formula that raises a target cell value to a fractional exponent. The formula **=C5^1/3** yields a very different result than **=C5^(1/3)**, and students need to understand the proper order of algebraic operations used by Excel. For the first several semesters, large numbers of students failed their attempt on this type of instruction ("Raise the value in cell C5 to the power of 1/3). Recently, many fewer are failing the skill.

Our conclusion is that students are sharing information about what the test requires them to do. And since various versions of the test have similar skills required but embedded in different instructions requiring different formulations, we do not think students are merely memorizing formulas. Rather, we speculate that the student grapevine is working in favor of students accessing the appropriate video tutorials and preparing to demonstrate a skill that they know will be required; or students are instructing each other in how to handle such problems. Perhaps they think they're "getting away" with something, perhaps not. And maybe they're viewing the tutorials, and maybe they're teaching each other. But either way – they're learning.

Procrastination

The biggest operational problem we have is student procrastination. No matter where we set the semester deadline for completing the test, large numbers of students put off starting their attempts until late in the semester. Some faculty have suggested offering students "early completion" awards in the form of bonus points on their target course grades, but it is the finance faculty's perspective that this is analogous to offering "early payment" discounts on accounts receivable: it's a very expensive way of primarily rewarding those who already pay on time and has little effect on those who are late payers to begin with, for whom the marginal benefit of paying early yields the smallest marginal time value. We have therefore to date rejected the offer of bonus-point awards. But neither do we have a better solution.

Grading and Logistics

The entire program is run by a single faculty member (your author) with clerical assistance from our departmental secretary and lone graduate assistant. The biggest

logistical issue we have faced is the ability to keep up with course registration changes, add/drops/withdrawals, as individual course section participation waxes and wanes throughout the semester. The roster for the Canvas program has to be manually updated to reflect section roster changes, and the Registrar's office has been less-than-cooperative, citing FERPA regulations (legitimately or not) as a constraint.

Grading of the individual test attempts has been far easier than we anticipated. The lone program director grades all attempts, usually within 72 hours of submission. While it may seem that this would be a lengthy and demanding process, in practice it is not. Because each attempt (at each level) is based on a different version of the same underlying exam, the grader's eye is quickly trained to spot common errors and to recognize correct numerical results. The grader keeps a Word document open on a second screen, containing a series of one-line descriptions of the most common errors, and can quickly cut-and-paste the descriptors into the Grade Comment note section on Canvas to provide student feedback. The average test submission takes just 5.5 minutes to grade.

Conclusion

We consider the spreadsheet program to be a great success. It is cost effective (the Project Director is compensated with one course release for every three semesters overseeing the program, which when including a summer semester means one course release every 3.3 calendar years), students are learning and developing self-study skills, faculty in the target courses have become enthusiastic supporters of the requirement, and the program is "self-assessing" in the sense that the exams are their own proof of student accomplishment. In a further study, we have collected data on student performance on both the Certiport Microsoft Proficiency Exam and the GMetrix Multi-Project 3 Excel Exam and have comparative performance data for those instruments vs. those developed and employed here. Those data will be reported in a separate paper.

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The Consistency Principle in Relation to the WACC Model

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An application of the discounted cash flow (DCF) model popularly used in financial education and corporate practice is the weighted average cost of capital (WACC) model which discounts free cash flows (FCFs) using the WACC to obtain a firm value. In this paper we show that the general principle of consistency is not satisfied by the WACC model. In particular the FCFs are defined on the assumption that the firm is fully equity financed, while the present value obtained with the model is the leveraged firm value. However we also emphasize that the WACC model gives the same firm value as a standard model using leveraged cash flows and is the most appropriate to use for corporate valuation. Given the WACC is a popular approach to valuation used by firms, our explanation will be of interest to finance academics, instructors, students, and practitioners.
Keywords: *Finance, theory, valuation, free cash flow, WACC*

Introduction

A popular application of the discounted cash flow (DCF) model in financial education and corporate practice is the weighted average cost of capital (WACC) model which discounts free cash flows (FCFs) using the WACC to obtain a firm value. Implicit in the application of the DCF model is the principle of consistency: the cash flows, the discount rate and the present value comprising the model must be defined consistently relative to the same object, the underlying real or financial asset. However, when we examine the WACC model we see that the general principle of consistency is not satisfied. The FCFs are defined on the assumption that the firm is fully equity financed, while the present value obtained with the model is the leveraged firm value. FCFs are unleveraged cash flows and the role of the WACC is to link these cash flows to the leveraged firm value, which is the value of most interest to general investors and managers.

While pointing out the contrast between the general principle of consistency and the special features of the WACC model, we show that the model yields the same

firm value as a standard model using leveraged cash flows, and our paper supports previous arguments in the literature that the WACC model is usually the most appropriate one to use for corporate valuation (see, for example, Booth (2002)). We believe our findings should improve students' and practitioners' understanding of the economic principles that underpin discounted cash flow models and enable them to become more confident in the application of these models in general and the WACC model in particular.

Literature Review

The origins of the weighted average cost of capital (WACC) model lie in the work of Modigliani and Miller (1958, 1963). Modigliani and Miller (1958) examine the impact of capital structure on the firm's value which in turn leads to a definition of the firm's weighted average cost of capital. A subsequent paper by Modigliani and Miller (1963) modifies their original findings by incorporating the impact of taxes on the cost of capital.

Subsequent to the work of Miller and Modigliani scholars have suggested alternative models for valuing the firm. Perhaps the most enduring of these alternatives has been the adjusted present value (APV) approach proposed by Myers (1974) which calculates the value of the firm as the sum of two components, namely the value of the firm's tax shield and the value of the unleveraged firm. A number of studies have discussed the WACC and APV approaches and debated the respective merits of each model. For example, Miles and Ezzell (1980) argue that the version of the WACC model frequently presented in textbooks is a special case of the APV model of Myers, which in turn is based on the results derived by Modigliani and Miller (1963). Booth (2002) cautions against the use of the APV, arguing that it is frequently unreliable. Massari (2007) suggests that the WACC and APV methods are equivalent for a growing leveraged firm, but the WACC requires some unexpected assumptions and APV is more flexible in dealing with the pattern of debt finance over time. Dempsey (2013) claims to correct Massari and argues that the WACC and APV are algebraically consistent.

Other debates have arisen about specific aspects of the WACC model. For example, Fernandez (2004) argues that the value of a company's tax shields is the difference between the present value of the unleveraged company's taxes and the present value of the leveraged company's taxes. However Cooper and Nyborg (2006) attempts to correct Fernandez by reconciling his results with standard tax shield valuation formulae. Miller (2009) argues that the WACC is a linear approximation of a non-linear function and therefore the cash flows implied by the model are not sufficient to compensate suppliers of finance to the firm; he presents a modified WACC. However Pierru (2009) claims Miller's modified WACC is not relevant and Keef, Khaled and Roush (2012), in response to both Miller and Pierru (2009), claim that the WACC model is dispensable in situations where interest paid

is not tax deductible and argue that unleveraged cash flows should be discounted using the required rate of return on unleveraged equity.

