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Exploring the Effects of Female Student Populations on Program Growth

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Finance is a field dominated by males in both professional organizations and universities. Many professional organizations have tried to address the disappointing rates of participation by females with limited success. Likewise, while some universities have tried to increase the number female finance faculty and students, females still are greatly underrepresented both as faculty and students. Previous research revealed a slight positive correlation in the ratio of female faculty members to that of undergraduate students. However, longitudinal data provided by a few institutions suggested additional research concerning the growth, or lack thereof, based on undergraduate student populations may reveal interesting and significant trends in the data.

While data collected for this study showed that both growth rates and participation by female students varied greatly among universities, there was no statistically significant relationship between gender composition and finance program growth.

Keywords: finance, female, undergraduate, education, gender

Introduction

College enrollment has grown and changed substantially over the past 60 years. As enrollments have grown, the demographics of undergraduate students has shifted to fit the labor market. This has created a system where, according to the National Center for Education Statics (NCES), female university students have outnumbered male students for over 3 decades. Likewise, female students are more likely to matriculate and ultimately graduate from college.

Finance is one of the fastest growing undergraduate majors with high in-field placement and lucrative career prospects (Colino 2018, Rapacon 2019). Programs have become increasingly competitive and attractive to incoming students. Despite the growth of finance majors and the increased overall proportion of female students on college campuses, finance programs still struggle to attract female students.

Preliminary data showed that females only account for 25% of undergraduate finance students. The data also showed a possible relationship between the ability to attract and retain female

students as a factor contributing to program growth. This prompted the collection of a larger sample and the addition of data from AACSB.

Problem Statement

The scope of this study is to explore the relationship between program vitality and number of female undergraduate students majoring in finance. Specifically, the question is whether the proportion of female students in undergraduate finance programs is related to the overall growth rate of the finance program as a whole.

Review of Literature

The contribution of women to the field of finance has been the subject of considerable research from many angles. Female traders have been found to achieve higher returns than those of their male colleagues (Barber and Odean, 2001). The research determined that female equity traders held positions longer and made fewer trades and therefore achieved higher returns. The research determined that both psychological and personality traits contributed to the difference in performance between men and women. Luongo (2011) found female-managed mutual and hedge funds performed better on a risk adjusted basis than those managed by males. In a difference from the research of Barber and Odean (2001), Luongo (2011) found the higher returns were not just the result of personality traits, but superior asset evaluation, selection, and execution.

Firms also benefit from women serving as financial managers. Women have been found to resist over-confidence in corporate decisions (Malmendier and Tate, 2005; Peng and Wei, 2007). Some firms have recognized the value of gender-diverse management teams (Merten, 2019), and credit firm success to, among other factors, female inclusion in management.

The contribution of women in the financial services industry has also been studied. Women have been found to have different risk tolerance and investment preferences than men. Bliss and Potter (2002) found that female fund managers were more risk aggressive than their male counterparts. However, from a personal wealth perspective, studies show that women often take less risky positions than men (Croson & Gneezy, 2009; Davar et al, 2007; Jianakopolos, 2007; Sunden, 1998). This difference in risk tolerance, combined with differences in consumption patterns and accumulation of wealth (Murthy et al, 2011), presents a case for increased female employment in the financial services industry.

Yet despite the documented advantages and performance differences of women in various fields of finance, women do not participate in the field of finance at the same rate as men. This remains true in spite of efforts by industry organizations (Bier 2016, IMF 2018). The existing literature is nuanced as women often represent only a small percentage of the population studied, even when the focus is on gender (Davar et al, 2007). Likewise, women do not major in finance at the same rate as male students, and females make up a small percentage of undergraduate finance faculty (AACSB, 2018; Jones and Merritt, 2020).

Previous academic research (Bauer 1999, Hatfield 2015, Jones and Merritt, 2020, Keys 2006) as well as industry studies (Adams 2016, Atkinson 2003, Neck 2015, IMF 2018) identify multiple factors that contribute to the scarcity of females choosing to major in finance. This low female undergraduate participant rate then perpetuates into industry and also into faculty.

In his work on student attrition, Tinto (1993) perhaps hints at the crux of the problem:

> *Institutions of higher education are not unlike other human communities … (they hinge) on the establishment of a healthy, caring educational environment which enables all individuals, not just some, to find a niche in one or more of the many social and intellectual communities of the institution. (205)*

Consequently, Tinto proposes culture as one of the leading factors of student persistence and conversely, culture is also a leading reason students depart from the field of study.

Cultural transmission begins at home, long before students enter fields of study, according to the work of Adams, Barber, and Odean (2018). In their study, the authors found that female students from families with at least one parent working (especially the mother) in a STEM field were significantly more likely to choose finance as a major or career. This study also sets precedent for viewing finance not only as a business discipline, but also as a STEM discipline largely due to its quantitative focus.

Some might wonder if a 'math-gap' could be used to explain disparate numbers of female students in STEM fields, including finance (Hooker, 2018), Feusting et al. (2019) point that the problem may be more cultural than intellectual. In their work, the authors point out that intellectual ability is often shaped by goals in a particular field of study. Also in their work, the authors find that faculty may contribute to this phenomenon through student interaction by either encouraging or discouraging female students in STEM fields. Other STEM fields such as engineering have demonstrated success of female-to-female mentoring programs in increasing female persistence in the field. Dennehy & Dasgupta (2017) provide statistical evidence from a field study that women studying engineering who were assigned a female peer mentor "experienced more belonging motivation, and confidence in engineering, better retention in engineering majors, and greater engineering career aspirations. Female mentors promoted aspirations to pursue engineering careers by protecting women's belonging and confidence. Greater belonging and confidence were also associated with more engineering retention".

Hawash and Stephen (2019) found that no math-gap existed between male and female students during their first-year college math course, and females in fact scored higher. Likewise, they found no statically significant difference in grades between female and male students in corporate finance classes. Their longitudinal study points to a trend in universities where lack of female representation cannot be explained by differences in academic aptitude.

Similarly, Wann and Lobo (2010) found that in an academic setting, male and female students exhibited different appetites for risk trading behavior. However, despite the differences in trading patterns, there was no statically significant difference in return. Also, of particular interest to this study found within their work, of the students studied, less than 30% were female. Patnaik, Venator, Wiswall, & Zafar (2020) studied risk preferences and earnings expectations in the choice of college major. The study found that while males are less risk averse and patient than females, gender differences in expectations about earnings potential and risk aversion cannot explain gender gaps in choice of college major.

Altogether the literature paints a picture of an academic field that is dominated by males. While female students perform equally to their male classmates, they are not attracted to the discipline. This trend continues post-graduation into industry despite industry push for diversity and often superior performance by females. The unequal participation based on gender, coupled with the dynamic and competitive nature of university enrollments, benefits from a study that examines impact gender plays in program growth.

Methodology

Data was compiled from institutionally reported data. This data was collected from university websites, through university registrars, and through university assessment officers. This initial data collection allowed for longitudinal observation beginning with the fall 2015 academic semester. Data was collected from 27 NCAA division 1 universities. Subsequentially, additional graduation and enrollment data was also purchased from AACSB.

Universities were divided according to the growth rate of undergraduate students majoring in finance. Stable programs were defined as programs with growth rates from -2% to 4%. Growth programs were defined as those with a growth rates of 5% or greater. All rates were based on annual geometric means of fall semesters. After classification, growth rates of all students, male students, and female students were compared.

Findings and Discussion

Analysis of Relationship of Finance Degree Growth and Female Enrollment

The goal of the study was to ascertain any relationship between the proportion of female student enrollment and changes in enrollment in undergraduate finance degree programs in U.S. universities. Two different data sets were utilized. The largest data set was annual undergraduate business degrees awarded as reported by the 536 accredited U.S. member schools in the Association to Advance Collegiate Schools of Business (AACSB). The data was summarized from the Business School Questionnaire (BSQ) from the 2010-2011 school year through the 2019-2020 school year. The second data set, which we will designate the Finance Trend Data (FTD), was collected from university web sites of NCAA division 1 universities. Universities included in the study reported yearly male and female student enrollment in finance degree programs for the five school years beginning fall 2015 through fall 2019. The sample size was 27 schools and 131 total yearly enrollment records.

The AASCB BSQ data did not include the male/female enrollments at the specific degree level (accounting, marketing, finance, etc.) until the 2018-2019 and 2019-2020 school years, nevertheless this large data set was deemed relevant to this study because it provided an overall picture of total business degree growth trends and male/female proportions over that 10 year reporting period. This data set had 4604 records of annual business degrees awarded with 527 different schools reporting at least one school year of degrees awarded data in this 10-year period.

Table 1 summarizes the total number of male and female graduates and number of reporting schools for each year of the 10 years of observed BSQ data, along with the proportion of female students each year. The table shows a modest increase in total business degrees awarded over this 10-year period, and a very constant overall proportion of female graduates at about 42.5%

Table 1

Summary of BSQ Data for Undergraduate Business Degrees by School Year.

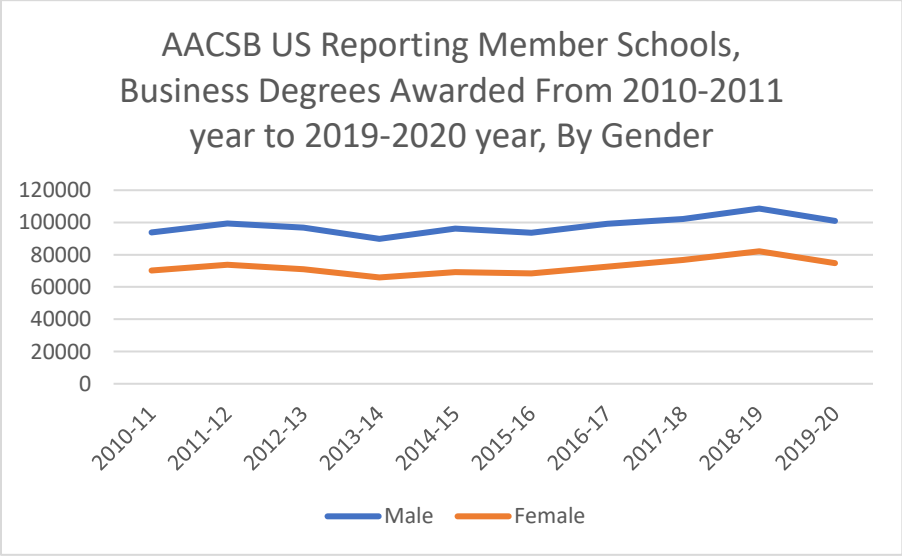
Year	Male	Female	Schools	Proportion Female
2010-11	93740	70190	394	0.428
2011-12	99369	73824	408	0.426
2012-13	96822	70982	401	0.423
2013-14	89843	65909	380	0.423
2014-15	96160	69269	389	0.419
2015-16	93714	68378	382	0.422
2016-17	99127	72592	379	0.423
2017-18	102220	76813	368	0.429
2018-19	108621	82127	365	0.431
2019-20	101055	74863	355	0.426
Grand Total	980671	724947	3821	0.425

Source: AACSB.

Figure 1 summarizes the results in Table 1 in graphical form and depicts the very gradual increase in total number of degrees awarded to male and female students, and that the mix of male and female students is very consistent through the yearly variations up and down.

Figure 1

Annual Total Male and Female Undergraduate Business Degrees Awarded by AACSB member schools in the U.S.

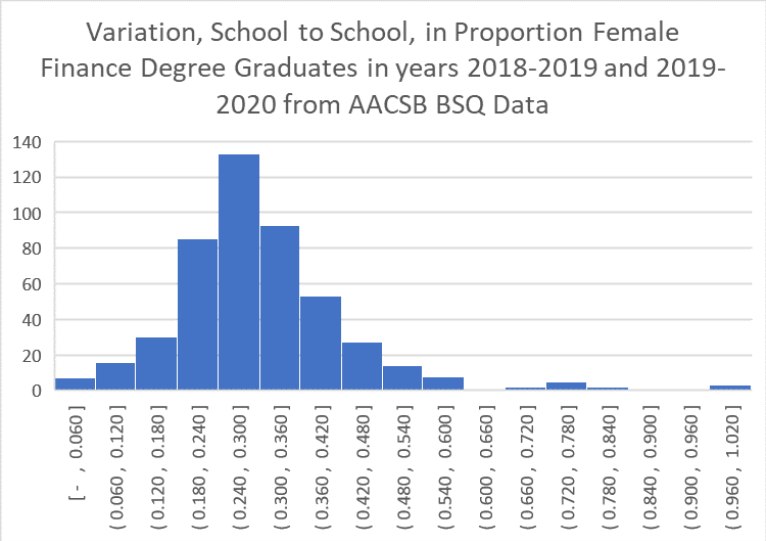


Source: AACSB.

For the two years with specific degree and gender breakout reported (2018-2019 and 2019-2020), the total accounting degrees were 24,552 male students and 23,463 female students, not including other accounting graduates of unreported gender breakout, reflecting a higher proportion of female graduates in accounting (49%) than the overall female representation in all business degrees over all 10 years, 42.5%. In contrast to accounting, there were a total of 36,990 male

finance graduates in these same two years and 15,643 female finance graduates, plus other finance graduates of unreported gender breakout, with an overall proportion of female finance graduates of .297 (29.7%). For all the data records reporting annual male/female graduations in finance from various schools in 2018-2019 and 2019-2020, those proportions of female graduates varied greatly around the mean .297 as shown in Figure 2.

Figure 2
Frequency Distribution of Proportions of Female Finance Graduates for All Schools Reporting Finance Graduations in 2018-2019 and 2019-2020.



Source: AACSB BSQ Data.

As seen in Table 1 and Figure 1, the overall mix of male and female graduates is very constant over the 10 years reported. Some of the member schools were growing in number of graduates over this period, and some were declining. So, we were interested if those schools who were growing enrollment (as measured by the number of graduates) might be doing so because of increased proportions of female students. So, we examined 290 schools that reported results for both the start year (2010-2011) and end year of a 9-year reporting period ending in 2018-2019 to examine changes in total enrollment and changes in the proportion of female enrollment to ascertain any possible relationship between program enrollment growth and increase in proportional female makeup of the graduating class. So, the "X" variable in the comparison was the delta change in total business graduates from the 2019-2020 year relative to the 2010-2011 year, and the "Y" variable was the delta change in proportion of female graduates in the 2019-2020 year relative to the proportion of female graduates in the 2010-2011 year. The sample correlation coefficient r between X and Y was .073 and the t test statistic = 1.25 and p-value .211 which is not significant at the .05 level of significance. So, there is no statistically significant correlation between change in total number of business graduates over this 9-year period and change in the proportion of female graduates. As a separate check on this finding, we observed that the average change in proportion female graduates among the 20 schools with the highest growth in total graduates was close to zero change in proportion female over the 9-year period, and the average change in proportion female graduates was also close to zero for the 20 schools with the greatest decline in total graduates over the 9-year period. So, growth or decline in school's business graduates seems unrelated to the proportion of female graduates.

We now turned our attention to the other data set to ascertain if this finding for all business graduates seemed to apply to trends in enrollment in finance programs and the proportion of female enrollment. The AASCB BSQ data did not have more than 2 years of data at the level of detail which specified major (finance) and gender. So, we collected data for the five-year period ending in the spring term 2015 to 2019. This five-year Finance Trend Data (FTD) is summarized in Table 2 showing the total growth trends across this period for the 27 schools in this sample which included 135 annual records of enrollment. The proportion of female students enrolled by year .269 (26.9%) is similar to the proportion of female finance graduates observed in the larger AACSB BSQ data set for 2018-2019 and 2019-2020 which was .297 (29.7%). Also note that there was growth in total finance programs enrollment over this five-year period for these 27 schools in total, the overall proportion of female enrollment actually declines. Thus, the observed growth is due to increased enrollment of male students more than female.

Table 2
Summary of Undergraduate Finance Program by Gender, Totaled by Year Across 27 Schools

Year	Total Male	Total Female	Total	Proportion Female
2015	9451	3707	13158	0.282
2016	10698	4110	14808	0.278
2017	11376	4170	15546	0.268
2018	11836	4174	16010	0.261
2019	11647	4126	15773	0.262
Total	55008	20287	75295	0.269

Table 3 summarizes the delta change in total finance program enrollment for the 27 schools in the data over the 5 years of observed data, broken out by gender. The results in the table show finance program enrollment growth over this five-year period, but that the growth is largely related to increase in male student enrollment.

Table 3
Total Undergraduate Finance Program Enrollment Increases over the 2015 Baseline for the 27 Schools Observed for the Five-Year Period 2015 to 2019

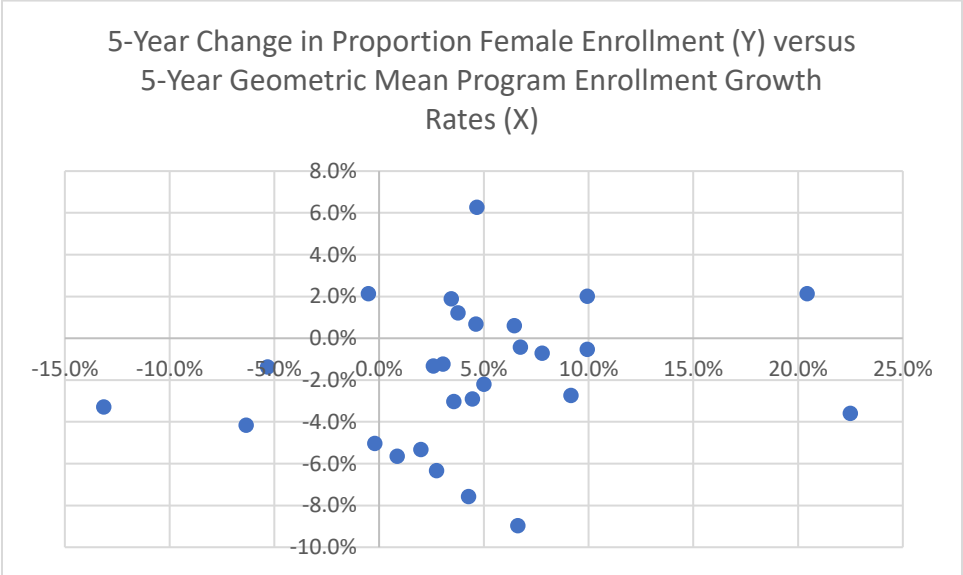
	Male	Female	Total
2015	baseline	baseline	baseline
2016	1247	403	1650
2017	1925	463	2388
2018	2385	467	2852
2019	2196	419	2615

Although Tables 2 and 3 show total enrollment growth in finance programs over this five year period, some of the 27 schools grew in enrollment and some declined. So, similar to the question studied for all business graduates in the AACSB BSQ data, the data was examined to probe any possible relationship between growth (or decline) and changes in proportion of female enrollment. In this comparison, the "X" variable was the equivalent rate of growth in finance enrollment over the five years, computed as a geometric mean rate of change. The "Y" axis was the percent change in proportion of female enrollment over the same five-year period. Figure 3 is a scatter plot of this

data showing a slight increasing relationship between the geometric mean rate of growth and the percent change in proportion female enrollment, but obviously many other unknown factors affect the mean growth rate other than the proportion of female students.

Figure 3

Relationship Between Geometric Mean Five Year Finance Enrollment Growth Rate (X axis) versus Percent Change in Proportion Female Enrollment in Finance (Y Axis)



The sample correlation coefficient r is .190 and the t test statistic = .968 with p-value .34 which is not significant at the .05 level of significance. Thus, while increase in the proportion of female finance program enrollment was more correlated with growth or decline in finance program enrollment (.19) in this sample of 27 schools finance programs than the observed correlation (.07) between total business degree enrollment change and proportion female graduates seen in the overall AACSB BSQ data, this correlation is still not deemed significant.

In comparing the schools with geometric mean growth rates at 5% or higher (which was the top 10 schools), the average proportion female students was .273 and the average net change in female proportion over the five years for this group of growing schools was (.014), reflecting the same overall decline in proportion female students shown in Table 2. The bottom group of 10 schools, growth-wise, who had little or negative growth rates, averaged .275 proportion female and averaged (.032) net change in female proportion over the five years.

Thus, there still seems to be an opportunity to grow finance program enrollment by recruiting a greater mix of female students, given that the proportion of finance enrollment (29.7% in overall AASCB schools and 26.9 in the five-year finance program enrollment trend data) is still well below the female representation in business programs overall and accounting in particular.

Future Research

While this research does not show a significant difference in program growth based on gender diversity, it does show a broad range of student composition based on gender that chose finance as their major. Future research could include recruiting practices that lead to diverse student populations. Similarly cultural analysis may explain not only why certain universities attract more

female finance students, but also what factor contribute to or detract from matriculation and retention.

With similar methodology, research could be conducted to find what relationships exist, if any, between racial diversity and program growth. Likewise, a matrix approach could be used to study the interrelationship between gender composition and racial diversity.

Conclusion

This paper explores the impact female student enrollment have had on undergraduate finance programs enrollment trends. Analysis of the data suggests that the ability of a program to attract and retain female students has not contributed to finance program growth at a statistically significant level. However, instead of concluding that growth of female participation in finance does not matter in program growth, one might instead interpret the results to indicate that growth in female enrollment still represents unrealized potential for future growth in finance programs and careers in both industry and academia.

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The Bridge and Torch Problem: Developing Critical Thinking Skills with Puzzle-Based Learning

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Hiring managers commonly use puzzle types of problems to examine a potential employee's critical and lateral thinking skills and their problem-solving skills and overall fit into an organization. Educators must seek out methods of teaching students higher-order thinking skills. Problem-based learning (PBL) uses problems to increase knowledge and understanding. We examine using a typical puzzle with Excel and Excel Solver as a PBL tool to enhance students' critical thinking and Excel skills. The Solver program uses an iterative method to examine sophisticated mathematical processes. The 'bridge and torch' problem is a well-known problem that presents a situation that enables the user to evaluate the situation and demonstrate quantitative analytical and logic skills to determine the most efficient approach to solving the problem.

Keywords: Problem-based learning, PBL, Excel, data literacy

Introduction

Problem-based learning (PBL) was initially designed to answer to the criticism that medical students were not being adequately prepared in academia for clinical settings Hung, Jonassen, & Liu, 2008). PBL is now being implemented across disciplines throughout higher education. PBL is increasingly popular in business programs, including finance, planning, and production (Jonassen, Previsch, Christy & Stavrulaki, 1999; Jonassen & Hung, 2015; Loviscek, Crowley & Anderson, 2003). Although PBL works well for group or team settings, recent advancements have suggested that students also benefit from the knowledge strategies to solve problems by themselves (De los Ríos-Carmenado, Lopez & Garcia, 2015). A 2017-2018 and 2018-2019 study on finance students found that PBL enhances self-reported competencies, utility, and reported satisfaction (Parrado-Martínez & Sánchez-Andújar, 2020).

Puzzles

The use of puzzles in PBL can be used to motivate and engage students and contributes to their interest in the subject (Kawash, 2012). Finding tools that can teach critical thinking often involve statistical literacy as well as data literacy. There are often challenges in finding and implementing problems with data literacy and classroom instruction (Stephenson & Caravello, 2007). Slayter &

Higgins (2018) found that data literacy could be taught simultaneously with Excel and PBL as tools to develop students' problem-solving abilities.

The Bridge and Torch Problem is a well-known published logic puzzle. It first appeared in *Super Strategies for Puzzles and Games in 1981* (Sillke, 1997). This puzzle is sometimes referred to as a "river crossing" problem, where objects, human and in some variations non-humans, must cross a river with significant constraints. The paper's exploration variation is defined below (Gribakin, n.d.).

Dangerous crossing. Four creatures *A*, *B*, *C* and *D* come to a river at night. The bridge is very thin and narrow, and can only hold any two of them at a time. Besides, it is dark and they need to keep their torch on while on the bridge. It takes *A* one minute to cross the bridge, *B* - 2, *C* - 5, and *D* - 8 minutes. Can they all cross to the other side if the batteries in the torch last only 15 minutes?

Peterson (December 2003) provides analysis of different variations, some quite humorous, of the problem in his paper "Tricky Crossings." Rote (August 21, 2002) provides an in-depth mathematical analysis in his "Crossing the Bridge at Night." Brimberg & Hurley (2007) assign the identities of the band U2 to the bridge crossers. They model and solve the problem using both integer programming and dynamic programming. Numerous websites and researchers cite the riddle as a job interview question for high technology companies, notably Microsoft (techInterview Discussion, n.d.).

Approaching a puzzle with the intention to formulate a mathematical solution lies within recreational mathematics. The best-known peer-reviewed journal devoted to recreational mathematics is the *Journal of Recreational Mathematics* (Baywood Publishing, Inc., n.d.). However, many journals give some passing attention to the subject through dedicated columns. For example, Communications of the ACM regularly publishes a column named "last byte" (Winkler, 2012). Alexander Dewdney's column in *Scientific American* was named "Computer Recreations" (Jiménez & Munoz, 2011). The column "Classroom Capsules" appears in *The College Mathematics Journal*. Problems and puzzles are often published in the column to provide an "effective teaching strategy or tool" for college mathematics instruction (Alfaro, Han, & Schilling 2011). In the early twentieth century, Carver (1923) suggested using Dudeney's puzzles as "stimulus" to investigate for students and teachers! In an empirical study on game-based learning, Hamari and others (2016) found that engagement with the game improves learning, as does achieving an acceptably high level of challenge. Probably outgrowths of recreational mathematics, Jiménez and Munoz (2011) describe "recreational programming," while Demain (2010) uses the term "recreational computer science." The Bridge and Torch problem provides an excellent, engaging setting for students to learn and practice spreadsheet modeling skills.

In this paper, we demonstrate the solution of the Bridge and Torch problem through two spreadsheet implementations. As students learn critical thinking by solving the puzzle, we formulate two Excel spreadsheet solutions that utilize Solver's Excel add-in optimizing tool rather than specialized optimization software or a general programming language, such as C++. This Excel add-in was developed for Microsoft by Frontline Systems. This Excel add-in was developed for Microsoft by Frontline Systems. Frontline has developed other optimization software capable of solving problems many times more extensive and complex than the Solver included in Excel. The website for Frontline provides a wealth of information about optimization, including the use of genetic algorithms and simulation (solver.com, n.d.)

Procedure

The first step in developing the spreadsheet model for the Bridge and Torch problem is to formulate the problem mathematically. It can be viewed as a special form of the shortest path or shortest route problem. In Barlow's (2005) excellent textbook on spreadsheet modeling, he describes shortest route problems as special cases of network flow problems. The network consists of arcs that join pairs of nodes. In our case, an arc represents a bridge crossing. Barlow's approach is to identify every possible arc and the possible combinations in order for Solver to search the solution space for the optimal route.

As a preliminary step to help visualize what appears to be, at least initially, a relatively small and simple problem, we have developed a network diagram, Figure 1. The problem is much more complex than some might initially believe. A summary of all of the possible combinations of pairs and individuals is displayed in Table 1. There are 108 possible routes, clearly more than the number of arcs in Figure 1. There are fewer routes displayed in Figure 1consolidates the history of previous choices. It is still an intimidating problem!

Figure 1
Network Schematic of Bridge and Torch Problem

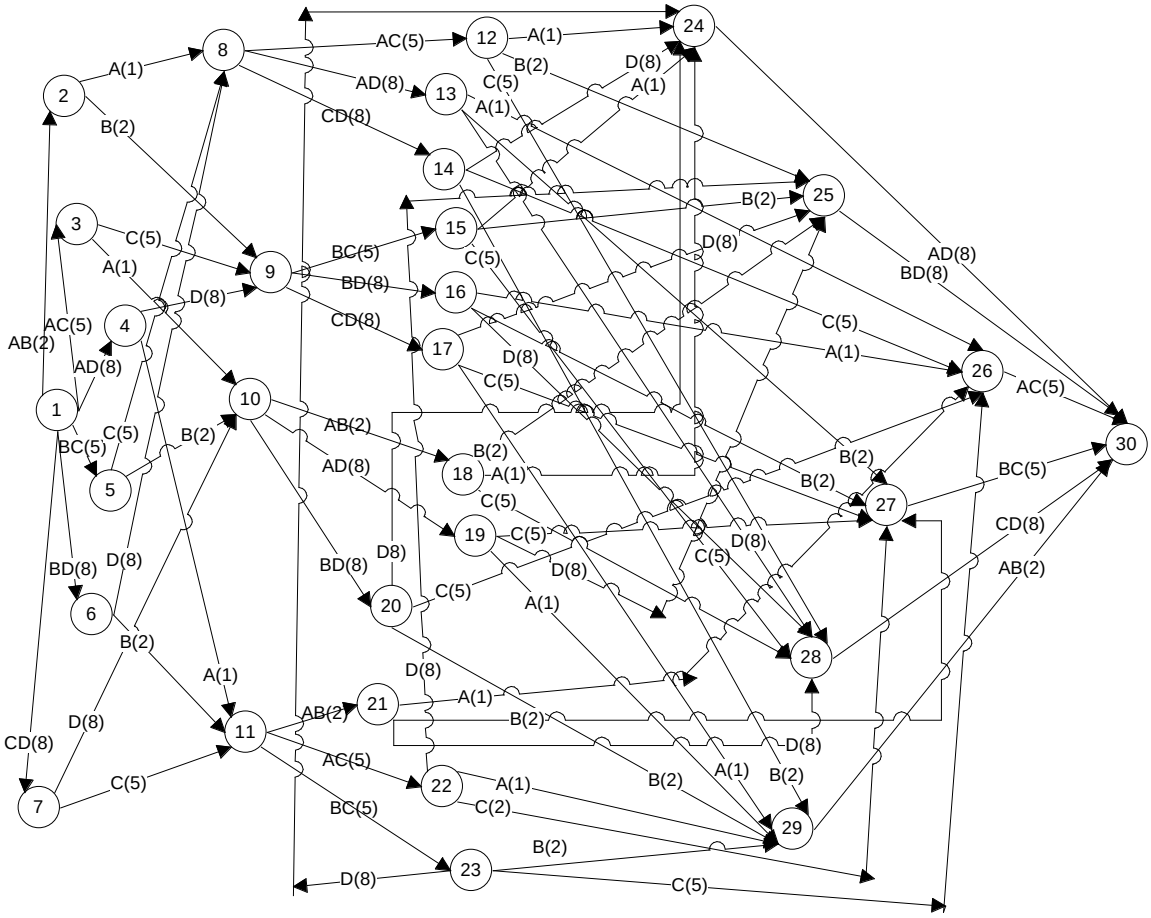


Table 1

Bridge and Torch Problem Paths

Cross	Return	Cross	Return	Cross	Network	Cross	Return	Cross	Return	Cross	Network
AB	A	AC	A	AD	1-2-8-12-24-30	BC	B	AB	A	AD	1-5-10-18-24-30
			B	BD	1-2-8-12-25-30				B	BD	1-5-10-18-25-30
			C	CD	1-2-8-12-28-30				C	CD	1-5-10-18-28-30
		AD	A	AC	1-2-8-13-26-30			AD	A	AB	1-5-10-19-29-30
			B	BC	1-2-8-13-27-30				C	BC	1-5-10-19-27-30
			D	CD	1-2-8-13-28-30				D	DB	1-5-10-19-25-30
		CD	B	AB	1-2-8-14-29-30			BD	B	AB	1-5-10-20-29-30
			C	AC	1-2-8-14-26-30				C	AC	1-5-10-20-26-30
			D	AD	1-2-8-14-24-30				D	AD	1-5-10-20-24-30
AB	B	BC	A	AD	1-2-9-15-24-30	BC	C	AC	A	AD	1-5-8-12-24-30
			B	BD	1-2-9-15-25-30				B	BD	1-5-8-12-25-30
			C	CD	1-2-9-15-28-30				C	CD	1-5-8-12-28-30
		BD	A	AC	1-2-9-16-26-30			AD	A	AC	1-5-8-13-26-30
			B	BC	1-2-9-16-27-30				B	BC	1-5-8-13-27-30
			D	CD	1-2-9-16-28-30				D	CD	1-5-8-13-28-30
		CD	A	AB	1-2-9-17-29-30			CD	B	AB	1-5-8-14-29-30
			C	BC	1-2-9-17-27-30				C	AC	1-5-8-14-26-30
			D	BD	1-2-9-17-25-30				D	AD	1-5-8-14-24-30
AC	A	AB	A	AD	1-3-10-18-24-30	BD	B	AB	A	AC	1-6-11-21-26-30
			B	BD	1-3-10-18-25-30				B	BC	1-6-11-21-27-30
			C	CD	1-3-10-18-28-30				D	CD	1-6-11-21-28-30
		AD	A	AB	1-3-10-19-29-30			AC	A	AB	1-6-11-22-29-30
			C	BC	1-3-10-19-27-30				C	BC	1-6-11-22-27-30
			D	BD	1-3-10-19-25-30				D	BD	1-6-11-22-25-30
		BD	B	AB	1-3-10-20-29-30			BC	B	AB	1-6-11-23-29-30
			C	AC	1-3-10-20-26-30				C	AC	1-6-11-23-26-30
			D	AD	1-3-10-20-24-30				D	AD	1-6-11-23-24-30
AC	C	BC	A	AD	1-3-9-15-24-30	BD	D	AC	A	AD	1-6-8-12-24-30
			B	BD	1-3-9-15-25-30				B	BD	1-6-8-12-25-30
			C	CD	1-3-9-15-28-30				C	CD	1-6-8-12-28-30
		BD	A	AC	1-3-9-16-26-30			AD	A	AC	1-6-8-13-26-30
			B	BC	1-3-9-16-27-30				B	BC	1-6-8-13-27-30
			D	CD	1-3-9-16-28-30				D	CD	1-6-8-13-28-30
		CD	A	AB	1-3-9-17-29-30			CD	B	AB	1-6-8-14-29-30
			C	BC	1-3-9-17-27-30				C	AC	1-6-8-14-26-30
			D	BD	1-3-9-17-25-30				D	AD	1-6-8-14-24-30
AD	A	AB	A	AC	1-4-11-21-26-30	CD	C	AB	A	AC	1-7-11-21-26-30
			B	BC	1-4-11-21-27-30				B	BC	1-7-11-21-27-30
			D	CD	1-4-11-21-28-30				D	CD	1-7-11-21-28-30
		AC	A	AB	1-4-11-22-29-30			AC	A	AB	1-7-11-22-29-30
			C	BC	1-4-11-22-27-30				C	BC	1-7-11-22-27-30
			D	BD	1-4-11-22-25-30				D	BD	1-7-11-22-25-30
		BC	B	AB	1-4-11-23-29-30			BC	B	AB	1-7-11-23-29-30
			C	AC	1-4-11-23-26-30				C	AC	1-7-11-23-26-30
			D	AD	1-4-11-23-24-30				D	AD	1-7-11-23-24-30
AD	D	BC	A	AD	1-4-9-15-24-30	CD	D	AB	A	AD	1-7-10-18-24-30
			B	BD	1-4-9-15-25-30				B	BD	1-7-10-18-25-30
			C	CD	1-4-9-15-28-30				C	CD	1-7-10-18-28-30
		BD	A	AC	1-4-9-16-26-30			AD	A	AB	1-7-10-19-29-30
			B	BC	1-4-9-16-27-30				C	BC	1-7-10-19-27-30
			D	CD	1-4-9-16-28-30				D	BD	1-7-10-19-25-30
		CD	A	AB	1-4-9-17-29-30			BD	B	AB	1-7-10-20-29-30
			C	BC	1-4-9-17-27-30				C	AC	1-7-10-20-26-30
			D	BD	1-4-9-17-25-30				D	AD	1-7-10-20-24-30

Table 2 contains some arbitrarily selected outcomes for the case where A and B cross the bridge first, A returns with the torch, A and C cross next. At this point, there are three remaining possibilities. Before formulating a spreadsheet model, it was necessary to state the problem as a general optimization linear programming model. The definitions for objective function and constraints are in Table 2.

Table 2
Path Analysis for AB cross, A Return, AC Cross

Return	Cross	Network	Time
A	AD	1-2-8-12-24-30	2+1+5+1+8=17
B	BD	1-2-8-12-25-30	2+1+5+2+8=18
C	CD	1-2-8-12-28-30	2+1+5+5+8=21

Mathematical Formulation of Bridge and Torch Problem

Minimize:
2A1_2+5A1_3+8A1_4+5A1_5+8A1_6+8A1_7+1A2_8+2A2_9+5A3_9+1A3_10+8A4_9
+1A4_11+5A5_8+2A5_10+8A6_8+2A6_11+8A7_10+5A7_11+5A8_12+8A8_13
+8A8_14+5A9_15+8A9_16+8A9_17+2A10_18+8A10_19+8A10_20+2A_11_21
+5A11_22+5A11_23+1A12_24+2A12_25+5A12_28+1A13_26+2A13_27+8A13_28
+2A14_29+5A14_26+8A14_24+1A15_24+2A15_25+5A15_28+1A16_26+2A16_27
+8A16_28+8A17_25+5A17_27+1A17_29+1A18_24+2A18_25+5A18_28+1A19_29
+5A19_27+8A19_28+2A20_29+5A20_26+8A20_24+1A21_26+2A21_27+8A21_28
+8A22_25+2A22_27+1A22_29+8A23_24+2A23_29+5A23_26+8A24_30+8A25_30
+5A26_30+5A27_30+8A28_30+2A29_30

The mathematical statement for the constraints is shown.
A1_2+A1_3+A1_4+A1_5+A1_6+A1_7=1
A1_2-A2_8-A2_9=0
A1_3-A3_9-A3_10=0
A1_4-A4_9-A4_11=0
A1_5-A5_8-A5_10=0
A1_6-A6_8-A6_11=0
A1_7-A7_10-A7_11=0
A2_8+A5_8+A6_8-A8_12-A8_13-A8_14=0
A2_9+A3_9+A4_9-A9_15-A9_16-A9_17=0
A3_10+A5_10+A7_10-A10_18-A10_19-A10_20=0
A4_11+A6_11+A7_11-A11_21-A11_22-A11_23=0
A8_12-A12_A24-A12_25-A12_28=0
A8_13-A13_26-A13_27-A13_28=0
A8_14-A14_24-A14_26-A14_29=0
A9_15-A15_24-A15_25-A15_28=0
A9_16-A16_26-A16_27-A16_28=0
A9_17-A17_25-A17_27-A17_29=0
A10_18-A18_24-A18_25-A18_28=0
A10_19-A19_25-A19_27-A19_29=0
A10_20-A20_24-A20_A26-A20_29=0
A11_21-A21_26-A21_27-A21_28=0

A11_22-A22_25-A22_27-A22_29=0
A11_23-A24_A29-A23_26-A23_29=0
A12_24+A14_24+A15_24+A18_24+A20_24+A23_24-A24_30=0
A12_25+A15_25+A17_25+A18_25+A19_25+A22_25-A25_30=0
A13_26+A14_26+A16_26+A20_26+A21_26+A23_26-A26_30=0
A13_27+A16_27+A17_27+A19_27+A21_27+A22_27-A27_30=0
A12_28+A13_28+A15_28+A16_28+A18_28+A21_28-A28_30=0
A14_29+A17_29+A19_29+A20_29+A22_29+A23_29-A29_30=0
0-A24_30+A25_30+A26_30+A27_30+A28_30+A29_30=-1

The spreadsheet formulation is displayed in multiple tables. Table 3 displays 30 of the paths (columns B through D) and the objective function and constraints (columns E through H). Table 4 displays the remaining 42 paths. Cell E75 will hold the optimized value from the objective function, which will be the total time for the suggested sequence for crossing the bridge. The formula view for the initial spreadsheet is displayed in Table 5. Table 6 displays assigned names for spreadsheet columns. The required Solver formulation parameters are displayed in Figure 2. When optimization is achieved, each cell in Column E of Table 4 will hold either a zero or a 1. A zero indicates that the path is not part of the solution. A "1" indicates that the path is part of the solution. Table 7 displays the portions of the spreadsheet that are part of the solution. As the values indicate, the suggested path is 1-2-8-14-29-30, suggesting the following sequence displayed in Table 8. The mission can be accomplished in 15 minutes. Figure 3 displays a graphical solution to the problem.