The debates and controversies outlined above touch on a number of possible issues with the WACC model but do not specifically address the inconsistency we identify, namely that free cash flows (FCFs) are defined on the assumption that the firm is fully equity financed, while the present value obtained using the WACC is the leveraged firm value. Standard textbooks such as Brealey, Myers and Allen (2014), Copeland, Weston and Shastri (2005), Damodaran (2015) and Ross, Westerfield and Jordan (2016) also do not address the issue.

Why then has the inconsistency we have identified never been previously discussed in the literature? Previous papers have focused on particular aspects of the WACC model that appear to be problematic, such as the valuation of tax shields (for example, Fernandez (2004)) and the applicability of the model to a growing leveraged firm (for example, Massari (2007)). The perspective of our paper is somewhat different in that it looks at the broader issue of whether components of the model are defined consistently relative to the same object.

The Consistency Principle in Discounted Cash Flow Models

Economic theory provides us with the rationale for a dollar tomorrow being worth less than a dollar today. In order to value a future cash flow, it must be discounted to the present, which requires the formulation of a discounted cash flow (DCF) model. The present value V(t) of a simple cash flow CF(t) is:

$$V(t) = \frac{CF(t)}{(1 + r)^t} \tag{1}$$

The cash flow CF(t) is associated with an underlying real or financial asset (or object), and the appropriate discount rate r is determined by the riskiness of the asset (or object), so that the calculated present value V(t) is the value of the asset (or object). At this point it becomes necessary to discuss the principle of consistency: the cash flow, discount rate and present value must all be consistent relative to the same object, the underlying real or financial asset. Generally we cannot discount the cash flows of an object A using the discount rate of an object B. The only time this might be possible is when we have sufficient information to lead us to believe that object A and object B have the same risk measure and thus the same discount rate.

An application of the DCF model popularly used in financial education and corporate practice (see, for example, the survey evidence in Graham and Harvey (2002)) discounts free cash flows (FCFs) using the weighted average cost of capital (WACC) to obtain a firm value:

$$\text{Value} = \frac{FCF_1}{(1 + WACC)^1} + \frac{FCF_1}{(1 + WACC)^2} + \cdots + \frac{FCF_1}{(1 + WACC)^\infty} \tag{2}$$

FCF is defined as the cashflow a firm is able to generate after taking into account asset expenditures, and WACC is defined as the average cost of capital to a firm

which takes into account all types of financing. Equation (2) appears to be a standard DCF valuation model, where FCF is the cash flow and WACC is the discount rate.

However if we consider the FCF formula:

FCF = EBIT * (1 − Tax) + Depreciation Expense + Amortisation Expense − Investment in Fixed Assets − Investment in Working Capital (3)

we see that it is actually the after-tax cash flow of a firm if it is fully equity financed (object A); whereas the resulting value after discounting the cash flows is the leveraged firm value, which is the sum of debt value and equity value (object B). In other words the formula in equation (2) is not a standard DCF and is not internally consistent. The difference between (or inconsistency of) the underlying assets (object A versus object B) in the formula, points to the key role of the WACC as a link between the two assets. The WACC functions like a bridge that connects a non-existent unleveraged firm's cash flows to an existing leveraged firm's value.

Corporate Evaluation Models

Once we clearly understand the principle of consistency, we can construct models to evaluate the cash flows generated by a firm. We begin with the observation that a typical company's assets can be expressed in the following form:

Net Operating Assets (NOA) + External Investments (INV) = Debt + Equity (4)

Four objects (asset groups) are defined: on the left-hand side, two real asset groups and on the right hand side, two financial asset groups. Real assets have the capacity of generating future cash flows and financial assets represent the rights to receiving those cash flows. The NOA are the core business of the company (controlled by the management) and the INV are the external investments of the company (not controlled by the management).

We assume in the analysis and example that follow that the company has a constant growth rate in future years, so that in years t = 1, 2, 3 ….. n there is a need to raise new debt to satisfy this growth. However, although more generally a firm's debt ratio may range from 0% to 100%, in this instance the firm's current debt ratio remains unchanged throughout the life of the firm. We also assume that each period all equity income and all new debt borrowing is returned to equity holders as dividends. Consistent with the treatment in most textbooks, external investments (INV) are ignored in the analysis. Focusing on the right-hand side of equation (3), we then obtain the following three sets of cash flows generated by a firm:

Cash Flows to Debt Holders (CF_Debt) = Interest Expense − New Debt Borrowing (or + Debt Repayment); (5)

Cash Flows to Equity Holders (CF_Equity) = (EBIT-Interest Expense)*(1−Tax) + New Debt Borrowing (or − Debt Repayment); (6)

Cash Flows to Firm Investors (CF_Leveraged)

= Cash Flows to Equity Holders + Cash Flows to Debt Holders

= (EBIT – Interest Expense) * (1−Tax) + Interest Expense

= EBIT * (1−Tax) + Interest Expense * Tax (7)

In the last line of equation (7) above, the first component, EBIT * (1−Tax), is the cash flows of an unleveraged firm (CF_Unleveraged). We can further define the second component, Interest Expense * Tax, as:

Tax Shield Cash Flows (CF_TaxShield) = Interest Expense*Tax (8)

Thus there are five series of cash flows defined above, and they are linked together in the following equation:

CF_Leveraged = CF_Debt + CF_Equity = CF_Unleveraged + CF_TaxShield (9)

Corresponding to these cash flows we define five discount rates, r_a, r_d, r_e, r_u, and r_{ts}. These rates depend on the company's debt ratio which in practice may range from 0% to 100%. However as noted above our assumption is that the firm's debt ratio remains unchanged throughout the firm's life. In line with the consistency principle the corresponding present values obtained with a discounting cash flow model are as follows:

$$V(\text{Leveraged}) = PV(\text{CF\_Leveraged}, r_a), \quad (10)$$

$$V(\text{Debt}) = PV(\text{CF\_Debt}, r_d), \quad (11)$$

$$V(\text{Equity}) = PV(\text{CF\_Equity}, r_e), \quad (12)$$

$$V(\text{Unleveraged}) = PV(\text{CF\_Unleveraged}, r_u), \quad (13)$$

$$V(\text{TaxShield}) = PV(\text{CF\_TaxShield}, r_{ts}) \quad (14)$$

where V(Leveraged) is the value of the leveraged firm, V(Debt) is the value of debt, V(Equity) is the value of equity, V(Unlevered) is the value of the unleveraged firm, and V(TaxShield) is the value of the tax shield.