Table 3
Initial Formulation of Bridge and Torch Problem (Part 1)

1\A	B	C	D	E	F	G	H
2	From	To	Value	Path	Node	Limit	Result
3	1	2	2	0	1	1	0
4	1	3	5	0	2	0	0
5	1	4	8	0	3	0	0
6	1	5	5	0	4	0	0
7	1	6	8	0	5	0	0
8	1	7	8	0	6	0	0
9	2	8	1	0	7	0	0
10	2	9	2	0	8	0	0
11	3	9	5	0	9	0	0
12	3	10	1	0	10	0	0
13	4	9	8	0	11	0	0
14	4	11	1	0	12	0	0
15	5	8	5	0	13	0	0
16	5	10	2	0	14	0	0
17	6	8	8	0	15	0	0
18	6	11	2	0	16	0	0
19	7	10	8	0	17	0	0
20	7	11	5	0	18	0	0
21	8	12	5	0	19	0	0
22	8	13	8	0	20	0	0
23	8	14	8	0	21	0	0
24	9	15	5	0	22	0	0
25	9	16	8	0	23	0	0
26	9	17	8	0	24	0	0
27	10	18	2	0	25	0	0
28	10	19	8	0	26	0	0
29	10	20	8	0	27	0	0
30	11	21	2	0	28	0	0
31	11	22	5	0	29	0	0
32	11	23	5	0	30	-1	0

Table 4
Initial Formulation of Bridge and Torch Problem (Part 2)

1\A	B	C	D	E
33	12	24	1	0
34	12	25	2	0
35	12	28	5	0
36	13	26	1	0
37	13	27	2	0
38	13	28	8	0
39	14	29	2	0
40	14	26	5	0
41	14	24	8	0
42	15	24	1	0
43	15	25	2	0
44	15	28	5	0
45	16	26	1	0
46	16	27	2	0
47	16	28	8	0
48	17	25	8	0
49	17	27	5	0
50	17	29	1	0
51	18	24	1	0
52	18	25	2	0
53	18	28	5	0
54	19	29	1	0
55	19	27	5	0
56	19	28	8	0
57	20	29	2	0
58	20	26	5	0
59	20	24	8	0
60	21	26	1	0
61	21	27	2	0
62	21	28	8	0
63	22	25	8	0
64	22	27	2	0
65	22	29	1	0
66	23	24	8	0
67	23	29	2	0
68	23	26	5	0
69	24	30	8	0
70	25	30	8	0
71	26	30	5	0
72	27	30	5	0
73	28	30	8	0
74	29	30	2	0
75				0

Table 5

Formula View of Spreadsheet

1\A	B	C	D	E	F	G	H
2	From	To	Value	Path	Node	Limit	Result
3	1	2	2	0	1	1	=SUMIF(From,F3,Flow)-SUMIF(To,F3,Flow)
4	1	3	5	0	2	0	=SUMIF(From,F4,Flow)-SUMIF(To,F4,Flow)
5	1	4	8	0	3	0	=SUMIF(From,F5,Flow)-SUMIF(To,F5,Flow)
6	1	5	5	0	4	0	=SUMIF(From,F6,Flow)-SUMIF(To,F6,Flow)
7	1	6	8	0	5	0	=SUMIF(From,F7,Flow)-SUMIF(To,F7,Flow)
8	1	7	8	0	6	0	=SUMIF(From,F8,Flow)-SUMIF(To,F8,Flow)
9	2	8	1	0	7	0	=SUMIF(From,F9,Flow)-SUMIF(To,F9,Flow)
10	2	9	2	0	8	0	=SUMIF(From,F10,Flow)-SUMIF(To,F10,Flow)
11	3	9	5	0	9	0	=SUMIF(From,F11,Flow)-SUMIF(To,F11,Flow)
12	3	10	1	0	10	0	=SUMIF(From,F12,Flow)-SUMIF(To,F12,Flow)
13	4	9	8	0	11	0	=SUMIF(From,F13,Flow)-SUMIF(To,F13,Flow)
14	4	11	1	0	12	0	=SUMIF(From,F14,Flow)-SUMIF(To,F14,Flow)
15	5	8	5	0	13	0	=SUMIF(From,F15,Flow)-SUMIF(To,F15,Flow)
16	5	10	2	0	14	0	=SUMIF(From,F16,Flow)-SUMIF(To,F16,Flow)
17	6	8	8	0	15	0	=SUMIF(From,F17,Flow)-SUMIF(To,F17,Flow)
18	6	11	2	0	16	0	=SUMIF(From,F18,Flow)-SUMIF(To,F18,Flow)
19	7	10	8	0	17	0	=SUMIF(From,F19,Flow)-SUMIF(To,F19,Flow)
20	7	11	5	0	18	0	=SUMIF(From,F20,Flow)-SUMIF(To,F20,Flow)
21	8	12	5	0	19	0	=SUMIF(From,F21,Flow)-SUMIF(To,F21,Flow)
22	8	13	8	0	20	0	=SUMIF(From,F22,Flow)-SUMIF(To,F22,Flow)
23	8	14	8	0	21	0	=SUMIF(From,F23,Flow)-SUMIF(To,F23,Flow)
24	9	15	5	0	22	0	=SUMIF(From,F24,Flow)-SUMIF(To,F24,Flow)
25	9	16	8	0	23	0	=SUMIF(From,F25,Flow)-SUMIF(To,F25,Flow)
26	9	17	8	0	24	0	=SUMIF(From,F26,Flow)-SUMIF(To,F26,Flow)
27	10	18	2	0	25	0	=SUMIF(From,F27,Flow)-SUMIF(To,F27,Flow)
28	10	19	8	0	26	0	=SUMIF(From,F28,Flow)-SUMIF(To,F28,Flow)
29	10	20	8	0	27	0	=SUMIF(From,F29,Flow)-SUMIF(To,F29,Flow)
30	11	21	2	0	28	0	=SUMIF(From,F30,Flow)-SUMIF(To,F30,Flow)
31	11	22	5	0	29	0	=SUMIF(From,F31,Flow)-SUMIF(To,F31,Flow)
32	11	23	5	0	30	-1	=SUMIF(From,F32,Flow)-SUMIF(To,F32,Flow)
75				=SUMPRODUCT(D3:D74,E3:E74)			

Table 6

Assigned Names

Column	Name
B	From
C	To
E	Flow

Figure 2

Solver Parameters for Bridge and Torch Problem

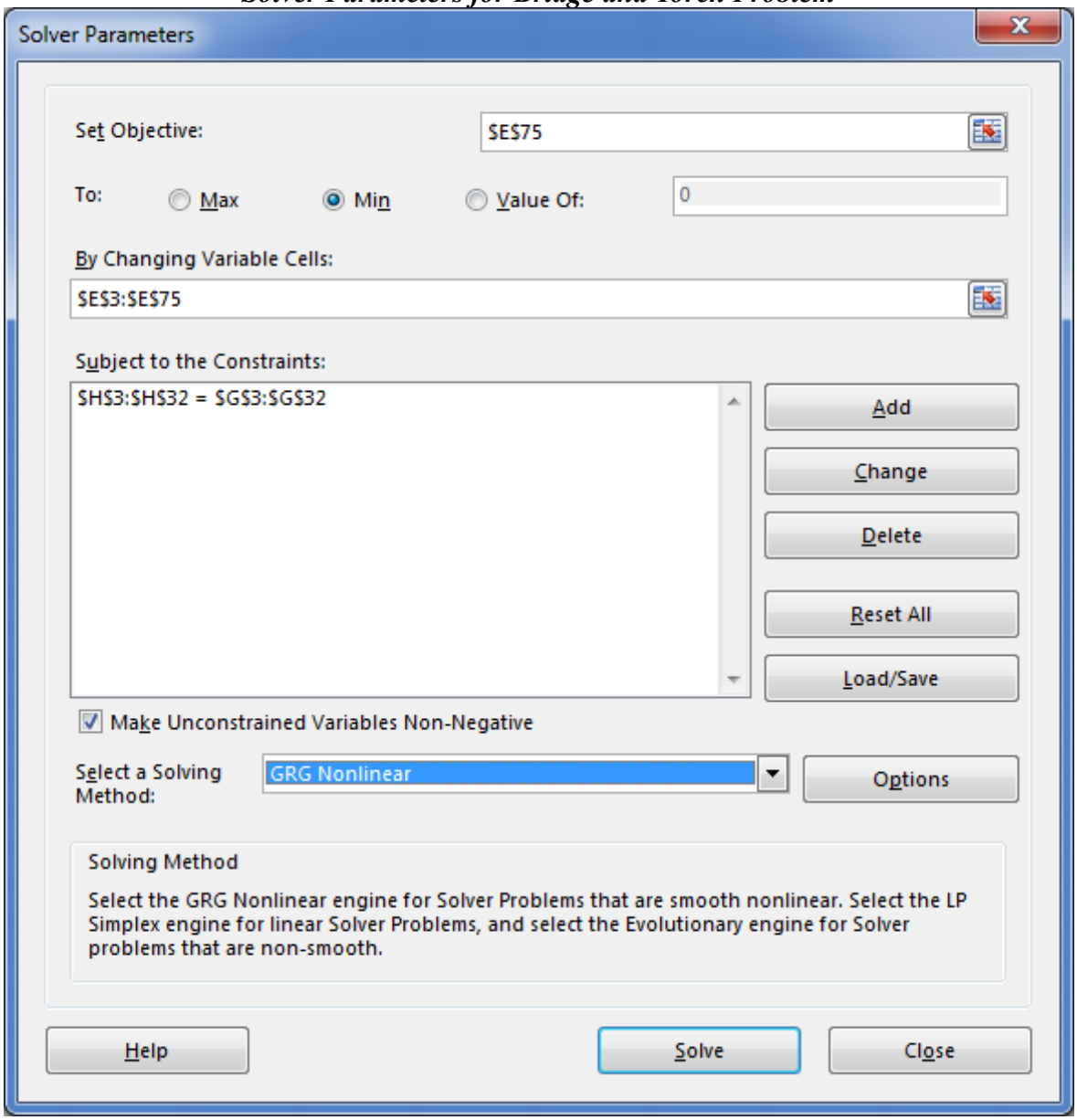


Table 7

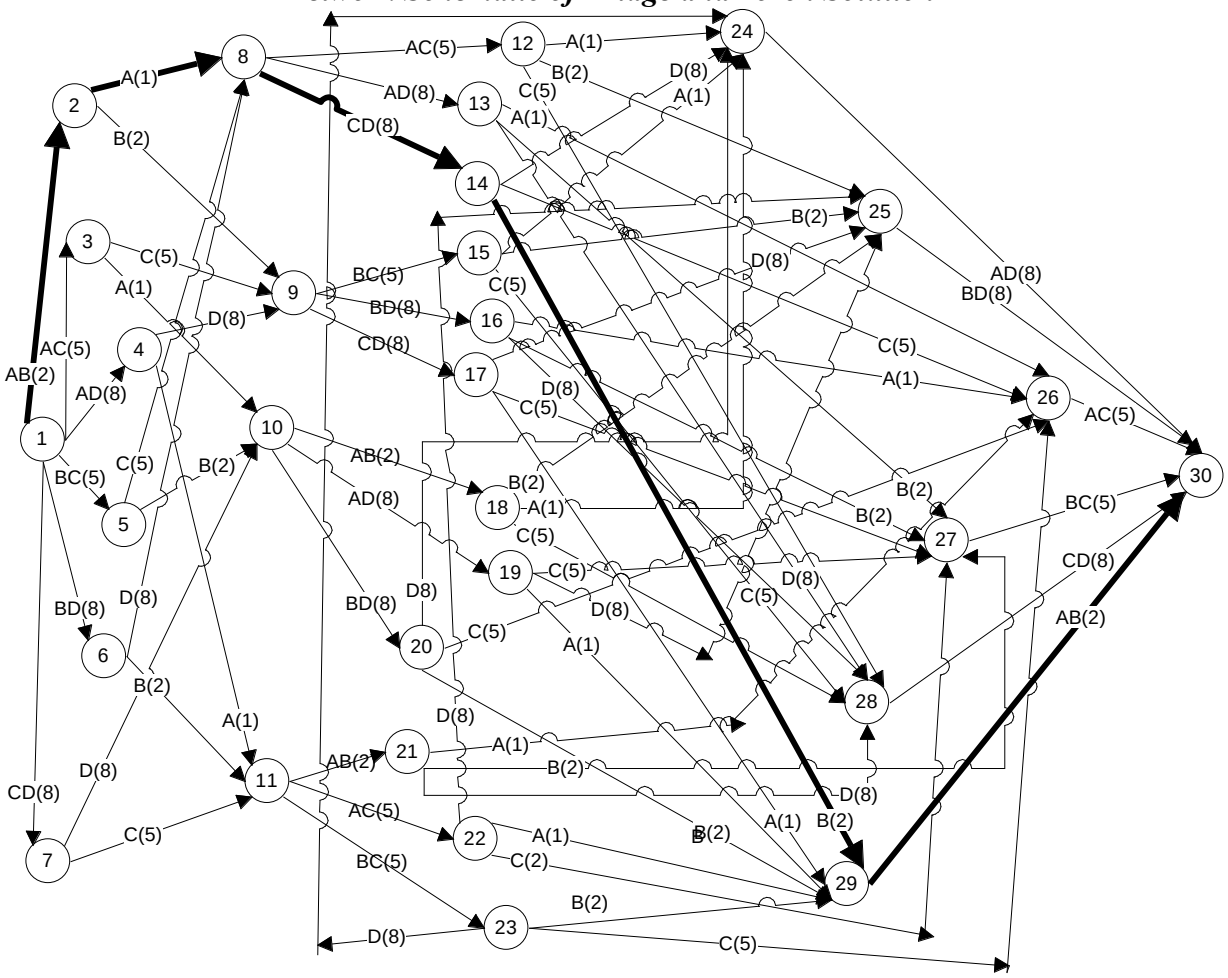
Solution to the Bridge and Torch Problem

1\A	B	C	D	E
2	From	To	Value	Path
3	1	2	2	1
9	2	8	1	1
23	8	14	8	1
39	14	29	2	1
74	29	30	2	1
75				15

Table 8
Description of Solution to the Bridge and Torch Problem

Cross	Return	Cross	Return	Cross	Time
AB	A	CD	B	AB	2+1+8+2+2=15

Figure 3
Network Schematic of Bridge and Torch Solution



Genetic Algorithm Approach using Spreadsheet Optimization and Logic

This approach was inspired by the notion that enumerating all possible answers to the problem, as shown in Barlow (2005), might not be necessary if the solution space could be defined in logical terms. The logical terms allow the modeler to configure the spreadsheet to generate routes and test them for acceptability while searching the solution space for an optimum. Rote (2002) proves a lemma that defines the optimal solution as having N-1 forward and N-2 backward moves. With N= 4 crossers, the problem can be optimally solved in 4-1 = 3 forward moves and 4-2=2 backward moves. This information is used to construct a solution vector, shown in Table 9:

Table 9
Problem Solution Structure

ARC	ID-Number
First Pair (forward)	
First Walker (backward)	
Second Pair (forward)	
Second Walker (backward)	
Last Pair (forward)	

The ID-Number can be either a Pair-ID-Number, of which there are six, or a Walker-ID-Number, of which there are four. Thus, a set of ID-Number entries in Table 9 would represent a possible solution. Tables 10 and 11 show those definitions of pairs (forward) and walkers (backward):

Table 10
Possible Pairs

Pair-ID-Number	Name	Time
1	A,B	2
2	A,C	5
3	A,D	8
4	B,C	5
5	B,D	8
6	C,D	8

Table 11
Possible Walkers

Walker-ID-Number	Name	Time
1	A	1
2	B	2
3	C	5
4	D	8

Of course, not all sets of entries that could be configured for Table 9 are acceptable. Table 12 shows two example entries; one of them is an acceptable solution while the other is not.

Table 12: Examples

ARC	ID-Number Acceptable	ID-Number Unacceptable
First Pair (forward)	1	1
First Walker (backward)	2	3
Second Pair (forward)	4	5
Second Walker (backward)	2	4
Last Pair (forward)	5	6
Time	19	31

We must define the logic of what makes an acceptable solution. Distinguishing between acceptable and unacceptable solutions allows Solver to try different solutions but keep only the acceptable ones as it searches for an optimum. We used the following Logic Items:

- The First Walker must be a member of the First Pair,
- The Second Pair has acceptable members,
- The Second Walker has an acceptable member,
- The Last Pair uses the last walker,
- All Members have crossed.

Configuring Excel Logic Functions

Excel's logic functions, particularly the AND, OR, and NOT functions return values of either TRUE or FALSE. If a TRUE is converted to the value 0 and a FALSE is assigned the value of 1, then the sum of the logical outcomes must be 0 in order for the solution to be acceptable. In order to evaluate the logical items, we had to convert the names of pairs into the individual members. This was accomplished using a function in the solution table, Table 9. We used the Excel text functions LEFT and RIGHT.

Logic Item 1 is relatively easy to program. We assess if the first walker is one of the members of the first pair. The Excel pseudo-code is:

=OR({First Walker=First Pair Member 1}, {First Walker=First Pair Member 2}).

The OR function returns TRUE if either or both statements evaluate to TRUE.

Logic Item 2 states that the second pair has acceptable members. This means that that the second pair must contain two members either who have not crossed yet or who have returned, i.e. the first walker. Another way to say this is to say that the second pair must not contain the members of the first pair unless one of those first pair members is the first returning walker. The Excel formula is more complicated than that for Logic Item 1; the pseudo-code is:

=AND (OR {2nd Pair Member 1 = 1st Walker, AND [NOT(2nd Pair Member 1 = 1st Pair Member 1), NOT(2nd Pair Member 1 = 1st Pair Member 2)] },
OR{ 2nd Pair Member 2 = 1st Walker, AND [NOT(2nd Pair Member 2 = 1st Pair Member 1), NOT(2nd Pair Member 2 = 1st Pair Member 2)] })

This statement confirms that the second pair is not the first pair unless the first walker is included in the second pair. An interesting and obvious question is: why is this statement so complicated? The basic structure is:

AND(OR(___, AND(NOT___, NOT___)) , OR(___, AND(NOT___, NOT___)))

Could this be made more apparent? In order to validate the usefulness of this approach, the remaining Logic Items were configured similarly. The Solver search was successful, although some Logic items were even more convoluted than Logic Item 2. One possibility is that the logical statements could be made shorter and less complicated if we knew which members had, or had not, crossed. We tried that approach next.

First, a table was constructed to define the crossers who remained on the near side after each step. An example of the table that shows the remaining crossers is found in Table 13. The ID-Number entries are found in Table 10 and Table 11.

Table 13
Who's Left?

					Who's left?				
ARC	ID-Number	member1	member2	Time		A	B	C	D
First Pair	1	A	B	2				*C*	*D*
First Walker	2	B		2			*B*	*C*	*D*
Second Pair	6	C	D	8			*B*		
Second Walker	1	A		1		*A*	*B*		
Last Pair	1	A	B	2					
				15	total time				

The shaded Who's Left? values are found by using If statements, often with OR conditions. Utilizing the information contained in Table 13, simplifies the evaluation of the five logic statements. They can now be programmed using IF, AND, OR, and COUNTBLANK functions.

The optimization is straightforward:

- Minimize time
- Subject to the sum of the five logic statements = 0
- ID-Numbers are integers between 0 and 6.

Each of the five Logic items yields a TRUE or a FALSE. By setting TRUE values to 0 and FALSE values to 1, the constraint (1) left hand side can be evaluated. Thus, the only candidate solutions that are considered are the ones where all five Logic items are TRUE.

The decision variables are shown as "ID-Number" in Table 13. Since the decision variables are integers, Solver was configured to constrain the answers to integer values. The solving method for integer programming problems is evolutionary. To converge to the correct answer reliably, the Population Size parameter was increased to 750 (from the default of 100); the Mutation Rate was increased to 0.1 (from the default of 0.075); and the Maximum Time without improvement was increased to 60 (from the default of 30). We solved the problem numerous times: the optimal solution was derived in approximately 79 seconds, on average. Occasionally a sub-optimal yet allowable solution was derived, usually much faster than the 79 seconds. It is generally good practice to make several runs when using search methods.

Results

The Bridge and Torch Problem is an interesting and occasionally a perplexing "riddle" from an optimization viewpoint, as illustrated in this paper. As previously discussed, it can be a challenging programming assignment, even utilized by companies like Microsoft in the interview process. Utilizing logic and intuition provides a much quicker solution. Consider the following key points:

- The torch will need to be returned from the side that the individuals desire as their destination.

- For the required two return trips to be taken by a single person, one would wish to utilize the fastest two individuals.
- Considering the first two points, A and B, the two fastest must cross first.

One would want the two slowest (C and D) to cross together. You would not want to "waste" one of the faster individuals by having them cross with either of the slowest two. Nevertheless, the two slowest cannot cross first because one of them would have to return. Furthermore, cross again as a partner to a faster person.

When one sees the problem with these critical points, it becomes evident that the suggested spreadsheet solution is indeed optimum. However, it is not the only optimum solution. Either one of the following solutions (Table 14) would be optimum. It does not matter if A or B returns first as long as either A or B makes the return trip.

Table 14

Description of Two Optimal Solutions to the Bridge and Torch Problem

AB	A	CD	B	AB	2+1+8+2+2=15
AB	B	CD	A	AB	2+2+8+1+2=15

One can see why such a logic puzzle might be helpful in an interview situation. It would test the logic and intuition of the candidate at the moment. Having an apparent answer in the classroom is often a valuable characteristic of an optimization problem. Students have immediate feedback about the efficacy and accuracy of their efforts. The Bridge and Torch Problem makes for a challenging modeling/optimization project, no matter what approach is utilized. It will undoubtedly give students a workout in Excel's Boolean logic functions.

Discussion

Engaging and motivating students with challenging and exciting topics in this ever-changing world of new technology can be challenging. However, by using puzzles and Excel as tools in a problem-based learning environment, academicians can enhance students' critical thinking and data literacy while increasing their satisfaction. These knowledge sets can provide students the confidence to acquire and keep jobs in high demand in today's market.

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Student-Led Venture Capital Funds: An Exploratory Study of Emerging Best Practices

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Student-led venture capital (VC) funds are an emerging form of VC fund design that stand to provide students with VC-related experiential learning and to fill a funding gap in university-based entrepreneurial ecosystems. We investigate six well-known, student-led VC funds currently operating in North America, with the aim of working toward a framework of best practices. Interviews with program representatives, along with secondary research, show a marked distinction in the founding principles among sample funds, which has important implications on the pedagogical and operating characteristics of the program. Based on our analysis, we recommend key areas that should be considered for the development of a student-led VC fund: student roles, curricular integration, development of an investment thesis, program structure, governance, investment terms, and fundraising.

Key words: venture capital, experiential learning, entrepreneurial ecosystems, higher education, pedagogy

Introduction

Entrepreneurial equity financing options include venture capital (VC), angel investment, crowdfunding, and accelerators/incubators. While scholars do not necessarily agree that VC is the most appropriate financing mechanism for new ventures (Carpenter & Petersen, 2002; Hall & Lerner, 2010; Himmelberg & Petersen 1994), VC money continues to be an important source of financing that fills the void between very early-stage sources of finance (corporations, government grants, friends, and family) and traditional sources of low-cost capital, including bank loans or private placement debt (Bertoni, D'Adda, & Grilli, 2016; Zider, 1998). Recent U.S. data shows that in 2018, VC firms averaged $101.9 million per first-time investment (National Venture Capital Association, 2019), though the trend among VCs is to drift towards larger and later-stage investments (Hellmann & Thiele, 2015).

Student-led VC funds are an emerging form of VC fund design that offer university students hands-on, experiential VC-related training, while also connecting VC money with fruitful entrepreneurial ecosystems of higher education institutions. In some cases, student-led VC funds are run by students and invest only in students, and in other cases, they are run by students and invest in any viable early stage venture. Experiential learning and entrepreneurial ecosystem theories assert that such programs stand to both make important pedagogical contributions (Kolb, 1984) and fill a resource gap in student entrepreneurial ecosystems (Wright, Lockett, Clarysse, & Binks, 2006), respectively.

Our research shows that there is a growing number in the United States and a handful of student-led VC funds in Canada. Specifically, we find that there are 24 such programs operating in the United States and 4 in Canada, most of which have been implemented in the past decade. While there exists a wealth of research on student-led investment programs (see for example, Neely & Cooley, 2004; Oldford, 2019), there is a dearth of research on student-led VC funds, even while they offer considerable benefits for students, institutions, and entrepreneurial ecosystems. In this current study, we provide an in-depth investigation of six well-known and reputable student-led VC funds currently operating in North America. Our research makes two important contributions to the literature and to practice. First, to our knowledge, our research is the first to contribute a study of this pedagogical innovation. Second, our research contributes a framework that practitioners can consult when developing VC-related experiential learning programs in their own institutions. We offer insight into the potential benefits of such a program, approaches to operationalization, and most importantly, the challenges and constraints that must be considered in the conceptualization and development of a student-led VC fund.

Our research takes a multiple-case study approach, similar to Bezerra, Borges & Andreassi (2017), as our research question is largely of a qualitative nature (Eisenhardt, 1989). We perform semi-structured interviews with representatives of five established student-led VC funds, and we assess secondary research on a sixth fund. Ours is a convenience sample, one that is comprised of North American funds where a representative agreed to be interviewed. The sampled funds are markedly different from one another, in their location, size, and integration with the VC community, and the differences in sample constituents bolsters the practical application of our study because the framework that we propose can provide guidance to a wide set of environments and institutions.

We uncover two philosophies -- investment- and academic-focus -- that guide the design and operations of student-led VC funds. Investment-focused funds are operated by students and have a thesis of only investing in student-founded companies. Further, these programs are associated with a parent VC firm. The academic-focus programs have the sole mandate of enhancing VC-related learning, and these funds do not have a restricted investment thesis. Therefore, investment-focused programs benefit students through two channels: experiential learning and enhanced funding opportunities for student ventures. Academic-focus programs are associated solely with the experiential learning opportunity. Based on our analysis, we recommend key areas that should be considered for the development of a student-led VC fund. We propose that these guidelines be viewed as emerging best-practices, since we expect these best practices to evolve while new programs launch and existing programs adapt. Our emerging best practices include definition of student roles, curricular integration, development of an investment thesis, program structure, governance, investment terms, and fundraising.

Related literature

Filling a Skills Gap through Experiential Learning

Research reveals that VC investment creates value in investees by providing services such as managerial support and performing a coaching function (Sapienza, 1992; Sørensen, 2007). Even more, VC investments also signal a company's quality to external stakeholders, thereby providing new ventures with access to external resources and competencies (Bertoni, D'Adda, & Grilli, 2016; Colombo, Grilli, & Piva, 2006; Hsu, 2006). Early research on the VC industry (MacMillan,

Siegel, & Narasimha, 1985) identifies self-reported criteria that venture capitalists use to make investment decisions, for example, management team or market characteristics. Subsequent research has since incorporated greater nuance, with evidence that VC evaluations are subjective, interactive, contingent, and in general, defy rational formulas and rigid approaches (dos Santos Alves, 2018; Franke, Gruber, Harhoff, & Henkel, 2008; Kirsch, Goldfarb, & Gera, 2009; Petty & Gruber, 2011). In addition, Zider's (1998) survey of VC firms provides evidence of a wide-range of activities that occur within a typical day working at VC funds, including soliciting business, serving as directors or monitors, acting as consultants, recruiting management, and assisting in outside relationships. This finding is echoed in a speech by VC firm 8VC (2019), "The role of a modern VC has become substantially more nuanced and multifaceted than VCs of the 1970s and 1980s could have ever predicted." Collectively, this research suggests that the variety and nuance of functions within oftentimes leanly-staffed and regionalized VC firms means that the requisite skillset of those entering this industry is equally varied and nuanced (Drover, Busenitz, Matusik, Townsend, Anglin, & Dushnitsky, 2017).

Meanwhile, the business community has raised concerns regarding traditional approaches to teaching in business schools. Critics of business schools call for more integrated and experiential approaches (Colby, Ehrlich, Sullivan, & Dolle, 2011; Weber & Englehart, 2011) that equip graduates with the skills necessary to face real world complexities (Barnett, 2000; Moore, 2003). In support of these calls, the literature highlights possible pedagogical innovations, with one of the most compelling being experiential learning programs (Paulson, 2011).

The tautological basis of this pedagogical innovation is experiential learning theory (ELT) (Kolb, 1984), which asserts that "ideas are not fixed and immutable elements of thought, but are formed and re-formed by experience. No two thoughts are ever the same, since experience always intervenes" (p. 26). ELT research also shows that moving from traditional lecture-based methodologies to more active and integrated learning can improve knowledge and skills acquisition (Lengnick-Hall & Sanders, 1997; Reynolds, 2009), as well as student efficacy, student engagement, student retention, and graduation rates (Baden & Parks, 2013; Caza, Brower, & Wayne, 2015; Stowe, von Freymann, & Schwartz, 2012).

Student-led VC funds are an example of an experiential learning innovation. Such programs act to parallel the operations of a VC fund (sourcing deals, due diligence, monitoring, etc.), with students involved in some, if not all VC-related activities, affording students real experience with real VC dollars. Given the multi-faceted, complex skill-set necessary for the VC industry, a VC-centric experiential learning program can be an integral step to fill the VC industry and university curriculum skills gap. Such programs offer a substantial improvement upon simulations (for example, Harvard's Venture Capital and Private Equity Simulation, as described in Rhodes-Kropf, Lerner, Felda Hardymon, & Burbank (2016)), since research has shown that simulations can distort the investment behaviour of students (Neely & Cooley, 2004).

Filling an Ecosystem Resource Gap

If a student-led VC fund is structured such that it funds only student ventures (i.e., a student-founder thesis), the program has the potential to fill the often-overlooked early-stage financing needs within student entrepreneurial ecosystems (EE). Attracting substantial attention from academics, practitioners, and policymakers alike, the EE literature provides new insights on the determinants of entrepreneurial success (Mason & Brown, 2014; Spigel, 2017). Stam and Spigel

(2016) define an EE as "a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory" (p.1).

The university environment has been proposed as a potential EE for both faculty and students (Fetters, Greene, & Rice, 2010; Guenther & Wagner, 2008; Robinson & Sexton, 1994), the latter being the focus of this study. Key components of a student EE include entrepreneurship curriculum, engagement and mentorship of alumni entrepreneurs, student incubators, prototype development and technology transfer services, and seed funding to university start-ups, among others (Rideout & Gray, 2013). Even with a wealth of EE research and the prevalence of student EEs, the number of students or recent graduates successfully launching ventures has not grown proportionately (Sieger, Fueglistaller, & Zellweger, 2014). Kew, Herrington, and Litvosky (2013) attributes this to a lack of business acumen, infrastructure, support structures, mentorship, links to professional networks, and most relevant to our study, a lack of financial resources.

A growing number of governments and universities offer student entrepreneurs various types of seed funding, including equity and non-equity investments, loans, and small grants (Degroof & Roberts 2004; Morris, Kuratko, & Cornwall., 2013; Mustar & Wright 2010; Rasmussen, 2008; Swamidass, 2013). Wright, Lockett, Clarysse, and Binks demonstrate that these funds are needed because venture capitalists do not typically invest in early-stage companies. However, in addition to providing liquidity, VCs can complement seed capital by also providing student entrepreneurs with credibility (Fernández-Alles, Camelo-Ordaz, & Franco-Leal, 2015), technical and managerial advice (Hayter, Nelson, Zayed, & O'Connor, 2018; Knockaert, Wright, Clarysse, & Lockett., 2010), and connections with industry (Vohora, Wright, & Lockett, 2004), thus contributing substantially to a student EE. Counter to Miller & Acs' (2017) conceptualization of a university EE in which VC firms are external to the ecosystem, we contend that by involving students directly with funding ventures with the introduction of a student-led VC fund to the student EE, the student EE stands to be more supportive of student entrepreneurship.

Method & Sampled Funds

A multiple case study design is used for this research, similar to Bezerra, Borges, and Andreassi (2017), as the research question is largely of a qualitative nature (Eisenhardt, 1989). We seek to understand and compare the characteristics of existing student-led VC funds, with the aim of documenting emerging program best-practices. The sample is comprised of six established funds that are currently operating in North America. Brief summaries of each fund in the sample are located in Table 1.

Of the sampled firms, the oldest is Tri-Colour Fund, which is only 12 years old at the time of writing. The others are an average age of about 3.5 years old, which highlights the novelty of this type of program. There is significant variation among sample programs, with an average capital base of approximately $1.5 million. Half of the sampled funds have formal ties to a parent VC firm, and moreover, these same programs source their capital from a set of limited partners, thereby closely mimicking the real-world VC structure. Of the programs without parent VCs, donations constitute the source of capital.

Table 1
Sample summary

	Founding Year	Primary location(s)	Size of fund	Parent VC firm	Source of capital
Arrow Capital	2018	California state	n/a	Bow Capital	Limited partners
Front Row Ventures	2016	Montreal, Canada	$600,000	Real Ventures	Limited partners
Rough Draft Ventures	2012	San Francisco, Palo Alto, NYC, Boston	n/a	General Catalyst	Limited partners
The Student Fund	2017	Waterloo, Canada	$1,000,000	None	Donations
Tri-Colour Fund	2007	Kingston, Canada	$4,000,000	None	Donations
Venture Grade	2014	Halifax, Canada	$180,000	None	Donations

We conducted semi-structured interviews, and the interview questions that helped to guide interviews are located in Appendix A. We used the Zoom platform, so each conversation could be recorded for further analysis post-interview. The average length of the interviews was forty-five minutes. We supplemented our findings with publicly available secondary research, including interview recordings and fund media coverage. Of the six funds that were analyzed, five were interviewed live. For Rough Draft Ventures, we evaluate reliable secondary sources for our research. While our sample is small, it does cover a substantial percent of operational programs. Our research shows that in the U.S., there are 24 programs, so we have a sample-to-population ratio of approximately 8%. In Canada, we have surveyed all 4 programs, so our rate is 100%. We admit there may be bias in the surveys given that we were only able to interview one representative from each program.

Findings

Student-Led VC Programs: A Framework

Upon evaluating the interviews, a thematic dichotomy emerged: investment- and academic-focused programs, and this dichotomy guided the construction of our framework and subsequent analysis. A summary of our findings is located in Table 2.

Investment-Focused Programs

Investment-focused student-led VC fund programs have a relationship with an established VC firm, and the main objective of this type of fund is to invest only in student-founded companies on the thesis of uncovering the next Facebook or Google, both which were founded by students and funded by VC. Involvement of an established VC firm serves to provide stability to the student fund with the provision of expertise and capital, as a limited partner of the student-led VC fund.

The student-led VC fund then operates as an off-shoot or subsidiary of the parent firm. VC firms benefit from this relationship through access to very early-stage companies, which positions established VC firms to participate in later rounds when the company has matured. In other words, it affords established VC funds structured access to the fertile student entrepreneurial ecosystem.

Table 2
Framework for emerging best-practices of student-led VC funds

	Investment-Focused Funds			**Academic-Focused Funds**		
	Front Row Ventures	Rough Draft Ventures	Arrow Capital	Venture Grade	Tri-Colour Fund	The Student Fund
Panel A: Pedagogical characteristics						
University affiliation	Multiple Canadian universities (ON, QC)	Multiple U.S. universities (CA, NY, MA)	UC Berkley	Saint Mary's University	Queen's University	University of Waterloo
Education level of students	n/a	Undergraduate or graduate	Undergraduate or graduate	Undergraduate or graduate	MBA students	Undergraduate or graduate
Curriculum prerequisite	3 month internal training	None	None	Semester course (Venture Capital 6110)	4, 3 hour training sessions	None
Semester-based?	No	No	No	Yes	Yes (Fall term only)	No
Course credit?	No	No	No	Yes	Yes	No
Panel B: Operating characteristics						
Student-founder thesis?	Yes	Yes	Yes	No	No	No
Co-investment thesis?	Co-invest or invest alone	Co-invest or invest alone	Co-invest or invest alone	Co-invest	Co-invest	Co-invest
Final investment decision	Students	Students	Students	University Board of Governors	Investment Committee	Investment Committee
Investment terms	SAFE	Uncapped convertible note	Uncapped SAFE	Convertible Note, SAFE, KISS, or equity	Note, SAFE, KISS, or equity	Note, equity, or SAFE
Number of investments (per year)	3	15-20	8	0-1	0-1	2-3
Typical investment size	$25K	n/a	$10-20K	$10-50K	$15K	$15-25K
Time to complete a deal	1-2 months	n/a	4-6 weeks	4 months	3-4 months	1-2 months
Number of exits	None to date	10	None to Date	None to Date	2	None to Date

Investment-focused programs are more suited to geographical areas where the seed-stage VC firms (and later stages) are vying for position in competitive rounds. These rising-star companies will have the ability to choose from a long list of interested VC firms, and therefore, early relationship-building between VC firms and entrepreneurs is a competitive advantage for the former. This type of competition is typically found in the United States in start-up hotbeds, such as Silicon Valley, Boston, Seattle, and New York. In Canada, this level of competition for VC firms is not prevalent and may reflect the low number of VC firms exploring the potential relational benefit of student-led fund involvement.

Academic-Focused Programs

Funds classified as having an academic focus are directly associated with a specific academic institution. The objective of this program structure is to provide students with an active experiential learning opportunity, where the students learn about the world of VC and the process that goes into making an investment in a start-up company. The direct tie to a university is formalized by the participation (or direction) of the program by one or more faculty members.