We can then write the equation linking these five values as follows:

V(Leveraged) = V(Debt) + V(Equity) = V(Unleveraged) + V(TaxShield) (15)

All of the above formulae are consistent with basic discounting theory and satisfy the consistency principle. The following example illustrates the validity

of equation (15) in particular. Although the example is couched in terms of a firm valuation, the analysis is also applicable to the valuation of a project.

Example 1

Company A has the following earnings before interest and tax (EBIT), which are expected to grow at a constant rate of 3% per annum indefinitely:

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
EBIT($000)	$40.00	$41.20	$42.44	$43.71	$45.02	$46.37	$47.76

The cost of the unlevered firm's equity r_u is assumed to be 12%. The company has a debt weighting, $w_d = 0.3$, which as noted above we assume remains constant throughout the life of the firm. The company's cost of debt r_d is assumed to be 6%, which also remains unchanged because of the constant debt ratio. The calculations of the cost of equity r_e, the cost of the leveraged firm r_a, and the cost of the tax shield r_{ts} are explained in Appendix 1. The company has a tax rate of 35%.

In the analysis that follows, the horizon value is calculated using the constant-growth DCF formula (see, for example, Brealey, Myers and Allen (2014).The value of the firm's debt at $t = 0$ is calculated by multiplying the firm's value (V(Leveraged)) by its debt weighting (w_d) (the value of V(Leveraged) is of course not known initially, but it can be shown that an iterative process approaches the target value of V(Leveraged); alternatively, by using the WACC formula we can calculate the target value directly). Debt in subsequent years is calculated by multiplying the previous year's debt by the firm's growth rate. Interest is then calculated as 6% of these debt values and new borrowing for each year as the difference between the value of the firm's debt for the current and following years. As noted above, we assume that the additional debt raised is paid out as dividends to equity holders.

The leveraged firm, debt, equity, unleveraged firm, and tax shield values can now be calculated:

Leveraged firm *(refer to equation A-5 in Appendix 1 for the formulation of r_a)*

r_a=11.37%	CF_Leveraged							
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Horizon Value**
EBIT	$40.00	$41.20	$42.44	$43.71	$45.02	$46.37	$47.76	$546.61
Tax	−14.00	−14.42	−14.85	−15.30	−15.76	−16.23	−16.72	−191.31
	26.00	26.78	27.58	28.41	29.26	30.14	31.05	355.30
Tax Shield	2.12	2.18	2.25	2.31	2.38	2.45	2.53	57.83
	28.12	28.96	29.83	30.72	31.65	32.59	33.57	413.14
Discount factor	*1.1137*	*1.2403*	*1.3814*	*1.5384*	*1.7133*	*1.9081*	*2.1251*	*2.1251*
V(Leveraged)=$335.92	$25.25	$23.35	$21.59	$19.97	$18.47	$17.08	$15.80	$194.41

Debt

r_d=6%	CF_Debt							
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Horizon Value**
Interest	$6.05	$6.23	$6.42	$6.61	$6.81	$7.01	$7.22	$247.90
New Borrowing	−3.02	−3.11	−3.21	−3.30	−3.40	−3.51	−3.61	123.95
	3.02	3.11	3.21	3.30	3.40	3.51	3.61	123.95
Discount factor	*1.0600*	*1.1236*	*1.1910*	*1.2625*	*1.3382*	*1.4185*	*1.5036*	*1.5036*
V(Debt)=$100.78	$2.85	$2.77	$2.69	$2.62	$2.54	$2.47	$2.40	$82.43

Equity (refer to equation A-3 in Appendix 1 for the formulation of r_e)

r_e=13.67%	CF_Equity							
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Horizon Value**
EBIT	$40.00	$41.20	$42.44	$43.71	$45.02	$46.37	$47.76	$461.00
Interest	−6.05	−6.23	−6.42	−6.61	−6.81	−7.01	−7.22	−69.69
	33.95	34.97	36.02	37.10	38.21	39.36	40.54	391.31
Tax@35%	11.88	12.24	12.61	12.99	13.38	13.78	14.19	136.96
Net Income	22.07	22.73	23.41	24.12	24.84	25.58	26.35	254.35
Dividend	3.02	3.11	3.21	3.30	3.40	3.51	3.61	34.85
	25.09	25.85	26.62	27.42	28.24	29.09	29.96	289.19
Discount factor	*1.1367*	*1.2921*	*1.4688*	*1.6696*	*1.8978*	*2.1573*	*2.4522*	*2.4522*
V(Equity)=$235.14	$22.07	$20.00	$18.12	$16.42	$14.88	$13.48	$12.22	$117.93

Unleveraged firm

r_u=12%	CF_Unleveraged							
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Horizon Value**
EBIT	$40.00	$41.20	$42.44	$43.71	$45.02	$46.37	$47.76	$546.61
Tax	−14.00	−14.42	−14.85	−15.30	−15.76	−16.23	−16.72	−191.31
	26.00	26.78	27.58	28.41	29.26	30.14	31.05	355.30
Discount factor	*1.1200*	*1.2544*	*1.4049*	*1.5735*	*1.7623*	*1.9738*	*2.2107*	*2.2107*
V(Unleveraged)=$288.89	$23.21	$21.35	$19.63	$18.06	$16.60	$15.27	$14.04	$160.71

Tax shield (refer to equation A-6 in Appendix 1 for the formulation of r_{ts})

r_{ts}=7.50%	CF_TaxShield							
	Year1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Horizon Value**
Interest	$6.05	$6.23	$6.42	$6.61	$6.81	$7.01	$7.22	$165.22
Tax Shield	2.12	2.18	2.25	2.31	2.38	2.45	2.53	57.83
Discount factor	*1.0750*	*1.1556*	*1.2423*	*1.3355*	*1.4356*	*1.5433*	*1.6590*	*1.6590*
V(TaxShield)=$47.03	$1.97	$1.89	$1.81	$1.73	$1.66	$1.59	$1.52	$34.86

As expected, the values of the debt cash flows ($100,780) and the equity cash flows ($235,140) together equate to the value of the leveraged firm's cash flows ($335,920), as do the values of the unleveraged cash flows ($288,890) and tax shield cash flows ($47,030).

Free Cash Flows and the WACC Model

In the previous section, we have identified the cash flows associated with the unlevered firm object (CF_Unleveraged). The advantage of this object is that it is determined solely by the firm's operational business and is therefore a useful tool for management to analyze the firm's operational results. The problem with using this object is that it is not fully aligned with the object of most interest to investors, namely the value of the leveraged firm (V(Leveraged)). The tool connecting these two objects, the cash flows of the unleveraged firm and the value of the levered firm, is precisely the special "discounting" rate called the weighted average cost of capital (WACC). The WACC formula is:

$$WACC = r_e * w_e + r_d * w_d * (1 - Tax) \quad (16)$$

where w_e and w_d are the weightings of equity and debt respectively. Applying the WACC to the unlevered cash flows, we obtain the value of the leveraged firm:

$$V(\text{Leveraged}) = PV(CF\_\text{Unleveraged}, WACC) \quad (17)$$

Given that the cash flows of the unleveraged firm are simply the free cash flows (FCFs) of the firm, we may restate equation (17) as follows:

$$V(\text{Leveraged}) = PV(FCF, WACC) \quad (18)$$

It is obvious that equation (18) does not satisfy the principle of consistency. In particular the FCFs are defined on the assumption that the firm is fully equity financed, while the resulting present value is the leveraged firm value. Nevertheless the formula in equation (18) has several advantages: it separates the operational from the financial analysis of the firm, it employs the normal discounting format, and it is a convenient method for estimating the value of the firm. In Appendix 2 we show algebraically that the WACC model defined in equations 17 and 18 does in fact provide the same valuation as the consistent model defined in equation 10 above.

To illustrate that the value of the firm obtained using the WACC model (Equation 18 above) is the same as that obtained using the leveraged cash flows model (Equation 10 above), we continue with our previous example.

Example 1 (continued)

Company A has the following estimated free cash flows (FCFs), in which the impact of leverage is removed:

	CF_Unleveraged							
	Year1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Horizon Value**
EBIT ($000)	$40.00	$41.20	$42.44	$43.71	$45.02	$46.37	$47.76	$587.75
Tax	-14.00	-14.42	-14.85	-15.30	-15.76	-16.23	-16.72	-205.71
FCF	$26.00	$26.78	$27.58	$28.41	$29.26	$30.14	$31.05	$382.10

Company A finances with 70% equity and 30% debt. The firm has calculated its cost of equity r_e to be 13.67% (refer to Appendix 1 for the derivation of r_e). The corporate tax rate is 35% and interest on debt is tax deductible. The borrowing cost for the firm is 6%. Therefore the WACC for Company A is calculated as follows:

$$\begin{aligned} WACC &= r_e * w_e + r_d * w_d * (1 - \text{Tax}) \\ &= 13.67\% * 0.7 + 6\% * 0.3 * (1 - 0.35) \\ &= 10.74\% \end{aligned}$$

Using the total free cash flows (FCFs) and WACC calculated above, Company A is then valued as follows:

$$V(\text{Leveraged}) = \frac{FCF_1}{(1+WACC)^1} + \frac{FCF_2}{(1+WACC)^2} + \frac{FCF_3}{(1+WACC)^3} + \frac{FCF_4}{(1+WACC)^4} + \frac{FCF_5}{(1+WACC)^5} + \frac{FCF_6}{(1+WACC)^6} + \frac{FCF_7}{(1+WACC)^7} + \frac{FCF_\infty}{(1+WACC)^\infty}$$

$$= \frac{\$26{,}000}{(1+0.1074)^1} + \frac{\$26{,}780}{(1+0.1074)^2} + \frac{\$27{,}580}{(1+0.1074)^3} + \frac{\$28{,}410}{(1+0.1074)^4} + \frac{\$29{,}260}{(1+0.1074)^5} + \frac{\$30{,}140}{(1+0.1074)^6} + \frac{\$31{,}050}{(1+0.1074)^7} + \frac{\$382{,}100}{(1+0.1074)^\infty}$$

$$= \$335{,}920$$

This is the actual value of the firm to all investors. It incorporates the cost of debt, including the tax-shield. As must be the case, the value of the leveraged firm calculated using the FCFs and WACC (V(Leveraged) = PV (FCF, WACC)) is the same as the value calculated using the leveraged cash flows and r_a (V(Leveraged) = PV(CF_Leveraged, r_a)).

Discussion and Summary

The standard discounting cash flows (DCF) model satisfies the general consistency principle, because the cash flows in the numerator and the discount rate in the denominator and the resulting present value are referring to the same asset or object. The popular formula (equation (2) above) used to calculate the leveraged firm value by "discounting" the unleveraged firm cash flows with a special discounting rate (WACC) does not satisfy the consistency principle, because the numerator and present value are defined relative to two different assets, namely unleveraged cash flows and leveraged firm value. Connecting these two objects using a normal discounting format is the special function of the WACC.

When students are originally introduced to the formula that discounts FCFs with the WACC, most text books explain that the FCFs are the cash flows that are available (or free) for distribution to all investors (stockholders and creditors). But when analyzing the FCFs, finance practitioners (and careful students) will note that FCF is calculated by deducting taxes from the company's earnings before interest and taxes (EBIT), which is independent of leverage. These cash flows are not the total cash flows distributable to all investors. As noted in the Literature Review above, there is no explanation of this apparent inconsistency in either text books or the academic literature.

One possible way of resolving this issue is to explain that the available cash flows for investors are actually the cash flows of the leveraged firm (CF_ Leveraged) defined above (not FCFs), that the appropriate associated discount rate

is r_a, and that discounting the CF_Leveraged with r_a gives the true leveraged firm value. The problem with this approach is that it does not distinguish the operational activities of the firm from its financial activities. It is also not convenient to use these identities in practice, for example, when considering the problem of a firm capital restructuring.

Therefore the WACC model remains the most appropriate to use for corporate valuation. The FCFs are independent of the leverage ratio and the impact of leverage is considered in the WACC. By using FCFs and the WACC, we also get the same leveraged firm value as we do using the leveraged cash flows and associated discount rate r_a. But it is important to emphasize to both students and practitioners that in order to calculate an existing firm value the first step is to de-leverage the firm's cash flows. Income and costs from financing activities should be removed from the operating cash flows of the firm. The after-tax net income resulting from this first step is the FCF. We then need to explain that using the WACC to discount the FCFs incorporates the tax-shield effect. The resulting present value (V(Leveraged)) is the true value of the cash flows going to the pockets of investors (both debt holders and equity holders) in an existing firm.

How might knowledge of the issue we have identified improve student learning outcomes and satisfaction? When teaching the WACC model instructors may point out the distinct features of FCFs and the WACC and the fact that aspects of the model are not consistent with the principle of consistency. However, it is also vital that instructors emphasize that the model gives the correct value of the firm to all investors, both shareholders and lenders, and that this value is the same as that produced by a standard model that discounts leveraged cash flows. We believe that by emphasizing the distinct features of the WACC model, and its relationship to a standard DCF model, students will become more confident (and thus have less chance of making errors) in implementing the WACC model to estimate the value of a company or a project.

However, the anecdotal experience of the authors of the present paper is that WACC is a concept students often struggle with. Moreover, some of the concepts we introduce such as the notion of consistency in relation to financial assets and the assigning of different discount rates to different sets of cash flows, are relatively sophisticated. Therefore, a discussion of the consistency principle in relation to the WACC model would be most useful in a more advanced undergraduate course or a postgraduate course. These comments are in fact borne out by the experience of one of the authors, who has taught the principle of consistency in relation to the WACC model in postgraduate classes. Although he has not conducted a formal survey or study, he has found that the stronger students in his classes have benefitted from discussion of this topic. An avenue for further research might therefore be to conduct a more formal study of positive learning outcomes that have been achieved, using for example survey evidence from students.