Academic-focused funds raise investment capital from charitable donations from the community or from alumni of the college or university. Where the main goal is student experiential learning, with financial returns being a secondary goal, the academic-focused programs in our sample are 'evergreen', with any returns on investment going back into the fund to further the experiential learning process. Since the typical timeframe to see returns on this investment class is 5-10 years (Zider, 1998), there are cases when academic-focused programs must dedicate time and resources to raising additional capital to ensure that there is a sufficient capital base for future students to invest.

Summary of Framework

All VC funds have the goal of identifying and investing in companies that are growing or have the potential of growth, with the ultimate aim of securing outsized returns. However, the definition of success in student-led VC funds will depend on whether the program is investment- or academic-focused. Investment-focused programs obtain funds from limited partners (LP), who are usually traditional investors such as banks, institutions, or pension funds. Success for an investment-focused VC fund is defined by a 'venture rate of return' to the limited partners, which is typically a 3x to 6x return on investment (Dean, 2017). In contrast, academic-focused funds will raise money from donations and charitable giving and will typically not have a set length of time placed on the fund; rather it will have an evergreen function where any profits from investments go directly back into the fund. In this case, returns are secondary, and the experiential learning is primary. As a result, success is much more qualitative and considers the amount of learning that takes place for each participating student. A possible avenue of success measurement is to track the subsequent career success of students or to survey post-graduates on what they learned in the program.

The difference in the overarching goal among the two types of programs has implications on other aspects of pedagogical and operating characteristics. In the following discussion, we leverage this framework to summarize our findings on these program components.

Pedagogical Characteristics

Students

Of the sampled funds, most have a rigorous process of selecting students who will participate as associate, analyst, or director of the fund. The particular roles of students are discussed in further detail in a subsequent section of this paper. The benefit to students is mainly experiential learning – where students have a concrete experience, review, and reflect on their experience, draw conclusions, and alter behavior based on experiences (Kolb, 1984). Student roles are volunteer positions, apart from Arrow Capital, where students are paid an hourly wage ($16/hour), in a part-

time capacity. Most student-led VC funds are open to both undergraduate and graduate students and generally are not restricted to their academic focus.

Our interviews show that students are required to go through a competitive application process. The criteria for selection are based on the program's need for diversity of backgrounds, experience, and education. The number of student participants vary from as small as 6 to as large as 45. Students often remain in the program for more than one year. While graduated students are not involved in the day-to-day operations of the fund, it is quite common for alumni to stay involved after graduation as student mentors.

Curricular Integration

The interviews reveal that a key concern among student-led VC programs is the lack of VC experience of students entering their programs. As a result, most student-led VC funds make efforts to provide formal training on the VC due diligence process. For example, The Venture Grade Fund at Saint Mary's University has a full pre-requisite course that students must complete prior to applying for the program. Similarly, Front Row Ventures structures a 'boot-camp' for students accepted into the fund, so the training coincides with the fund activities. Programs that provide students with course credit are semester-based, which has an impact on the cadence of the investment cycle. These funds will only accept applications from investee companies looking for funding at a set time each year so that it aligns well with the fund's education cycle. This can be problematic as the semester-based cycle may not align well with the company's fund-raising requirements or timeline, which can result in the fund missing an investment opportunity and a lower deal cadence.

While some academic-focused funds, such as Venture Grade and Tri-Colour Fund, provide course credit for participating, others such as The Student Fund and all other investment-focused funds do not. These programs take a fully experiential approach to student learning in the spirit of ELT (Kolb, 1984), via the support of advisors to the students, learning while working on investment opportunities. The investment cadence is not semesterized, which amplifies the number of deals these programs can consider.

Operating Characteristics

Investment Thesis

The student-founder thesis of a student-led VC fund is premised on the belief that students are prime candidates to source and fund new ventures. Students are 'boots on the ground' in universities and are, therefore, well-connected to be first in line for student-founded companies that are germinating in 'dorm rooms' (Bergmann, Hundt, & Sternberg, 2016). Given that many students have limited responsibilities beyond classes, students often have the time to nurture ideas and, moreover, have the capacity to take risks.

Consistent with the EE literature (e.g., Breznitz & Zhang, 2019), sampled fund representatives note that universities are natural environments to support student entrepreneurship, since they have a built-in team of mentors and advisors in their professors and fellow students. Funds, such as Arrow Capital, Front Row Ventures, and Rough Draft Ventures, mandate that any investee must have a current or recent graduate as a founder in order to be a candidate for investment. This criterion is commonly found in investment-focused funds where the group's investment thesis is

to target only early-stage, 'dorm-room' companies. Thus, student-led VC funds with a student-founder thesis serve to fill a gap in student EEs because they establish a formal connection between VC funds and student entrepreneurs, thereby supplying the student EE with the benefits of VC participation, including liquidity, expertise, and legitimacy (Bertoni, D'Adda, & Grilli, 2016; Sørensen, 2007).

There is a variety of opinions among sampled funds on limiting potential investments to companies in a certain geographic location. For example, Arrow Capital will only invest in UC Berkley-founded companies due to its parent venture firm, Bow Capital, being supported by the university's endowment fund. Another example is Venture Grade, a program that is restricted to the provincial (Nova Scotia) start-up ecosystem due to its agreement with a government-backed venture firm. In contrast, Rough Draft Ventures and Front Row Ventures both expand their investments and representation across the United States and Canada, respectively, with the thesis that a wide geographical mandate is vital to their student-founder investment thesis. There are several factors to consider when establishing a geographic-focused thesis, including the size of the university, the robustness of the local start-up ecosystem, and the source of the capital. Ideally, a student-led fund would expand its investment area as far as possible to give participating students increased inventory of potential investments in order to maximize experiential learning potential. If the potential investment geographical area is too large, it could be challenging for the students to effectively complete their due diligence, though technology can help to reduce some of these obstacles. Moreover, the depth of knowledge among students of a particular market will decline with greater geographic coverage, which can reduce the quality of decision-making.

Program Structure and Governance

The structure of the sampled programs is such that a team of students assume the role of a VC fund partner, though there are levels of seniority among student positions. If the program's group numbers are larger, it is common to have two tiers of student positions, Associates and Analysts, each of which focus on different aspects of the due diligence process. This is the case for University of Waterloo's The Student Fund and results in students being put into groups of 2-4, where each group will perform the due diligence for one company.

In the sampled programs, there is a senior student (or team of students) appointed to the position of Managing Director, which is typically occupied for one year. Responsibilities of this position involve organizing fund events, communication with the investment committee, planning weekly meeting agendas, and general promotion of the fund, all which are consistent with Zider's (1998) survey of the day-to-day activities of a VC fund. For investment-focused funds, such as Front Row Ventures, the managing director is not necessarily a current student and is paid a salary by the parent venture firm to manage the operations of the fund. In academic-focused programs, there is a supervising university representative or industry expert that leads the group and provides perspective to group discussions.

The interviews reveal that a challenge in these programs is determining how investment decisions are made. Most fund representatives in the sample communicate apprehension regarding whether students have requisite experience to make the final decision on $15,000 - $150,000 investments. Sampled funds struggle with whether or not this should be left to students or if students should only conduct the due diligence, make a recommendation, and a team of seasoned VC investors make the final decision.

The governance of the sampled funds differs significantly between academic- and investment-focused funds. Academic-focused funds have a layered and process-orientated structure, which starts at the student participant level where the sourcing and due diligence of investments take place. Next, there is a university representative who acts as the principal within the program. This individual makes the recommendation to move an investment prospect from the fund-level to the investment committee for review. This committee is formed by the university representative, and 3-5 other stakeholders from both the university and the entrepreneurial ecosystem. The investment committee reviews the students' due diligence, and upon approval from the investment committee, there is typically a university committee or board that will provide the final approval, which triggers the release of the funds to the investee company.

Among investment-focus programs, this process is much leaner. We find that they pride themselves on leaving full decision-making to student partners, with the assistance of the Managing Director(s), and the decision is a function of a general consensus vote. Once the decision to invest is made, the parent venture firm receives instructions to release the investment capital to the investee. This governance structure allows the student-led VC program to be agile in making investments in early-stage companies.

Some student-led VC funds have decided that they would rather defer the investment decision and subsequent terms to an established, more experienced VC firm, so they co-invest. Tri-Colour Fund, Venture Grade Fund, and The Student Fund only co-invest alongside another experienced lead individual or firm, while others, like Arrow Capital and Front Row Ventures, will invest solo or co-invest, depending on the deal. The co-investing method has arguably less risk for the student-led program, as the student program rarely makes the final decision on investments, deferring to the more experienced VC firm. The downside of co-investing is that there can be a misalignment between the experienced firm and the student-led fund regarding the stage of the venture (early, mid, or late) and the size of the investment. This approach also places a limit on students' experiential learning, since their contribution to decision-making is lessened.

Investment Terms

The student-led funds in the sample typically fund very early-stage ventures with smaller investments of less than $50,000, an amount that is often regarded in industry as pre-seed or angel amounts. Arrow Capital will invest up to $50,000 per investment, with the remaining sampled programs never exceeding $25,000. The outlier is Tri-Colour Fund, which invests up to $150,000 in slightly later-staged companies. This early stage VC funding fills an important gap in the student entrepreneurial ecosystem, as most institutional seed money is less than these amounts and most VC firms will only invest in companies in later stages.

The general investment philosophy of early stage VC firms is to structure their investment as founder-friendly. Taking steps towards this philosophy, early-stage VCs typically invest with SAFE (simple agreement for future equity), KISS (keep it simple security), convertible note, or fair equity investment structure. The objective of each of these investment terms is to expedite the process of funding the investee, in a manner that minimizes legal costs and delays. With most of these investment vehicles, the valuation process is delayed until a later investment round or another trigger event, which works to limit both the due diligence period and valuation risk. These are reflected in the term sheets of all the interviewed student-led venture funds. As evidenced in Table 2, there are differences in the variety of vehicles used when assessing the two program styles:

academic-focused programs use a greater variety of instruments (at least three), whereas, investment-focused funds use one.

The SAFE is a concept originally created by Y Combinator lawyer Carolynn Levy, as a simple strategy for early investments. In exchange for VC funds, the VC investor receives the right to purchase stock in a future equity round, subject to certain parameters defined by the SAFE contract. The premise of this investment instrument is that it is too hard to properly evaluate early stage companies and it provides a quick and easy way for investors to inject funds into an early stage company without the need for heavy legal fees or a lengthy due-diligence period (Levy, 2018).While there is a variety of SAFE types, there are only two used in the sample of student-led VC funds: standard SAFE (described above) and uncapped SAFE. A SAFE instrument is uncapped when the SAFE converts to equity, and what the founders received is not bounded by a specified amount, as is the case with a vanilla SAFE. The interviews show that most student-led VC funds use SAFEs, with Arrow Capital being the sole program using uncapped SAFEs. Rough Draft Ventures, however, does not use either of these instruments.

Only about 5 years old, KISS documents are a similar investment vehicle to SAFE instruments. Like SAFEs, the KISS is also a new venture financing vehicle that avoids long and expensive negotiations with investors. There are two types of KISS agreements: debt (with an interest rate and a maturity date) and equity (without interest or maturity date) (Raiten, 2014). Two of the six sampled programs (Venture Grade and Tri-Colour Fund) use this instrument, both of which are academic-focus programs.

A convertible note is a financing instrument very similar to SAFE's in that it involves no equity or valuation at the time of investment. These are used by the three academic-focused funds: Venture Grade, Tri-Colour, and The Student Fund. The key difference between convertibles and SAFEs is that convertible notes are a loan to the company with agreed upon and contractual repayment terms and interest rates (Huerga & Rodriguez-Monroy, 2019). Upon a future conversion trigger, typically a formal investment round, the VC investors have the option to convert their notes into equity at the new terms and valuation that has been presented in the new round.

Two student-led funds, Venture Grade and Tri-Colour, use equity as a financing method. With equity investments, a valuation is assigned to an early stage company and the fund receives shares in the new venture. This is a challenging exercise, particularly for student-led funds, because there is often very little data to facilitate an adequate valuation. Unlike the aforementioned instruments, equity investments have rights, including board seats, share preferences, and other stipulations. Because of these additional terms, this form of investment document can be quite lengthy and costly.

Fundraising

Investment- and academic-focused funds in our sample take very different approaches to raising capital. The source of funds for academic-focused programs is donations. Due to the evergreen nature of academic-focused student-led VC funds, there is a constant requirement for more capital to replenish the fund. This can be done through donations, returns on past investments in companies that have been acquired, had an IPO, or from accrued interest from the fund account. In contrast, investment-focused funds raise a set amount of capital from various limited partners before any investments are made, as is the case with Front Row Ventures, Arrow Capital, and Rough Draft Ventures. Investment-focused funds raise all capital and are typically 8-10 year funds. Normally, these investment-focused funds raise a subsequent fund after the first fund has been

fully invested, and as such, sustainability is less of an issue for our sample investment-focused funds.

Should an academic-focused fund require additional capital, the program must solicit charitable donations. Venture Grade, for example, solicits donations from local wealthy individuals or businesses when in need of a capital injection. Furthermore, the representative of Venture Grade notes that their program places great emphasis on the learning opportunity associated with raising capital. While the experience of raising capital from charitable donations is not a direct reflection of raising funds for return purposes, the principles of making a case to donors is nonetheless an excellent learning experience on fundraising. The interviews point to Tri-Colour Fund model as an example of how an academic-focused program can achieve sustainability over time. Their approach involves only investing accrued interest earned from the capital base, which enables the fund to have a sustainable source of VC funds. The challenge with implementing this approach, however, is securing a sufficiently large capital base such that interest is sizeable enough for VC investments.

Discussion

Our study provides both the literature and practice with a first insight into a new pedagogical tool that enhances VC learning: student-led VC funds. A review of venture financing, experiential learning, and entrepreneurial ecosystems literature highlights two potential benefits of this type of program. Within VC firms, there is a substantial variety and nuance among the functions, and we, therefore, argue that these firms demand a skillset that is equally varied and nuanced. We contend that traditional teaching styles are insufficient to meet this industry demand, but experiential learning programs, such as a student-led VC fund, provide a rich, hands-on learning opportunity that can better prepare students and thereby fill a skills gap. In addition, we rely on existing student EE literature to build the argument that student-led VC funds stand to fill an important funding cap within current student EE models. Our paper seeks to better understand this VC-funding innovation, with the aim of providing a summary of the emerging best practices of such programs. We label these emerging best practices, as we do not have sufficient data on program success, and we therefore expect these best practices to evolve while new programs are introduced and existing programs adapt.

We use a multiple case study analysis of six existing student-led VC funds. Interviews with program representatives, along with secondary research, show a marked distinction in the founding principles among sample funds, which has important implications on the benefits mentioned above, as well as the pedagogical and operating characteristics of the program. Investment-focused funds have a primary objective of achieving financial returns through funding student-founded firms. Most, if not all, VC functions are carried out by students, including the final investment decision. Thus, this type of program fills both the VC skills gap and the student EE funding gap. The challenges associated with investment-focused funds are related to students having the skillset to adequately perform all elements of the VC process, particularly, the final investment decision. On the other hand, academic-focused programs have the central goal of student learning, so in this style of program, fund returns and students learning goals are never at odds. The academic-focused programs in our sample do not maintain a student-founder thesis, so this style of program is only associated with experiential learning benefits. Being closely associated with the university, academic-focused programs are challenged by being constrained by semesters and the layered processes associated with making investment decisions. Interviews also revealed other important

differences between the two program styles, including ties to a parent VC firm, source of VC capital, co-investment thesis, investment vehicles used, and the time to complete deals.

These emerging best practices stand to not only inform the design of new, similar programs, but they can also inspire the development of new styles of student-led VC funds. For example, an academic-focused fund with a student-founder thesis may be a possible design. Important to any future program, however, is consideration of the constraints mentioned throughout this paper, including proximity to and health of existing EEs, source of VC capital, commitment of university (or collection of universities), and ties with the VC community.

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Appendix A
Interview questions

- How long has your fund been in operation?
- What is the size of your fund?
- What is the life cycle of your fund?
- How many investments have been made to date?
- How many exists? What was the average (Internal Rate of Return) IRR on these investments?
- What is the typical investment amount? Why? Is there any follow-on investment from the fund?
- What funding round does your firm typically participate in?
- What are the terms of investment for your fund?
- How many investments are typically made per year?
- What is your Fund's Thesis for investment?
- How many paid employees are at your firm? How many student volunteers?
- How many Managing General Partners are at your firm?
- How many Limited Partners does your firm have?
- Is your firm linked / or has a relationship with any other firm for co-investing?
- Does your firm lead a round on investment? Or always co-invest?
- Does your firm have a board of advisors? If so, what is the structure of that board?
- Walk me through the decision making / due diligence process for making an investment.
- Are there any other non-financial benefits to a company when taking investment from your firm?
- Is there an academic benefit for students when participating in your firm?
- What are the criteria for student to participate in your firm?
- Is your firm directly linked to the curriculum of an academic course at a university/collage?
- What are some commonalities you have seen in the successful companies that you have funded?
- Take me through the sourcing process that a student associate would go through to find a company?

Financial Services Digital Badging: Applying Self-Determination Theory to Student Motivation

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As industry and education transition to online modes of operation, students can expect to take greater ownership of their learning. Finance educators may utilize technology-based training to foster student motivation and independent learning. Digital badging is one such approach where students progress through learning modules with assessment of content knowledge and skills development along the way. The purpose of the study was to assess student motivation and learning in a digital badging program using self-determination theory as a foundation. It is premised on autonomy, competence, and relatedness as motivations for growth and well-being. This study applied the three dimensions to a digital badging program focused on financial services using Salesforce Trailhead. This study took place using students (n = 104) from three finance courses taught by the same instructor at a public regional university. Survey results provide evidence that financial services badging addressed autonomy, competence, and relatedness needs. Survey results also showed students were motivated and agreed that they understood the content and learned a lot. Therefore, finance educators can more confidently utilize financial services badging, knowing that it addresses the needs of self-determination to foster student motivation and student learning.

Keywords: Digital badging, self-determination, financial services, student motivation, independent learning

Introduction

As higher education makes greater use of online course delivery, students adapt by using technology to enhance their academic experience. By necessity or design, students become more independent in their approach to education. Finance educators can capitalize on this trend by helping students take greater ownership of their learning. This can be accomplished by using a pedagogical approach that gives students flexibility to progress at their own pace, which builds confidence that they can develop their skills in a remote setting. Online instruction also provides finance educators with a platform to stay current in curriculum development while meeting industry needs. The collegiate classroom, in-person or online, can be supplemented with external learning experiences designed to prepare students with the content knowledge and skills competency expected by future employers.

Industry organizations provide free training programs, such as digital badging, to give instructors access to the latest trends in industry to improve pedagogy while also gaining access to students for recruitment (Y. Wang et al., 2018). These badges often go beyond the content and skills of the instructional materials provided with business courses. Instructors are incentivized to

incorporate digital badges to keep the curriculum current and relevant for career preparedness. A study by Moreo et al. (2018) found industry professionals value certifications when considering new hires. A global survey by Digital Learning Consortium (2019) found 90% of job seeking respondents would value a portable learning record of their experience documented as digital badges. The interest and utility for digital badging spans industry, society, and higher education.

Free credentialing programs are offered by many companies including Google, Hootsuite, Hubspot, and LinkedIn as well as several professional organizations such as the American Institute of Certified Public Accountants, the American Marketing Association, and the Financial Data Professional Institute. Salesforce Trailhead is a free module-based program offered by Salesforce, a cloud-based customer relationship management platform. Over 150,000 companies utilize Salesforce, including many financial services firms such as ADP, American Express, Barclays, Morgan Stanley, and US Bank to name a few (Salesforce, 2022). Salesforce Trailhead offers digital badges in marketing, social media, communications, and financial services organized by functional area, skill level, and role (Salesforce Trailhead, 2022). This study uses Salesforce Trailhead by creating a Financial Services Badging (FSB) program to answer the call by Boyle et al. (2016) to investigate gamification elements in educational design and their influence on student motivation and learning.