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Appendix 1

Derivation of Formulae for Cost of Assets, Cost of Equity and Cost of Tax Shield

The following discussion is based upon Modigliani and Miller (1958, 1963) and Copeland, Weston and Shastri (2005). As noted in Copeland et al., Modigliani and Miller implicitly or explicitly make 10 assumptions about capital markets when constructing their models of corporate valuation, capital structure and cost of capital. These include the assumptions that corporate tax is the only form of government levy and that all cash flow streams are perpetuities (i.e., there is no growth). However Modigliani and Miller also note that relaxing many of the assumptions does not change the major conclusions of the models.

Free Cash Flow (FCF) is defined as the after-tax cash flows from operations:

$$\text{FCF} = \text{EBIT} * (1-\text{Tax}) + \text{Depreciation} - \text{New Investment in Operating Assets}$$

which is "…the cash flow that the firm would have available if it had no debt at all" (Copeland and Weston, p.561).

Based on the assumption of no growth (Modigliani and Miller's seventh assumption), the depreciation each year must be replaced by the new investment in operating assets so that:

$$\text{FCF} = \text{EBIT} * (1 - \text{Tax})$$

and, given Modigliani and Miller's second theorem stating that V(Leveraged) = V(Unleveraged) + Debt*Tax:

$$\frac{\text{CF\_Leveraged}}{r_a} = \frac{\text{FCF}}{r_u} + \text{Debt} * \text{Tax} \qquad \text{(A-1)}$$

If the company's new investment is ΔI, then the increased firm value is V(Leveraged). Copeland et al. show that:

$$\frac{\Delta V(\text{Leveraged})}{\Delta I} = \frac{(1 - \text{Tax})}{r_u} * \frac{\Delta \text{EBIT}}{\Delta I} + \text{Tax}\,\frac{\Delta \text{Debt}}{\Delta I}$$

The manager's decision rule should be:

$$\frac{\Delta V(\text{Leveraged})}{\Delta I} > 1$$

which is equivalent to:

$$\frac{(1 - \text{Tax})}{r_u} * \frac{\Delta \text{EBIT}}{\Delta I} > r_u * (1 - \text{Tax} * \frac{\Delta \text{Debt}}{\Delta I})$$

The right hand side of (A-1) is defined in Copeland et al. as:

$$\text{WACC} = r_u * (1 - \text{Tax} * \frac{\Delta \text{Debt}}{\Delta I})$$

With marginal NPV = $\Delta 0$, we have $\Delta V(\text{Leveraged}) = \Delta I$ and therefore:

$$\text{WACC} = r_u * \left(1 - \text{Tax}\,\frac{\Delta \text{Debt}}{\Delta V(\text{Leveraged})}\right) = r_u * (1 - \text{Tax} * w_d) \qquad \text{(A-2)}$$

Additionally it is shown in Copeland et al. that the expected equity return is:

$$r_e = r_u + (1 - \text{Tax}) * (r_u = r_d\, w_d) * \frac{w_d}{w_e} \qquad \text{(A-3)}$$

Combining (A-2) and (A-3), Copeland et al. show that another form of WACC is as follows:

$$\text{WACC} = r_d * w_d * (1 - \text{Tax}) = r_e * w_e \qquad \text{(A-4)}$$

Given these definitions, the optimal decision is: $\frac{\Delta FCF}{WACC} = \Delta 1 = \Delta I$ (and NPV=ΔV(Leveraged) $-$ ΔI $= 0$) which means:

$$\text{V(Leveraged)} = \frac{FCF}{WACC}$$

Given that by definition $r_a = r_d{*}w_d + r_e{*}w_e$, we can also substitute equation (A-2) into equation (A-4) to obtain:

$$r_a = r_u - (r_u - r_d) * \text{Tax} * w_d \qquad \text{(A-5)}$$

which indicates that when Tax $= 0$, or $w_d = 0$, $r_a = r_u$.

The above formulae are generally true under the condition that the operating business has constant growth (g), except equation (A-1) which is a special case of the constant growth scenario if g goes to 0. The discount rate r_{ts} for the tax shield cash flows (rd*Debt*Tax) is:

$$r_{ts} = r_d \left(\frac{r_u - g)}{r_u}\right) + g \qquad \text{(A-6)}$$

Our worked Example 1 demonstrates that the relationships hold when growth is positive.

Appendix 2

Equivalence of the WACC Model and the Consistent Model

Assuming a constant growth firm, we wish to show that:

$$V(\text{Leveraged}) = \frac{CF\_Unleveraged + CF\_TaxShield}{r_a - g} = \frac{CF\_Unleveraged}{r' - g} \quad \text{(B-1)}$$

if ***r'*** = WACC. Recognising that:

$$CF\_TaxShield = V(Debt) * r_d * Tax \quad \text{(B-2)}$$

we may substitute equation (B-2) into equation (B-1) and rearrange and simplify as follows:

$$V(\text{Leveraged}) * (\boldsymbol{r'} - r_a) + V(Debt) * r_d * Tax = 0 \quad \text{(B-3)}$$

Dividing equation (B-3) by V(Leveraged) we obtain:

$$(\boldsymbol{r'} - r_a) + w_d * r_d * Tax = 0 \quad \text{(B-4)}$$

Recognising that:

$$r_a = r_d * w_d + r_e * w_e: \quad \text{(B-5)}$$

we may substitute equation (B-5) into equation (B-4) and rearrange as follows:

$\boldsymbol{r'} = r_a - w_d * r_d * Tax = (r_e * w_e + r_d * w_d) - w_d * r_d * Tax = r_e * w_e + r_d * w_d * (1 - Tax) = WACC$

Why Do I Need to Know This? What's In It for Me? Enhancing the Relevance of Finance in the Business Curriculum

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The main theme of our paper is that financial analysis and management can best be appreciated and mastered by students from various majors when financial concepts and models are shown to be relevant and presented within the context of their respective majors. Context has a complex and powerful influence upon successful learning because it provides meaning, thereby helping students remember the important financial lessons and take a deeper approach to their learning in finance (and business) classes. In this paper, we develop and illustrate contextual examples showing relevance and application of finance to other majors in the business curriculum. We establish relevance by using academic discipline-specific examples and applications, and in so doing we hope to provide a framework for relating what we are teaching to students' academic interest(s). We also present a storyboard and an integrating model for relating finance to students' academic interests, thereby heightening their motivation for learning financial topics.