The research question in this study is, "What is the effectiveness of the FSB program regarding the student experience and its intended goals of developing financial services content knowledge and student motivation?" The results of the study are important to finance educators by providing evidence for adopting digital badging as a strategy to foster independent student learning. The next section provides a review of the relevant literature regarding digital badging, self-determination theory, and student motivation. The next section elaborates on the steps taken to implement the FSB. Then, the paper focuses on the methods, data analysis and results of the study. Finally, there is a discussion on the conclusions and directions for future research.

Literature Review

Digital Badging

A digital badge is an online display of achieving a skill or competency (Alt, 2021). The badge icon includes metadata and a link to the sponsoring organization authenticating the validity and integrity of the credential (Heavlin, 2019). Digital badges provide value in that they are publicly documented, transparent, and portable evidence of capability or competency (Everhart, 2018). In this way, they act as a form of currency that industry professionals create for students to earn and then are consumed by hiring employers. Finance educators act as endorsers in this exchange by verifying the content and skills learned are relevant and valid. The accumulation of digital badges speaks to a student's independence and motivation to further one's own education for a chosen profession.

Digital badges are scalable, in that novice students can engage in basic material and advance over time to more advanced content and skill-based activities (Pothier, 2021). This scaffolding approach fits well with confidence-building in that initial successes with digital badging motivates students to progress with more challenging tasks (H.-S. Wang et al., 2021). Digital badging provides a dynamic learning environment where students can access in-depth industry-relevant content knowledge, which, compared to traditional instruction, is seen as more attractive and holds students' attention (Ma et al., 2016). Online game-based learning using digital badging can spark

intrinsic motivation with interesting and exciting activities (Banfield & Wilkerson, 2014). Moreover, digital badges can enhance student engagement by providing a credential as extrinsic motivation (Alaswad & Nadolny, 2015).

Self-Determination Theory

Self-determination theory explains human behavior as fulfilling psychological needs leading to motivation (Deci & Ryan, 1980). The premise is that satisfying psychological needs for autonomy, competence, and relatedness leads to psychological growth, integrity, and well-being (Deci & Ryan, 2000). The degree to which individuals believe they can satisfy these needs determines their behavior in pursuing and attaining their goals (Ryan & Deci, 2018). Self-determination theory has been applied to studies in marketing education (Syrdal et al., 2021), accounting education (Karsten et al., 2020), and economics education (Durso et al., 2016). In those studies, students enhanced their experience and motivation from engaging in learning opportunities with autonomy, competence, and relatedness.

Autonomy

The need for autonomy is based on the premise that one's behavior is self-organized (Di Domenico & Ryan, 2017). The idea is that the motivation to complete an activity has to do with one's sense of internal control and self-regulation (Ryan et al., 2021). Although autonomy does not have application to all motivation situations in academia (Fedesco et al., 2019), it can be applied as a pedagogical strategy. The study by Zainuddin and Perera (2019) examined autonomy in a flipped classroom. The results of their research found that the self-regulated learning environment fostered autonomous learning skills and higher intrinsic motivation. Jayathilake and Huxham (2021) found that students take greater ownership over the timing and organization of study sessions when challenged to do so.

Autonomy suggests that students learn independently and take responsibility for their learning. A foundational premise of autonomy in the context of finance education is giving students the choice to complete tasks at their own pace and on their own time (Chen & Jang, 2010). Meeting the need for autonomy helps develop graduates with increased confidence about their ability to work independently in their chosen profession (Adi Badiozaman et al., 2020; Henri et al., 2018). Web-based performance feedback encourages self-regulation for students working independently on course assignments (Raska, 2014). These scenarios are experienced with digital badging in that students choose the timing of their study sessions and are assessed in each module to reflect their content mastery and skills performance. Therefore, it is posited:

H_1: FSB completion is positively associated with student autonomy.

Competence

Individuals feel effective when their fundamental need for competence is satisfied (White, 1959). Competence has been defined as an intrinsically motivated activity that encourages cognitive development and fosters mastery over new challenges (Elkind, 1971). Therefore, individuals can address the need for competence through learning. Competence aligns with autonomy in that students who independently meet new challenges maintain intrinsic motivation to continue learning (Niemiec & Ryan, 2009). Students feel more competent when they actively

participate in learning new material rather than passively receiving information through a lecture or video (Abeysekera & Dawson, 2015).

Self-directed learning fosters student competence (Leisen Pollack & Lilly, 2008). A study by Bratianu et al. (2020) demonstrated the need to shift business education from knowledge transfer to competence development. Students feel accomplished when they develop competencies expected by future employers (Fried, 2020). Positive experiences with digital badging enhance skills for job search and career preparation (Laverie et al., 2020). Moreover, a study by Boo and Kim (2020) conducted over seven semesters found a positive association between digital certification completion and course performance. Therefore, it is posited:

H_2: FSB completion is positively associated with student competence.

Relatedness

Relatedness can be considered as the need for social interaction and to feel close with others (Thomson, 2006). As noted in the pedagogy of vulnerability, collaborating with others by knowing and sharing of oneself is essential to the human experience (Brantmeier & McKenna, 2020). Building relatedness in the collegiate classroom can be beneficial for students, particularly when the connection is fostered with the instructor, as opposed to just the other students in the course (Fedesco et al., 2019). Benefits of instructor relatedness include an increase in student interest, enjoyment in the course, and self-reported effort.

A study by Granitz et al. (2009) found instructors who developed relatedness with students encouraged class members to work harder and be more engaged. A study by Syrdal et al. (2021) demonstrated that being authentic and transparent with students increased perceived instructor relatedness. Relatedness is further manifested when students sense that the instructor has confidence in their ability to master the course content (Uğur et al., 2015). This confidence, or a sense of trust from the instructor, can be demonstrated by assigning an independent learning experience that scaffolds the material to build success at each step, such as with the FSB. Therefore, it is posited:

H_3: FSB completion is positively associated with instructor relatedness.

Student Motivation

Motivation can be classified as intrinsic or extrinsic according to self-determination theory (Abeysekera & Dawson, 2015). Students display extrinsic motivation when they engage in activities because they value earning rewards or avoiding negative consequences. Intrinsic motivation is based on participating in activities that are perceived to be fun, interesting, and enjoyable. (Deci & Ryan, 2002). In a social context, enhancing feelings of autonomy, competence, and relatedness fosters intrinsic motivation (Van Nuland et al., 2012). The underlying premise is that students are more likely to engage in individual activities when they perceive personal benefits are possible and they do not feel compelled to do so. Therefore, in this study motivation is defined as self-reported effort.

Student motivation is linked to active learning where students engage in classroom exercises that foster participation and practical application (Vander Schee, 2011) with lasting motivation and achievement benefits (Vander Schee, 2007). Digital badging is one of several approaches that transitions pedagogy from passive to active learning (Spiller & Tuten, 2019). In the digital badging process, students may be motivated to master learning outcomes for their own academic

development. However, the results in prior research have been mixed. Coleman (2018) found this to be the case, whereas Chen and Jang (2010) as well as Facey-Shaw et al. (2020) did not find evidence to support this proposition. Therefore, it is posited:

H_4: FSB completion is positively associated with student motivation.

Financial Services Badging

The first step for the instructor is to sign up for an account in Salesforce Trailhead (trailhead.salesforce.com). It is free and easy to do using an institutional email account. One can then use the search function to find individual modules (i.e., badges) or trails (i.e., a combination of modules organized as a guided learning by path). Instructors can also find or create trailmixes, which are customized learning paths by topic area. Students earn badges as they complete the assigned modules. Badges are earned by correctly answering questions posed at the end of a content-based module or successfully completing a task at the end of a skills-based module.

Points are associated with each badge. The more time or skill level needed to complete the module, the greater the number points earned. Full credit is only given for a content-based module if all questions are answered correctly on the first try. Second and third attempts earn partial points from the total possible. The estimated time to complete and the number of points associated with each module is listed in the directory, ranging anywhere from 10 minutes to two hours and 100 to 500 points. Students start at the Scout rank and move up to Hiker, Explorer, and Adventurer as they earn a certain number of badges and points.

In this study, students were assigned 19 Salesforce Trailhead badges related to financial services totaling a possible 9,700 points. Students had to earn the Adventurer Ranking (equivalent to at least 10 badges and 9,000 points) to earn full credit for the Financial Services Badging (FSB) portion of the course. FSB was utilized in the second eight weeks of the semester with an estimated 2.5 to 3 hours needed per week. General topic areas for the badges included an overview of Trailhead and Salesforce financial services, client management, connecting with customers, and data modeling Appendix 1 includes a full listing of trails and badges assigned by week with the associated time estimate and possible points earned.

Method

The FSB program was utilized in three undergraduate finance courses, namely personal financial management (general education and finance elective), financial management (required for all business majors), and investments (finance major requirement), at a public regional university. Two of the three courses were taught in-person and one was taught online by the same instructor over the same 16-week semester. The FSB took place over the last eight weeks of the semester for students to become comfortable with the course content and the instructor. The instructor checked in regularly with students regarding FSB progress. Completing the FSB was worth 10% of the final grade in each course.

Students were administered a survey after completing the FSB as part of earning full credit for the assignment. The 3-item autonomy scale was adapted from Bicen and Laverie (2009). The competence scale was developed from three items in the career preparation scale by Li et al. (2007). The scale measuring instructor relatedness included 3 items and was adapted from Fedesco et al. (2019). The 3-item motivation scale was adapted from the self-reported effort scale by Plant

and Ryan (1985). The survey also collected demographic information and student perceptions regarding their level of learning and comprehension of the FSB content.

Results

IBM SPSS 28 was used to conduct descriptive statistics and exploratory factor analysis. Of the 102 students enrolled in the three courses, 74 completed the FSB, with 72 also completing the survey for a 71% overall response rate. Of the survey respondents, 27 (38%) were female and 26 (36%) were students of color. College major was balanced among business disciplines, with the highest representing finance at 33%. Year in college was also balanced with 29 (40%) seniors, 28 (39%) juniors, 9 (13%) sophomores, and 6 (8%) freshmen. Most students (77%) reported spending on average one to three hours on FSB per week.

Exploratory factor analysis was conducted to assess each factor for convergent validity using varimax rotation based on eigenvalues greater than 1.0. Four factors emerged, explaining 84.2% of the variance. Cronbach alpha scores for all factors (autonomy = .89, competence = .94, relatedness = .88, motivation = .85) exceeded the .70 benchmark recommended by Nunnally (1978), thus establishing internal validity. Table 1 shows the results of the rotated component matrix for the four factors along with corresponding coefficient alpha scores.

Table 1
Exploratory Factor Analysis Rotated Component Matrix for FSB Measures

Measurement Items	Factors			
	Autonomy (α = .89)	Competence (α = .94)	Relatedness (α = .88)	Motivation (α = .85)
It was under my control to do well in the FSB.	.942			
I had freedom to choose how I performed in the FSB.	.911			
My performance in the FSB was determined by things I can control.	.835			
I will use the skills I learned from FSB after I graduate.		.918		
My career preparation has been enhanced by FSB.		.917		
FSB helped me develop my career skills.		.907		
I get along with the instructor in this course.			.917	
I really like the instructor in this course.			.890	
The instructor in this course cares about me.			.835	
I did not try very hard to do well in FSB. (Reverse)				.897
I put a lot of effort into FSB.				.877
It was important to me to do well in FSB.				.827

All individual weights achieved the recommended threshold of .70 (Nunnally, 1978) as well as exhibiting minimal cross loadings. Common method bias was assessed in the EFA using Harman's single-factor method. The single factor explained 36% of the variance suggesting insignificant common method variance.

Table 2 shows the mean composite scores for the FSB measures. The mean composite score for autonomy was 4.40 (*SD* = 0.822) on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*), suggesting that students developed autonomy with a sense of freedom and control over their performance while completing the FSB program. This finding supports the first hypothesis. The mean composite score for competence was 4.10 (*SD* = 0.919) on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*). The results indicate students developed competence in financial services from completing the FSB program, thus supporting the second hypothesis.

The mean composite score for relatedness was 4.76 (*SD* = 0.568) on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*), suggesting that students developed instructor relatedness in the

course using the FSB program. The third hypothesis was supported from this finding. The mean composite score for motivation was 4.38 (*SD* = 0.724) on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*). The results indicate high self-reported effort from completing the FSB program, thus supporting the fourth hypothesis.

The survey also asked students about their perceived effectiveness of the FSB on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*). Students agreed that they learned a lot from the FSB (*M* = 4.08, *SD* = 1.219) and understood the content from FSB (*M* = 4.14, *SD* = 1.092). These results are encouraging as indirect measures of student learning, in addition to FSB completion as a direct measure of student learning.

Table 2
Factor Composite Scores for FSB Measures

Factors	Mean	Std. Dev.
Autonomy	4.40	.822
Competence	4.10	.919
Relatedness	4.76	.568
Motivation	4.38	.724

Note. Items measured with Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Conclusion and Future Research

The results of this study provide evidence that the FSB program addressed the motivational needs of self-determination theory, namely, autonomy, competence, and relatedness. These results have implications for finance educators in that faculty can build trust with students by utilizing independent learning to complement in-class instruction. More specifically, related to competence, this study builds on the study by Kim et al. (2019) which showed students found digital badging as a great resource for career preparation. In the current research, job search and career preparation were highlighted in the survey results.

Survey results showed that the FSB fostered student motivation. Although course grades and digital badges provide extrinsic motivation, this study focused on intrinsic motivation as self-reported effort. Badges that require evidence of content mastery or skills development are more highly valued than digital badges based on participation (Carey & Stefaniak, 2018). Students progressed through the interactive digital badging experience engaging with the material with continuous feedback based on the built-in assessments. Students could not guess their way through because the points earned per badge were reduced as the number of times it took to get the correct responses increased. Therefore, the Adventurer ranking could not be earned from a passive approach to the FSB.

It should be noted that students gained content knowledge and skills competency from completing the FSB. This is evidenced in successfully completing the assessments required to earn credit for each badge. Survey results also affirm their perception of having gained knowledge as an indirect measure of student learning. Pairing the two measures provides evidence that students advanced their financial services acumen and could articulate such to others. Taken together, the study reached its intended objective of using digital badging to develop financial services content knowledge and student motivation.

The results of the study provide confidence that finance educators can adapt the FSB program to improve student learning and motivation. This study builds on prior research showing that

students are satisfied with using digital badging as part of business courses (Humphrey et al., 2021). Industry professionals note that new employees with earned certifications show greater productivity and efficiency at the outset of their employment (Dodson, 2016). Therefore, the FSB also helps students build independent learning that provides benefits beyond course completion.

Some limitations should be kept in mind when making application of the results of this study to other settings. In this study, the FSB was due by the end of the semester. It is recommended that instructors enforce weekly deadlines. The number of students who did not complete the FSB in this study (27%) is attributed to procrastinating too far into the semester to get started such that it was simply not possible to complete the FSB in time. Therefore, it is not known whether the results were biased toward students who are motivated by academic achievement. The FSB was an all or nothing assignment such that partial credit was not an option. This may have dissuaded students who were overwhelmed by the number of required badges from starting.

It is worth mentioning that there was some confusion regarding how students can be recognized in their online personal brand for completing the FSB. Students should not post each individual badge earned on LinkedIn. Rather, they should use the ranking designation (in this case, Adventurer) in the Certifications section of their LinkedIn profile. The link provided with the ranking connects to the specific badges completed once on the Salesforce Trailhead site. This approach is common among other digital certifications or rankings that have numerous modules or micro-credentials within them.

Students might be motivated to continue with Salesforce Trailhead, earning badges in other areas related to finance including financial literacy, risk management, and investments. Future studies could investigate the degree to which students continue with digital badging after course completion. Research in this area could shed light on whether intrinsic or extrinsic motivation plays a greater role in digital badging. Future studies might also address renewal rate of digital badges to assess the long-term retention content knowledge or acquisition of skills competency.

Future research could investigate the experience of digital badging with platforms other than Salesforce Trailhead. Although Salesforce Trailhead offers a comprehensive mix of cross disciplinary business materials, other platforms more specialized in areas other than customer relationship management may yield different results. Digital badging also extends to other business disciplines such as Hubspot Academy for marketing, Tableau Essentials for data visualization, DataRobot University for machine learning, and Google Analytics for data science.

Digital badges clearly communicate to prospective employers regarding readiness for a specific position or advancement based on documented content mastery or skills competency (Everhart, 2018). However, online credentials can be displayed within a personal profile such as LinkedIn or they can be accumulated in an online repository set up for that purpose. For example, Accredible, Badgr, CertifyMe, and Credly are online digital credentialing warehouse providers. Research investigating the efficacy of the location, volume, and variety of posting digital badges could provide insights in how they can best be used by students for signaling career preparedness.

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Appendix 1

Financial Services Badging Program Content Listing

Salesforce Trailhead Badge	Week	Points	Time*
1. Trailhead: Quick Look	1	100	5
2. Trailhead Navigation: Quick Look		100	5
3. Trailblazer Community: Quick Look		100	5
4: Trailhead and Trailblazer Community		400	20
5: Salesforce Platform Basics	2	900	50
6: Financial Services Cloud Basics		300	30
7: Financial Services Cloud Customization		300	60
8: Financial Services Cloud for Users	3	200	35
9: Client Management with Financial Services Cloud		2,000	105
10: Client List Growth with Financial Services Cloud	4	200	40
11: Insurance Agent Console for Sales and Service		1,400	105
12. Mortgage Mastery with Financial Services Cloud	5	500	50
13. Insurance for Financial Services Could Admin Essentials		600	115
14. Insurance for Financial Services Cloud Data Model Basics	6	500	50
15. Record Rollups in Financial Services Cloud		200	30
16. Financial Services Cloud Data Modeling	7	400	90
17. Action Plans for Financial Services Cloud		700	120
18. Financial Services Cloud for Salesforce Partners	8	400	50
19. Salesforce Billing Basics		400	45
Total		9,700	1,020

Note. Total time equal to 17 hours. *Time in minutes.

Web Applications for Teaching Portfolio Analysis and Option Pricing

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Two of the most common tools used in finance teaching in a modern classroom are spreadsheets and the web browser. Spreadsheets are perhaps unmatched for building simple models and explaining concepts, while the browser provides access to online calculators and data from websites. In this paper we show how to combine the power of tools of spreadsheets with ubiquity of the internet browser to build web based applications for teaching portfolio analysis and option pricing. While spreadsheets can easily demonstrate the efficient frontier with two securities, it is hard to go beyond two securities and show how the efficient frontier with many securities rules out a large fraction of feasible portfolios. Similarly, while spreadsheets can perform the basic Black Scholes option pricing calculations, they are ill-suited for building high quality interactive visualizations of option values and Greeks. By exploiting the power of R programming language and packages, we show how to build web applications for teaching portfolio analysis with arbitrary number of securities and visualizing option Greeks. Students do not need to learn any programming as they are just using a browser. For instructors, the learning curve is short with even a rudimentary exposure to programming in any language.

Keywords: Portfolio frontier, Markowitz, Option pricing, Black-Scholes, Greeks, Visualization, R, Shiny

Introduction

Despite the rising popularity of R in finance research and practice, Microsoft's Excel spreadsheet software remains the most popular data analysis tool with instructors in undergraduate economics and finance courses (Nash, 2006; Zhang, 2014; Barreto, 2015; Bauer, 2006). The number of articles published in the *Journal of Financial Education* illustrating finance concepts ranging from portfolio theory to CAPM to option pricing using Excel (Loviscek, Crowley, & Anderson, 2003; Gubellini, 2014; Pfaff, 2006) is indicative of its sustained popularity around the world.

This is not without good reason. Books, journal articles, videos and websites illustrating applications in Excel abound. There is no dearth of helpful material on Excel for topics ranging from time value of money (Zhang, 2014) to regression (Briand & Hill, 2013) and simulation exercises (Drougas & Johnson 2004; Engelhardt, 2015) to solving complex problems of optimal control (Nævdal, 2003). With the generations of instructors themselves being trained in and used to Excel, and with Apple and Microsoft re-sellers bundling the Office suite virtually for free for students, popularity of Excel is not surprising.

Barreto (2015) argues that Excel provides a "just right" balance of software for training in the classroom. As Zhang (2014) illustrates, with enough advanced features available, it offers the advantage of gradually moving up the learning curve to implementing more complicated models. However, it is also well-known that Excel is plagued with inaccuracies of statistical procedures (McCullough & Heiser 2008; Yalta, 2008). Also, a lack of efficient separation of data, inputs and outputs in spreadsheets gives rise to frequent operational errors and has reportedly led to significant financial and reputational losses across organizations (Powell, Baker, & Lawson, 2009). The case in point being the evidence unearthed during the post-mortem of the 2008 financial crisis finding mistakes in Excel coincident with bad decision making (Panko & Ordway, 2008; JP Morgan, 2013). The European Spreadsheet Risks Interest Group keeps a running record of the incidents of large operational losses which may be attributed to improper use of spreadsheets in organizations (http://www.eusprig.org/horror-stories.htm).

Notwithstanding its immense utility for building small examples, from a pedagogical standpoint, in our experience teaching quantitative finance courses, we have found that the use of spreadsheets does constrain the depth of analysis that is possible in the classroom, especially when teaching topics in fixed income and option pricing. Cagle et. al. (2010) reports similar findings on limitations of spreadsheets when teaching more quantitative topics, especially for female students. At the same time, however, we do recognize that the other extreme of only relying on programming languages may also be impractical and ineffective when teaching a diverse class.

It turns out that given the power and accessibility of a modern internet browser, one can leave the Excel ecosystem while still maintaining the visual appeal (Barreto, 2015; Zhang, 2014), and yet bring the power of modern programming languages to the classroom without burdening the students. All modern web browsers today are able to render text, data, figures, tables and videos equally well, and there is hardly any student who does not know her way around a browser. In this article we introduce one such browser-based alternative to spreadsheets called Shiny for teaching portfolio analysis and option pricing.

Shiny brings together the power of HTML and Cascading Style Sheets (CSS) with the sophistication of the R programming language and contributed packages. Keeping the input data (in a file), its analysis (in R) and output (in browser) neatly separated, it allows for focus to remain on important issues like the role of parameters and assumptions in models. Without having to deal with the clutter of data and unwieldy formatting, the instructor can go beyond the toy problems that are often necessitated by the nature of spreadsheets.

After briefly introducing R and the Shiny environment, we illustrate its ease of use and power with a detailed discussion of portfolio analysis with multiple securities taught in a standard financial markets/economics class. We then show the power of R and Shiny for creating production quality visualization for classroom use in the context of teaching Black Scholes Greeks. The article ends with step-by-step instructions for setting up Shiny on the free Amazon EC2 cloud service. With applications hosted on the cloud, all that is needed is a browser or a smart phone and instructions for running the app. The learning curve for building and hosting such apps is short for anyone interested with even a rudimentary exposure to programming in any language.

The R Environment and the Shiny Package

The R project and the programming language began in the 1990s as an offshoot of the 'S' language by Robert Gentleman and Ross Ihaka at the University of Auckland. Its name is both a hat-tip to the developers' initials while also being a play on the name of the language on which it

is based. Since the mid-2000s, R has come to be one of the most important languages and environment for empirical work in academia and businesses. And with the rise of data science as an industry, R has come out to be the main competitor of Python as a scripting language.

For someone new to R, there is no dearth of books, tutorials and online courses. Since the wealth of information available can be overwhelming for a beginner, we recommend starting with the official R manual and tutorials available at its home page (https://cran.r-project.org/) and then going from there to finding web resources depending on one's background and needs. The installation instructions for different platforms are also available at the same page as the manuals. Once one has understood the basic R syntax and practiced examples given in the manual, R manual also describes how to install the right R packages. The core development team has come up with a suite of packages called Task Views (https://cran.r-project.org/web/views/), so as one prepares to work in any given field, say, empirical finance, all one needs is to install the associated Task View ('*Finance'* in this case).

The Shiny package was developed by RStudio (https://www.rstudio.com/), the company behind the popular eponymous integrated development environment (IDE) for R. A Shiny application (or app) is essentially an HTML document hosted on a computer running R, which means any device running a modern browser can run the apps. Like any app in the modern smart phone sense of the word, it can take clicks and keystrokes, interpret them and send the output back to the browser window. The input can be in the form of sliders, drop-downs, text fields or even mouse clicks, and it supports output in all familiar forms including figures, tables, texts and summaries. Once developed, the apps can be shared via cloud, intranet or internet, and run on any browser-enabled computer or a smart phone, making it ideal for use within and outside the classroom.

Even though an advanced user can easily enhance and embellish the Shiny apps by using HTML and JavaScript, it neither assumes nor requires any knowledge of HTML on part of the instructor. Pretty sophisticated apps can be built by simply Shiny functions alone, so an instructor need only be familiar with R and the basics of Shiny. A quick way to get a feel of Shiny apps is by studying examples available on the Shiny gallery page at https://shiny.rstudio.com/gallery/.

Teaching Portfolio Analysis using Shiny

Emphasizing the Importance of Portfolio Theory

Portfolio theory studies how economic agents decide on a portfolio of real and financial assets as well as liabilities. Unlike the decision to consume a basket of goods and services (which is driven by the concavity of preferences), the decision to hold a portfolio of assets depends only very mildly on preferences, and is driven almost entirely by the somewhat counter-intuitive nature of the mathematics of risk (Markowitz, 1991; Arnold, 2002). Basically, an asset which is unattractive when viewed in isolation can be highly valuable as part of a portfolio. For example, students often think that a highly risk-averse investor should simply choose the safest asset, but the mathematics tells us that adding a small amount of a riskier asset would make the portfolio safer because of diversification. It is as if adding a small amount of poison could make milk more wholesome.

That portfolio theory is important to the theory of monetary and financial economics would be stating the obvious. It is not only required for teaching demand functions for money and other risky assets, it is also the critical first step towards getting to the Tobin separation theorem and the

'demand side' of the Capital Asset Pricing Model (Buiter, 2003). Its importance to modern economics and finance is reflected in the two Nobel prizes that have been accorded for this theory (the 1981 Nobel to James Tobin and the 1990 Nobel to Harry Markowitz and William Sharpe).

Even though much of portfolio theory was developed and applied in the context of investment in financial assets, we find that students appreciate the intuition better when the logic of diversification and systematic risk is placed in the context of other more concrete economic decisions like:

- A farmer apportioning his limited land to different crops (and animal husbandry) is building a portfolio of real income streams.
- An engineer who decides to pursue an MBA is building a portfolio of human capital.
- A company diversifying into related product lines is building a portfolio of businesses.
- Buying insurance at a premium in excess of the actuarial fair premium makes sense only as a portfolio decision. The same is true for all hedging decisions.

On teaching of portfolio theory, Arnold (2002) argues the importance of linear algebra and Biederman (1992) emphasizes the use of calculus and explicitly bringing out the role of expected utility theory and measures of risk aversion. In our experience, this approach is more effective with senior Master's students or graduate students than with the diverse class one finds in a business school. In our experience, students better grasp the intuition by themselves graphically mapping out the risk-return characteristics of diverse portfolios. While Excel does the job adequately with two securities, with multiple securities it quickly gets unwieldy and complicated in Excel, as for example in Carter et. al. (2002). In contrast, as we show later, a Shiny-R environment is perfectly suited for illustrating the possibilities with multiple securities.

The Analytical Set-up: The Two Securities Case

The standard approach to portfolio analysis in a typical financial economics or investment class begins with mean-variance optimization (Markowitz, 1952). While in general it involves solving a quadratic programming problem, the basic insight of Markowitz is that the risk of a security as part of a portfolio is very different from its standalone risk. In most textbooks and classrooms, the intuition of this idea is usually illustrated by working with two securities. Before describing the issues and compromises involved in the process, we first lay out the mechanics of implementing the standard two securities case.

If there are two securities, say, *A* and *B* with their expected return and risk (standard deviation) pair (μ, σ) as $(10\%, 20\%)$ and $(15\%, 30\%)$ respectively, Markowitz's key insight is that risk of the portfolio of the two securities is not minimized by putting all of one's money in security *A* (the one with a lower standard deviation). Shifting a small amount of money to security *B* with a higher standard deviation in fact reduces the portfolio standard deviation as long as the return of the two securities is not perfectly correlated.

With just two securities, this idea of diversification ("don't put all eggs in one basket") is easy to illustrate with a spreadsheet. This begins by plotting the portfolio mean and portfolio standard deviation against the portfolio weight in one of the security, say *B* (w_B). Students quickly see that the portfolio mean (σ_P) rises linearly from 10% to 15% when the weight in security B is increased from 0% to 100%.

The portfolio standard deviation (σ_P) being a non-linear function of standard deviations of the constituents behaves in a more complex manner. It goes from 20% to 30% as expected, but not in

a straight line: it falls below 20% before beginning to rise. This non-linearity follows from the elementary statistics formula for variance of a sum of random variables:

$$\sigma_P^2 \quad = w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2\rho w_A w_B \sigma_A \sigma_B$$

where, ρ is the correlation between the return of two securities.

In Excel all of this can be demonstrated by building the portfolio of the two assets with varying weights in two columns. The portfolio return and risk are then easily evaluated using the formulas above in different columns. It is then possible to plot return versus risk to obtain the classical parabolic shape of the Markowitz efficient frontier as illustrated, for example, in Carter et. al. (2002).

Going beyond Two Securities

The difficulty in using spreadsheets lies in extending the analysis beyond two securities. Traditionally, the approach in the classroom has been simply to persuade students by citing important results (Merton, 1972) that the efficient frontier has the same shape when there are a larger number of securities.

One difficulty is that with two securities, all portfolios lie along the parabola (including the "inefficient" lower half), and there are no portfolios in the interior of the parabola. With more than two securities, most portfolios are in the interior and by restricting portfolio choice to the efficient frontier, we are able to rule out a very large fraction of feasible but inefficient portfolios. This key insight of modern portfolio theory cannot be demonstrated with two securities and is therefore either very hard or cumbersome to show with a spreadsheet.

Two Asset Frontiers and the Feasible Region

Working with two securities in Excel also makes it impossible to show that two asset frontiers bound the feasible region. The analytical proof of this is non-trivial and to our knowledge not available in standard references. Depending on the class background, this can be motivated theoretically in advance as follows.

The second derivative of the portfolio variance is the variance covariance matrix which is positive definite. Hence an interior minimum for the variance is possible, but an interior maximum is not possible. So, the portfolio variance is maximized at the boundary of the feasible region in portfolio space. Any such boundary point in an n-dimensional space must be the intersection of n constraints which must consist of $n-2$ non-negativity constraints, the target mean constraint and the unit sum of weights constraint. For each choice of $n-2$ weights to be set to zero, the remaining 2 non negativity constraints together with the mean and sum constraints define a two asset frontier.

If we draw a horizontal line at a fixed target mean, its intersection with the all-asset frontier is the minimum possible risk, and the intersection with the rightmost two asset frontier is the maximum achievable risk. The feasible risk therefore lies on the line segment joining these two points.

This establishes the result that the boundary of the feasible region consists of the all-asset frontier and all the two asset frontiers. To establish that all points on the above line segment are achievable, it is enough to note that if we take convex combinations of the two portfolios (minimum and maximum risk for fixed target mean) with weights w and $1-w$, then the variance of the convex combination is a continuous function of w. The intermediate value theorem from calculus then ensures that variance will assume every value between the minimum and maximum risk.

A Shiny App for the Efficient Frontier with Multiple Securities

By working in a Shiny-R environment, all the nuances of the general case (more than two securities) can be visualized. While R gives access to a large set of packages making handling large number of securities a cinch, using Shiny allows the instructor to exploit the power of R without intimidating the students who might not be familiar with this or any other programming language, or even Excel (Cagle et. al. 2010).

Students only need to point their browser to the Shiny app and interact with it. They can see the plots change instantly as they change any of the input parameters. In fact, nothing needs to be installed even in the computer provided to the instructor in the classroom. The instructor also merely needs a browser to connect to a server (possibly on a free cloud service like Amazon EC2 as we describe later).

The way Shiny is designed, there are two components to every app:

- The user interface script (*ui.R*): This handles the user experience and sets the page details (the way the app looks like), lists the input options and defines the output formats.
- The server script (*server.R*): This does all the R work, meaning it handles the instructions given to the app and returns the output objects to be displayed on the browser.

For our purpose, the R package *fPortfolio* (part of the '*Finance*' Task View) provides all necessary functions for computing and plotting the efficient frontier as well as the portfolio composition along the frontier. We describe the user-interface and server files separately. Our Github page at https://github.com/jrvarma/rshiny-efficient-frontier contains the full source code, and below we describe the main elements along with the screenshots. The line numbers in parentheses correspond to line numbers in the associated source files.

ui.R for the Portfolio Frontier

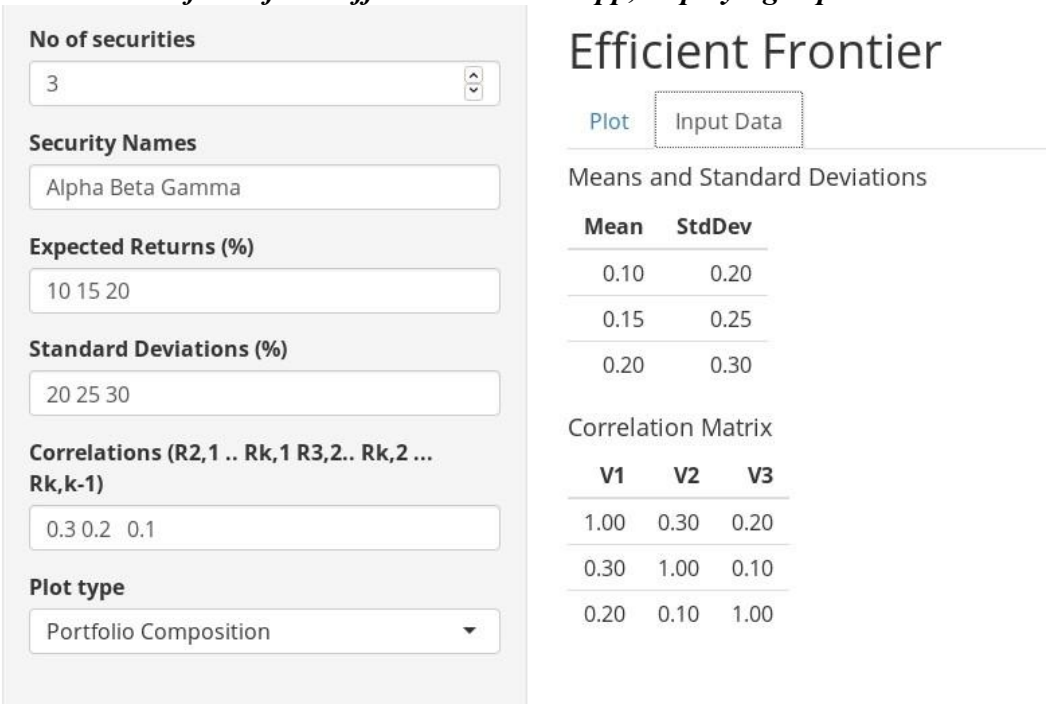
The user interface of the app is designed like any calculator, with the left panel designed to take inputs (called the *sidebarPanel*, line 2) and a *mainPanel* designed to display outputs. The *sidebarPanel* (line 3) collects all inputs including the number of securities (*numericInput*, line 4), the names of these securities, their means, standard deviations and the correlations (*textInput*, lines 5-10).

Analogous to different kind of input functions, the user interface creates output objects using output functions. Output objects are created in a *mainPanel* (line 26), and given the two category of outputs, the main panel is sub-divided into two separate tabs. In the user interface file, this is referred to as *tabsetPanel* with a separate *tabPanel* for each category of output. Within the *tabsetPanel*, *plotOutput* (line 29) contains the plot and the *tableOutput* (line 34) contains the input data table. Figure 1 shows the screenshot of the main interface with input data displayed. For a finance instructor with an understanding of inputs required to compute the frontier, the design should appear quite familiar.

In the same panel, the user also chooses whether to plot the efficient frontier or the portfolio composition (*selectInput*, lines 11-14). If the frontier is chosen, there are further choices: whether to plot the two asset frontiers, and whether to plot random portfolios and if so how many

(*conditionalPanel*, lines 15-23). Figure 2 gives a screenshot for the example when check boxes for both random portfolios and two asset frontiers are selected by the user.

Figure 1
Main interface of the Efficient Frontier App, displaying Input Data Tab



Other output possibilities in Shiny include *dataTableOutput* (for an interactive table), *htmlOutput* (for raw HTML), *imageOutput* (for an image), *textOutput* (for simple text), *uiOutput* (for a Shiny user-interface element) and *verbatimTextOutput* (for verbatim text).

`server.R` for the Portfolio Frontier

The server script requires a bit more effort. It needs to read the inputs, compute the correlation matrix and render the output. It calls the following functions from the *fPortfolio* package:

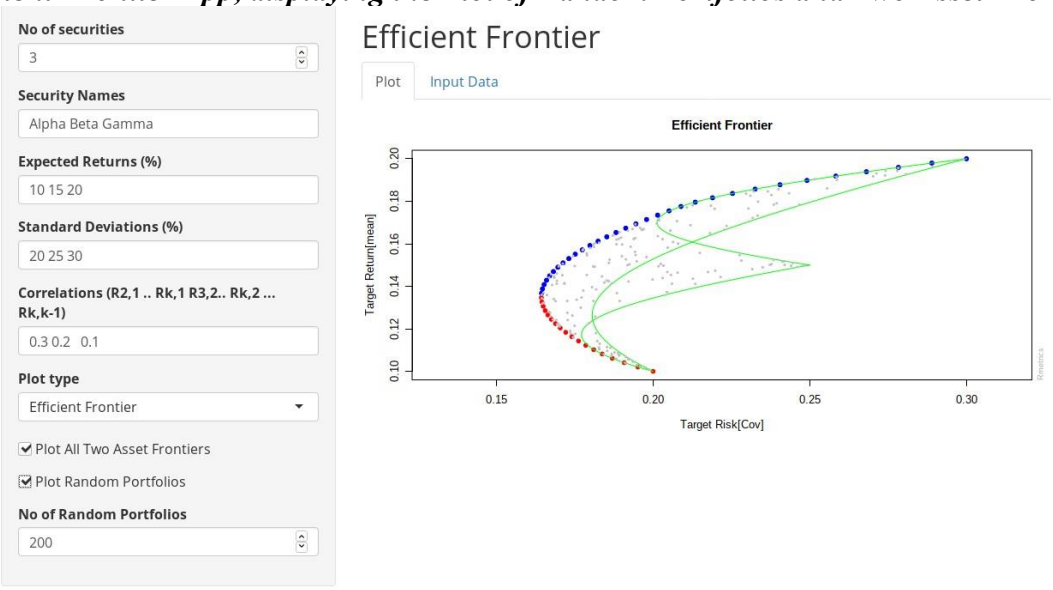
- *portfolioFrontier* computes the frontier (line 13), and *weightsPlot* plots the portfolio composition (line 15)
- *twoAssetsLines* plots all two-asset efficient frontiers (line 19). If there are three securities, *A*, *B* and *C*, the efficient frontier drawn by *portfolioFrontier* contains portfolios including all three stocks. *twoAssetsLines* draws three additional efficient frontiers taking two securities at a time: the frontiers with only *A* and *B*, with only *A* and *C* and with only *B* and *C*.
- *monteCarloPoints* plots the mean and standard deviation of a number of random portfolios (line 21). Most of these would be inefficient portfolios, but they map out the entire feasible region in mean – standard deviation space. The efficient frontier produced by *portfolioFrontier* appears as the upper boundary of the feasible region.