INTRODUCTION

The need for faculty responsiveness to student successful performance in the introductory business finance course is widely recognized. A quick review of the past issues of the Journal of Financial Education reveals several approaches to address these concerns. One approach is to review the prerequisites to the introductory financial management class and then develop learning outcomes and assessment instruments (Eisenmann, Mettler, and Shrikhande [2006]). Another approach is to develop models for projecting student performance (Liesz and Reyes [1989]). Others have incorporated various forms of experiential learning activities that include, but are not limited to, simulations and comprehensive

team projects (Faulk and Smolira [2007]), the use of Excel for model building (MacDougall and Follows [2006]), current event discussions (Morey [2015]), technology such as clickers (Chan and Snavely [2009]), podcasting and animation (Biktimirov and Nilson [2006], and Swidler [2015]), video clips (Shipley [2015]), and online interactive homework activities (Grinder [2014]). Other approaches have included the adoption of course management systems (Spivey, M.F. and J.J. McMillan [2013]) and the incorporation of personality and learning styles into the course development and delivery (Ashraf, Fendler, and Shrikhande [2013]).

In this paper, we take a different approach. We propose that providing context and illustrating relevant financial management examples motivate students—most especially non-finance majors—to take a deeper approach to their learning in finance (and business classes). The main theme of our paper is that financial analysis and management is complex. It cannot be appreciated and mastered by students from various majors through repeated financial problem solving (i.e., the "drill-and-kill" method[1]) that is typically employed when teaching fundamentals of financial management. They are best appreciated and understood when financial concepts and models are shown to be relevant and presented within the context of their chosen majors. Context provides meaning and helps students remember the important financial lessons. Context has a complex and powerful influence upon successful learning, and yet discussion of context is scarce (Tessmer and Richey [1997], p. 85). Meaningful discussion of context for non-finance majors is particularly scarce in the finance education literature. This is not surprising because the literature has documented that differences in disciplinary culture affect the ways faculty think about and teach in their discipline (see, e.g., Becher and Trowler [2001]). Laird et al. [2008] present evidence suggesting that faculty members' emphasis on deep approaches to learning varies considerably by disciplinary area.

In this paper, we will present and illustrate contextual examples showing the relevance and application of finance to other majors in the finance principles course. The finance principles course is required for all business majors and with the diverse range of majors taking the course, there are typically a larger proportion of non-finance majors in the finance principles courses. Additionally, at many institutions, this course may be the only finance course students ever take. Hence, we view it to be extremely important that non-finance majors find the finance fundamentals course engaging and relevant so that students successfully complete the course with a better appreciation and deeper understanding of the finance principles.

We will attempt to establish relevance by using academic discipline-specific examples and applications, and in so doing, we hope to provide a framework for

[1] The drill-and-kill approach also reinforces "academic silos". By incorporating relevant and contextual examples, we begin to break down the silos. Our approach, therefore, offers students opportunities to develop cross-functional perspectives, thereby helping address the Mintzberg and Gosling (2002) critique that management education fails because of its focus on functions instead of organizing it around the nature of managerial work.

relating finance to students' academic interest(s), life experiences, etc. To the best of our knowledge, discussion of context and relevance to non-finance majors is scarce in the financial education literature. Our paper seeks to fill in that gap. Doing so helps prepare our students for the real world, where a cross-functional perspective is highly desired; for example, see publications titled "financial intelligence for HR professionals," "marketing's role in managing assets," "integrating operations and finance" (Please see Appendix B for details).

In the next section, we present a brief review of the literature on the association between context and relevance, and student motivation and learning. Then we illustrate several contextual applications of finance.

CONTEXT, RELEVANCE AND STUDENT LEARNING

Kember, Ho, and Hong (2008) report that establishing relevance is the most prominent and often cited student response to the question of motivation. Establishing relevancy to students may include (1) showing how theory can be applied to practice, (2) establishing relevance to local cases, (3) relating material to everyday applications, and (4) illustrating applications in current newsworthy issues. These findings were obtained from interviews of students from nine undergraduate programs at three Hong Kong universities. Additional support for relevance comes from neurology. For example, neurologist-turned-teacher Judy Willis [2008] writes:

> "When you provide students with opportunities to apply learning -- especially through authentic, personally meaningful activities -- and then provide formative assessments and feedback throughout a unit, facts move from rote memory to become part of the memory bank. These opportunities activate the isolated small neural networks of facts or procedures, which then undergo the cellular changes of neuroplasticity that link them into larger neural circuits of related information. These extensive neural circuits integrate new information when they are a) simultaneously activated and b) when they recognize patterns in common."

Hence, if a student receives new information that s/he perceives to be unrelated to anything already stored in her/his brain, then it is difficult for that new information to be assimilated because there is no scaffolding to which that new information can connect.

Advocates argue that relevance, when effectively incorporated into the course curriculum and instruction, can heighten students' motivation to learn and engage. Establishing relevance is critical because the personality traits and interpersonal behaviors that predispose students to select certain business majors also affect the effectiveness of different pedagogical strategies in facilitating their learning

(Ulrich [2005]). For example, marketing and management majors rate simulations and case studies higher than finance and accounting majors, whereas the latter rate problem exams higher than management and marketing majors. Students need a personal connection to the material.

In the next section, we establish relevance and context by relating finance concepts to what students already know (academic relevance), their personal interests, prior knowledge, and experiences (personal relevance) or by relating the concepts to real-world issues, problems, and contexts (life relevance).

CONTEXTUAL APPLICATIONS OF FINANCE IN THE BUSINESS CURRICULUM[2]

The typical time value of money chapters in corporate finance textbooks often include several numerical problems on retirement planning. As is usually the case, though, students lose sight of the implications of the problem because they are often bogged down on the mechanics of the application of PV of an annuity to determine the target retirement fund, then the application of FV of annuity to estimate the required contributions to achieve the desired retirement fund.

Suppose the calculated annual deposit is $5,175 in order to save $936,492 on the day of retirement, assuming a 10% investment return. That is the equivalent to $431 monthly contribution. In our classes we then pause to introduce defined benefit versus defined contribution retirement plans and vesting requirements in order to show the students that the a $431 might not be as onerous as they think ($431 is a large amount for college students). We also impress upon them that these are questions they should ask during job interviews. Additionally, many of these concepts are of considerable importance to HR majors studying employee benefits. Showing students the efficacy of investing that $431 annually, we connect the time value problem to their own situation, thereby increasing their awareness on the importance and relevance of this retirement problem that they might only see as a potential time value of money question in the exam.

Financial Forecasting and Pro-Forma Financial Analysis

When Finance professors present financial planning and pro-forma analysis, we tend to focus on the percentage-of-sales technique and its implications for external funding needed (EFN). But we can provide context for marketing and human resources majors as well by pointing out their role(s) in accomplishing sales growth targets (for marketing majors) and staffing needs (for human resources majors).

[2] We continue to develop and catalog detailed contextual examples and financial applications across business disciplines.

Take the case of a fast-growing high-tech company. After going through the mechanics of preparing the pro-forma financial statements, the resultant EFN, and its impact on the firm's capital structure, non-finance and accountings students can be engaged as follows:

Marketing Majors: Discuss how they might use marketing research techniques to forecast sales growth. How might they use promotional strategies to achieve the target revenue growth? Specifically, we can ask about the size of the market, potential requirements for the market to justify the capital investment, the initial market share, and minimal market share needed to justify the investment. What distribution strategies would need to be considered to get this level of sales? What additional expenses would be encountered to get this level of sales? With respect to price, price is unlikely to stay stable, thus what price floor would exist in order to still achieve some level of profitability?

Operations Management Majors: If the company is close to operating at full capacity, then do they lead demand with an incremental expansion? Or do they build initially for a higher potential capacity? How might they use capacity planning techniques to ensure that the company has the requisite number of engineers to meet revenue target? What capital is needed to finance raw materials and work-in progress?

Accounting Majors: How does the timing of inflows and outflows of money influence EFN. How do delays in accounts receivable influence the growth of the firm?

Information Systems Majors: What type of system is needed to manage the flow of information and ensure that it is safeguarded and accessible? What are the initial and maintenance costs for this type of a system?

HR Majors: Discuss the challenges they might face to attract engineers to staff the projected sales growth. How would they formulate a recruiting strategy to meet the growing operational needs? What training needs might be required?

By engaging the non-finance majors beyond the mechanics of pro-forma financial statements, they will immediately see the relevance and importance of understanding financial planning and pro forma financial statements.

Capital Budgeting in the Product Planning Process

The product (and process) development process presents a fruitful example for highlighting the cross-functional decision-making that occurs among marketing, finance, operations, and HR, among others. When motivating the topic of capital budgeting, we begin by going through the stages: Trigger, Development, Analysis and decision-making, Implementation, and Post-audit. One trigger for a capital investment is a new product opportunity identified by the marketing department.

In today's environment of teamwork in the workplace, we can engage the following students:

Marketing Majors: What is marketing's role in new product development? We can allow marketing majors to lead the discussion of marketing research in assessing the current demand as well as untapped/unidentified market for the project. What costs will the firm encounter to establish the distribution channel? To promote the new product, what are the various forms of promotions (and their respective costs) for reaching the desired target markets? Students can consider price floor and price ceiling. At what point is price so low that we no longer make a profit? At what point is price so high that customers seek competitor products or even substitutes?

Operations Management Majors: We can discuss quality and costs of the product or service. What are the costs associated to having high quality? What are the costs associated to having inferior quality? What costs does a firm face when building capacity too early or too late?

Accounting Majors: We can discuss the appropriate depreciation methods for the proposed asset. What are the relevant costs?

Information Systems Majors: We can discuss the importance of the information backbone to the organization and, specifically, the method(s) for which we communicate across and within the various functional areas of the organization. What costs does the firm encounter to build, manage, and protect this vital information system?

HR Majors: Similarly, the example offers an opportunity to engage HR majors in a discussion of implications and procedures for hiring or layoffs (in the case of a project abandonment), thereby deepening the relevance to the students of the importance of capital budgeting to their academic study.

Customer Lifetime Value as a Capital Budgeting Problem

In marketing, customer lifetime value is a projection of the net profit derived from the relationship with a customer for the purpose of assessing the financial value of that customer. Customer lifetime value is forward looking and involves the present value of projected relevant cash flows from the customer relationship.

Reichheld and Teal (2001) discuss the application of NPV analysis to estimating the value of a credit-card customer. The following illustration is a modification of their example. A credit-card company has a 70% customer retention rate, and management is formulating a plan for increasing it to 80% over the next year. It costs $100 to acquire a customer (including the cost of setting up the customer's account). Estimated annual profits per cohorts of 100 customers are shown in Table 1 below.

Table 1. Customer Lifetime Value as a NPV Application

Year	$ Profit Per Customer	A Cohort of 100 Customers	Total $ Profits Per Cohort of 100
1	$ (100.00)	100.0000	$ (10,000.00)
2	$ 50.00	70.0000	$ 3,500.00
3	$ 55.00	49.0000	$ 2,695.00
4	$ 60.00	34.3000	$ 2,058.00
5	$ 65.00	24.0100	$ 1,560.65
6	$ 70.00	16.8070	$ 1,176.49
…	…	…	…
25	$ 140.00	0.0192	$ 2.68
26	$ 140.00	0.0134	$ 1.88
27	$ 140.00	0.0094	$ 1.31
28	$ 140.00	0.0066	$ 0.92
29	$ 140.00	0.0046	$ 0.64
30	$ 140.00	0.0032	$ 0.45

If the credit-card company's cost of capital is 10%, then the lifetime value of a customer is only $2.81. Table 2 presents different estimates of customer values at different retention rates (and a 10% cost of capital).

Table 2. Estimated Customer Lifetime Values at Different Retention Rates

Retention Rate	Customer Value
70%	$ 2.81
75%	$ 30.07
80%	$ 68.74
85%	$ 126.97
90%	$ 221.65
95%	$ 390.27

The table shows that increasing customer retention rate from 70% to 80% increases a customer's value to $68.74. Customer value jumps to $390.27 at a 95% retention.

Marketing Majors: We can discuss how students might use survey research to determine customer experience and perception of the company customer service performance. How might students then use the survey results to develop a marketing plan to increase the customer base and retention rate? What are the costs for attracting new customers? Does the firm need to invest in advertising,

sales promotions, personal selling, direct marketing, etc.? If so, to what extent and in what combination? What are the costs for retaining a new customer? When faced with competitive pressures, what accommodations need to be made in order to retain customers? What strategies could be considered when customers cost more to attract or retain than their CLV indicates?

Operations Management Majors: What additional costs does the firm face with higher retention rates? How does a firm plan for declining retention rates?

Accounting Majors: What are the relevant costs? What are the variable costs? What about fixed costs?

Information Systems Majors: Access to information regarding acquisition and retention costs is critical for employees managing customer interactions. What type of system must be built in order to facilitate this? Who should have access to this information, and how does this influence the cost structure?

HR Majors: What training needs might be required in order to deliver the customer service required to increase customer retention rate?

Multi-Disciplinary Applications to Sales Order Processing

In our classes, we walk the students through the decisions that take place once a customer order has been received and highlight the coordination necessary in finance, marketing, and operations in order to ensure that the customer order is delivered as specified. Consider the following example illustrated in Figure 1.

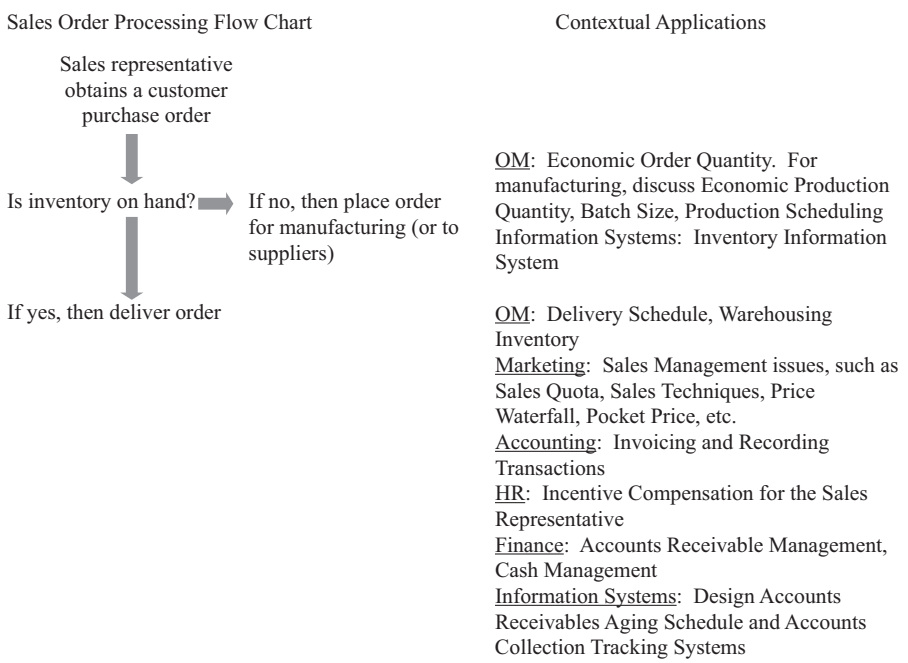
Figure 1 contains a story board for bringing up working capital management topics, such as EOQ, Baumol Model of Cash Balance, Cash Management, and Credit Management within the context of sales order processing. Instead of marching through these topics as if they are independent topics that might be of interest only to finance (and accounting) majors, the sales order processing flow-chart highlights the relevance and utility value of the topics to the non-finance majors.

Summary and Conclusion

The main theme of our paper is that financial analysis and management is complex. It cannot be appreciated and mastered by all students through the normal "drill-and-kill" method. The principles of finance can best be understood fully when financial concepts and models are shown to be relevant and presented within the context of their chosen majors. Context provides meaning and helps student remember the important financial lessons.

In this paper, we present several contextual examples showing the relevance and application of finance to other majors in the finance principles course. We establish relevance by using academic discipline-specific examples and

Figure 1. A Multidisciplinary View to Sales Order Processing



applications, thereby offering students utility value for the finance principles they are learning in class.

There are numerous other contextual examples and financial applications across business disciplines. Appendix A offers an integrated view of the utility value of various financial management topics to business majors, and in so doing affords an approach for enhancing the relevance of finance to all business students, most especially non-finance majors. Appendix B presents additional references that illustrate the integration of finance into other business functions. One major benefit of our approach is that students hearing applications from other majors helps facilitate the development of their cross-functional perspective of business.

Our evidence to support the use of context is anecdotal and is based on discussions with employers who seek to hire students who not only have mastery of their major but also understand how their major relates to others, have the increased desire to integrate business concepts, and have achieved improved education outcomes when more engaged in the classroom. From an assurance of learning standpoint, one could compare two courses taught during the same term where one is taught in a more traditional sense and another has significant contextual applications. A simple set of pre- and post-tests could be used to measure knowledgeability of finance topics as well as attitudes towards the application of finance to other

business domains. Many programs have students taking finance in the sophomore or junior year, and then either have a common set of capstones (for all majors) or program specific capstones. In either case, a set of measures could be taken in these courses to evaluate relevance and knowledgeability. A third mechanism could be through the use of standardized testing that some programs use. While this testing does come at a cost in time and financial resources, this testing mode could be used to compare performance in prior years or to other institutions. In our courses, we will begin by comparing student interest and motivation (e.g., regular class attendance) and performance in exams and satisfaction.

Our approach is also easily transferable. Our framework and examples can be used by instructors in other business classes where finance students are enrolled. We hope our pedagogical approach has begun to contribute to these curriculum conversations.

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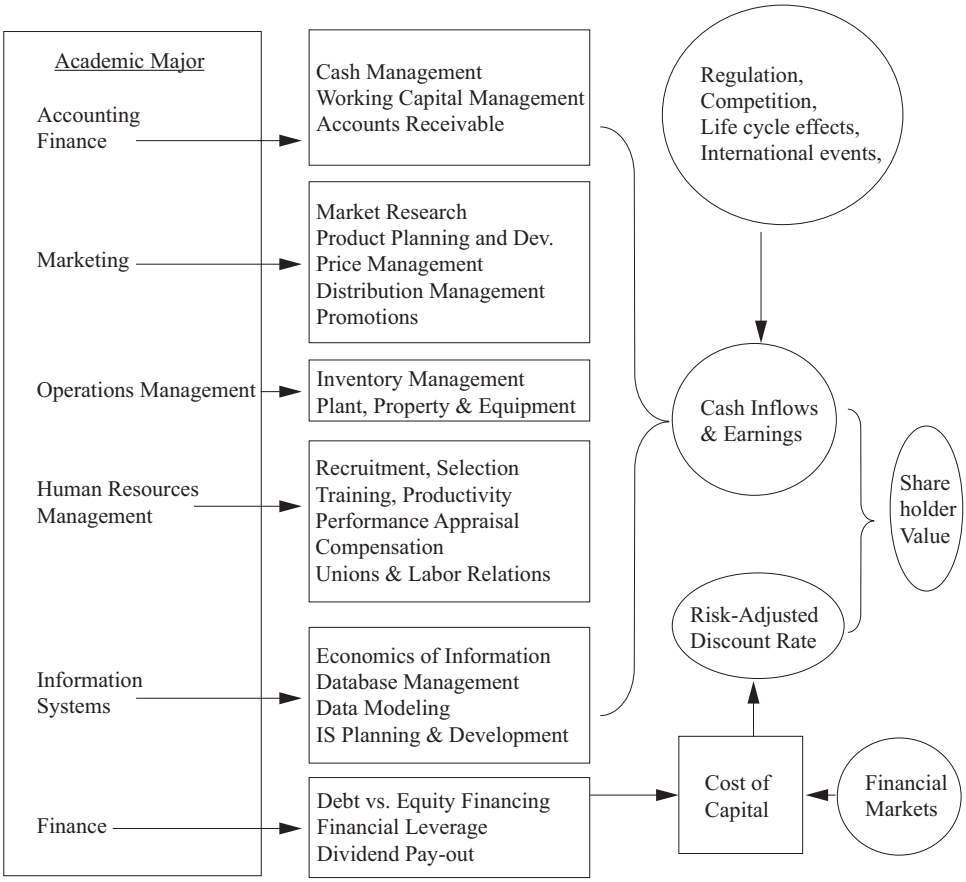
Appendix A

An Integrated View of the Utility Value of Finance to Business Majors



Appendix B
Additional Examples of Finance in Other Business Functions

Human Resources

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