The remaining part of the server script (before *renderPlot*) consists in parsing the input data, and computing correlations. In this particular case, the mean input also needs to be converted from percent to decimal (line 4). While the *scan* function is standard in R for reading text data, reactivity requires that this be called as a reactive expression (line 4) so that it can respond to any changes in the data input by the user.

The correlation matrix computation part of the code requires some care because only the lower triangular part of the correlation matrix is typed by the user, and the code has to copy this into the upper triangular part and also fill the diagonal with ones. This needs about a dozen lines of additional R code, following the steps found in any standard econometrics text.

Figure 2

Efficient Frontier App, displaying the Plot of Random Portfolios and Two Asset Frontier



Finally, *server.R* also contains two additional functions which are necessitated because of a quirk in the way *fPortfolio* package uses sample moments. *fPortfolio* package does not allow direct inputs of mean and covariances, but insists on computing these from the supplied time series of returns data. While R has no difficulty generating a sample with specified population mean vector and variance-covariance matrix one needs to be careful as the sample mean and variance of this sample will not be *exactly* equal to that of the population parameters.

The function *iid.sample()* helps sets this up. After drawing uncorrelated multivariate normal variates (lines 2-4), first the mean and standard deviation are respectively set to 0 and 1 using the *scale* function in R (line 8). The R function *chol* (for Cholesky factorization) is used to getting the correlations right (line 13). The main job of *my.sample()* (lines 16-48) is to rescale the data back to get the desired correlation matrix, standard deviation and means (lines 35-47). It also includes some validation to ensure basic requirements, like positivity of standard deviations and size of inputs. Ignoring the annotated comments and validation, the relevant part of the *my.sample()* code is merely 5 lines.

This may seem additional work, but it helps put into perspective issues involved in setting up a powerful general purpose software. While prima-facie the steps involved in building Shiny apps

may seem much ado about not much, an instructor whose teaching involves using or creating similar applications regularly, the benefits far outweigh the costs.

Reactivity and Visualization in Shiny: The Case of Black Scholes Greeks

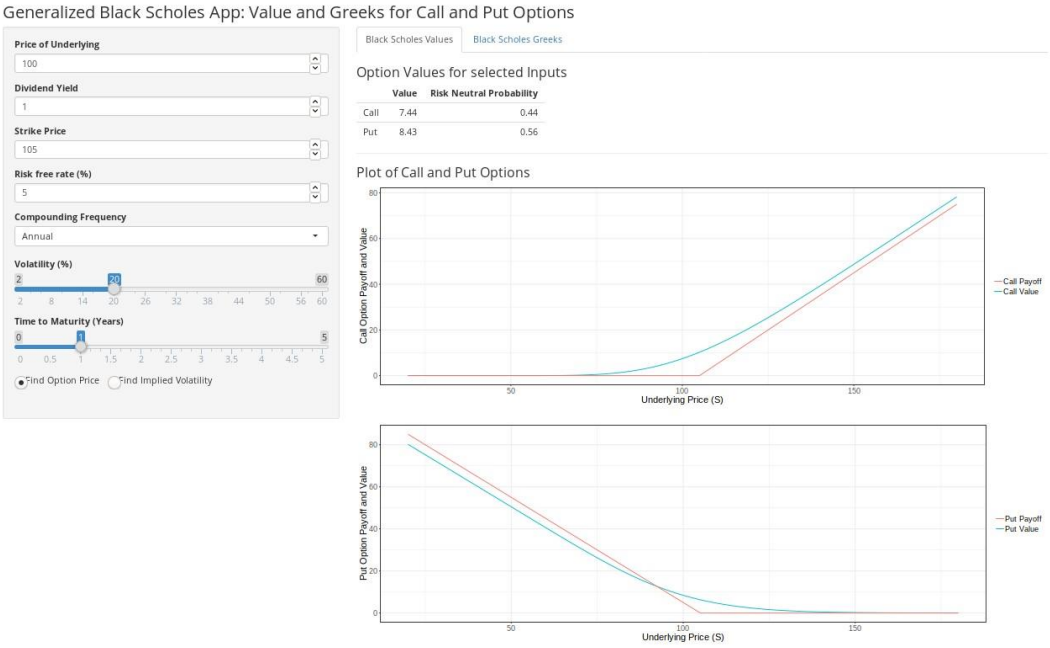
Spreadsheets are particularly infamous for the poor quality of their charting utility for communicating scientific results. In comparison, R offers a modern approach to data visualization using the layered grammar of graphics with a package called *ggplot2* (Wickham, 2010). Coupled with the interactivity that Shiny offers, *ggplot2* is leaps ahead of any spreadsheet software in exploring and visualizing complex data.

We illustrate the power of visualization in Shiny in the context of Black Scholes option pricing calculator. The Black Scholes model solves the problem of finding the price of derivatives written on an underlying, say a stock price. Assuming friction-less markets and Normal distribution for stock returns, the formula for a European call option is given by:

$$V \quad = Se^{-qT}N(d_1) - e^{-rT}KN(d_2)$$

where d_1 and d_2 depend on S (value of the underlying), K (strike price), r (continuously compounded risk-free interest rate) and T (time to maturity), q is the equivalent dividend yield continuously compounded and $N(\cdot)$ represents the Normal cumulative distribution function.

Figure 3
Main Panel of the Black Scholes App



Given that closed form formulas exist for the price of simple European options, it is not difficult to build such a calculator on a spreadsheet (Pfaff 2006). Its simplicity and utility, however, makes it is ideal for illustrating Shiny's benefits of visualization. Figure 3 shows the main panel for Black Scholes option pricing calculator (the source files are available at our Github page at https://github.com/jrvarma/rshiny-Black-Scholes).

One of the things that students often have most difficulty in option pricing theory is understanding the sensitivity of the price to changes in value of the inputs to the model. Referred to as Greeks, these represent partial derivatives of V w.r.t. S (called Delta, $\Delta = \frac{\partial V}{\partial S}$), r (called Rho, $\rho = \frac{\partial V}{\partial r}$), $T - t = \tau$ (called Theta, $\Theta = -\frac{\partial V}{\partial \tau}$), and σ (called Vega = $\frac{\partial V}{\partial \sigma}$). An option seller is often also interested in how these sensitivities vary, and then the second order partial derivatives are also used. The important of these are those w.r.t. S (called Gamma, $\Gamma = \frac{\partial^2 V}{\partial S^2}$) and σ (called Vanna = $\frac{\partial^2 V}{\partial S \partial \sigma}$ and Volga = $\frac{\partial^2 V}{\partial \sigma^2}$). Standard textbooks have all the formulas (Hull, 2017), and explain the use and meaning of many of these sensitivities.

From a pedagogical point of view, however, the best way to teach these is by showing how their graphs respond to changes to other inputs. While their mathematical formulas can be easily derived, given that non-linear functions are involved, in our experience, students appreciate their meaning and their limiting behavior if they can change the input values and see the output from graphs change on their own. This is achieved through what is called reactivity.

Reactivity is a key design element of Shiny, and this is what makes the user experience like interacting with an Android or an iOS app. An Excel user might think of reactivity as a spreadsheet with automatic refresh/calculate turned on. There are 'reactive values', 'reactive functions' and 'reactive objects'. For example, in the case of Greeks, where the user selects the appropriate Greek to be plotted using radio buttons, the *switch* command is made reactive. This ensures that the value and plots of only the selected Greek are displayed. For example, Figure 4 shows the screenshot for the Greek Theta (Θ) is displayed with the radio button for 'Theta' selected. Screenshots for other Greeks, including Delta (Δ), Gamma (Γ), Vega etc. are included on our Github page at the link https://github.com/jrvarma/rshiny-Black-Scholes/tree/master/screenshots.

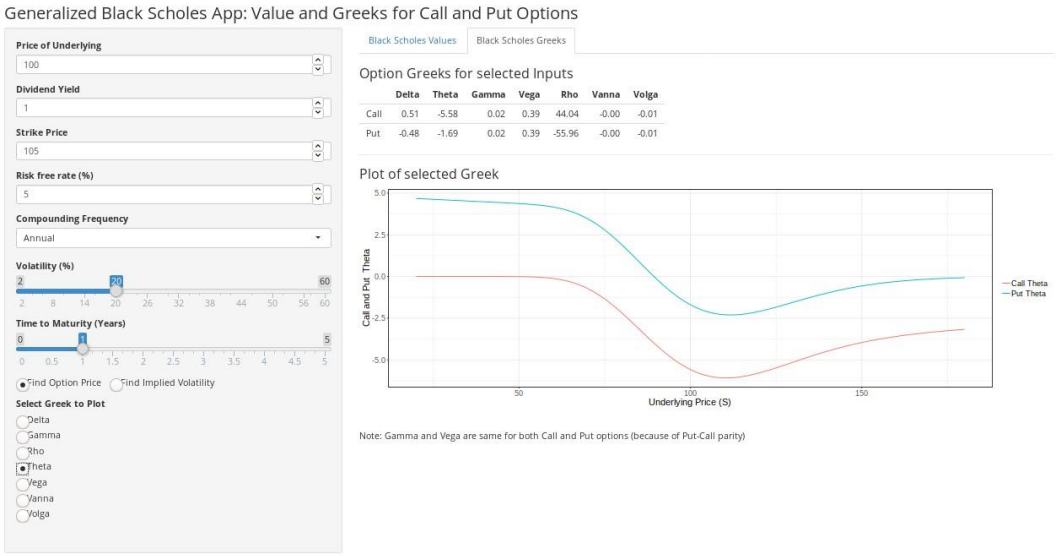
While reactive expressions ensure that all kinds of objects can react to user inputs as in Excel, unlike Excel's auto-refresh/calculate, Shiny offers a lot more control on what is to be recalculated and when. So, if one does not want the app to respond to any specific changes in the app (say, if one wants to keep certain inputs or texts frozen), one can easily 'isolate' them using the *isolate() function*. Its use makes an object non-reactive, and then it behaves like normal R values. There are circumstances when a reactive value needs to be called multiple times within the same code, and then it is often convenient to work with reactive expressions. Called as functions, reactive expressions cache their values to the most recent calculation avoiding unnecessary computations.

Other Advantages of Shiny over Spreadsheets

- Reusability: Once the apps are created, they can be used across for audience with different backgrounds. While spreadsheets too afford reusability to an extent, as argued earlier, Shiny keeps the focus on the elements crucial for a session. The layout of the app can be designed such that the same app can be used for different groups by using tabs to separate different outputs by difficulty level without cluttering the environment that tends to happen with spreadsheets. Select data can also be made non-reactive by using *isolate()* as need be.

Figure 4

Tab for Greeks with Plot for Theta (Θ) in the Black Scholes App



- Object-oriented and vectorized: Many problems in portfolio theory and quantitative finance are naturally cast in terms of linear algebra. This makes R an almost-perfect fit for the task, given that indexing, operators and functions in R closely resemble the algebra of matrices. Its vectorization capabilities are often leveraged to speed up the code (Wang, Padua, & Wu, 2015). Beyond the environment it offers, R is also a full-fledged objected oriented programming language allowing for building large scale data analysis applications using classes (S3 and S4 in R)
- Extensions: The biggest advantage of working in the R and Shiny environment is possibilities afforded for extensions to the server script by including more advanced versions of basic models. Some possible extensions include:
    - Non-Normality of asset returns, say, by bringing in other elliptical or stable distribution by using, for example, the *fBasics* package.
    - Black-Litterman's approach (Black & Litterman, 1992) for introducing investor views and opinions in the Markowitz problem using the *BLCOP* package. For many such nonlinear problems, spreadsheets are known to be particularly unsuitable (Almiron et al., 2010).
    - Bring in stylized facts (Cont, 2001) and time series methods to the class using *fGarch*, *rugarch* and *rmgarch* packages.
    - Bring in live financial and macroeconomic data from important financial markets directly into the R workspace using packages like *quantMod* and *quandl*.
    - Animate apps as GIF or flash movie using the *animate* package (Xie, 2013).

In fact, as many of the extensions can be built as the instructor desires and the extended features can be selectively used depending on the students' background. So, time and opportunity permitting, even a beginner class can get a flavor of subtler and advanced issues without having to worry about details of their implementation. It also has the added side effect of making the interested students curious about implementation of the more advanced features.

These are only a few obvious examples. Richness of R allows for customization and extensions in different directions. For those fussy about the look-and-feel of the apps, Shiny offers a variety customization possibilities using layouts, panels and HTML tags (in our experience, the basic design elements available from Shiny functions are more than adequate for classroom use). In a sense, then all one needs are a basic understanding of these functions and some idea on how to customize the user interface using the in-built HTML wrapper functions. While investment required on part of the instructor differs depending on the nature of the application developed, interacting with Shiny is a bit like using a smartphone – a high-end Android phone may have more features than a low-end one, but both run on the same kernel and offer the same look-and-feel.

Sharing and Deploying Shiny Apps

Sharing the Component Files

Sharing Shiny apps is as easy as sharing any file. If the users are familiar with R and have all the necessary data available and R packages are installed on their computers, an app can be launched by the user by running the commands locally. It is crude, but it works and is apt for a small class familiar with R.

This may not be ideal with a non-programmer audience though, as the users may inadvertently damage the app by tinkering with the user interface or server files. If the objective is to teach R and Shiny, then an instructor could share component files for an incomplete app and have students finish them as homework. Other than simply sharing the two files over a network or otherwise, they can also be hosted on Github or Gist and run directly from there.

Hosting a Shiny Server on Cloud

The utility of Shiny really comes through as an app hosted on cloud, especially if the users do not have R installed or are not keen to install it. All that is needed is a browser and instructions for running the app.

RStudio provides a paid service to do so at https://www.shinyapps.io/. There is also a bare bones free/trial version. An alternative to using RStudio is to deploy apps using a Docker-based technology at the service called ShinyProxy (https://www.shinyproxy.io/) which only relies on the open-source Shiny package without any dependency on the server version of Shiny or RStudio.

Those with some experience in web hosting or a helpful IT department may either set up a Shiny server locally (instructions at https://github.com/rstudio/shiny-server/) or on any cloud hosting service. Given the popularity of free Amazon Web Service, in the Appendix we provide step by step instructions for installing and running the efficient frontier Shiny app discussed earlier as an instance on Amazon EC2. This ensures that nothing needs to be installed even in the computer provided to the instructor in the classroom. The instructor simply uses a browser to connect to a server, an Amazon EC2 instance.

Conclusion

Spreadsheets are perhaps unmatched for building simple models and explaining concepts in the classroom, which explains the popularity of Excel for its use in teaching finance concepts. Even so, known statistical and formatting issues has put Excel on the spot for giving rise to frequent

operational errors in organizations. Lack of efficient separation of data, inputs and outputs in spreadsheets can also often constrain the depth of analysis that is possible in the classroom.

Recent software advances have brought browser-based tools to fore as capable alternatives to spreadsheets. In this article we have shown how to combine the power of spreadsheets with ubiquity of the internet browser to build web based applications for teaching portfolio analysis and option pricing. We have also described the compromises necessitated due to the use of spreadsheets when teaching portfolio analysis, and provided detailed steps for building a web based application for explaining mean-variance efficient frontier with arbitrary number of securities, and illustrated the use of sophisticated visualization capabilities for teaching Black Scholes option valuation and Greeks. The full source code for both applications is also shared on our Github page. The applications are not only amenable to extensions for more advanced courses, as we illustrate with instructions for Amazon Web Service, it is also straightforward to set it up on the cloud for easy accessibility by any modern browser or a smart phone.

Appendix
Deploying the Efficient Frontier Shiny App on Amazon Web Services

The following steps sets up the efficient frontier Shiny app on a Free Tier EC2 instance on Amazon Web Services (AWS). To begin with, the basic setup involves the following steps:

Create an Amazon account (or use an existing account) and log into the AWS console *https://console.aws.amazon.com/*

- Launch an EC2 Instance: choose the *Ubuntu Server 16.04 LTS* Amazon Machine Image (AMI), select a t2.micro instance type
- Create new key pair, download it as say *my-key.pem* and change the file permissions to give all rights only to the owner (Unix permission 400).
- From the AWS Console, determine the public DNS (hostname) of the instance say *my-ec2.amazonaws.com*
- To connect to a running instance one needs to use secure shell (SSH) as: *ssh -i my-key.pem ubuntu@my-ec2.amazonaws.com*

We then proceed to install R and all requisite packages by running the commands as in Table 1:

Table 1
Commands for Installing R and Relevant Packages on AWS

```
# Some packages require newer version of R, so we use the RStudio
repository
sudo apt-key adv --keyserver keyserver.ubuntu.com--recv-keys
E298A3A825C0D65DFD57CBB651716619E084DAB9
sudo add-apt-repository   'deb [arch=amd64,i386]
https://cran.rstudio.com/bin/linux/ubuntu xenial/'
sudo apt-get update
sudo apt-get upgrade
sudo apt-get install r-base
# install all packages required for fPortfolio and its dependencies
sudo apt-get install libcurl4-openssl-dev
sudo apt-get install libxml2-dev
sudo apt-get install coinor-symphony coinor-libsymphony-dev coinor-libcgl-dev
sudo apt-get install xorg-dev libglu1-mesa-dev
sudo apt-get install  glpk-utils libglpk-dev
```

After the packages have been installed we then run R as *root* or with superuser privileges (*sudo R*) and execute the commands as follows: *install.packages(c('fPortfolio', 'shiny'))*

We may now copy the files *ui.R* and *server.R* to the EC2 instance using *scp* on our local machine as: *scp -i my-key.pem /path/to/my/efficient-frontier/*.R ubuntu@my-ec2.amazonaws.com:*

This command will upload the files from the local machine to the home folder of user *Ubuntu*, but they can be moved into the right folder later. Coming back to the SSH terminal, we execute the commands as in Table 2 below on the EC2 instance.

Table 2
Uploading Files from the Local Machine to the Home Folder

```
sudo apt-get install gdebi-core
wget https://download3.rstudio.org/ubuntu-12.04/x86_64/shiny-server-1.5.1.834-amd64.deb
sudo gdebi shiny-server-1.5.1.834-amd64.deb
sudo mkdir /srv/shiny-server/efficient-frontier
sudo mv *.R  /srv/shiny-server/efficient-frontier/
sudo chmod 755 /srv/shiny-server/efficient-frontier/*
```

At this point, we can terminate the *ssh* connection to the EC2 instance. Now in the AWS Console (in the browser), navigate to Security Group, edit and add rule for inbound traffic. For *Type*, choose *Custom TCP Rule*, for *Port* select *3838* and for *Source*, accept the default *0.0.0.0/0, ::/0*.

Finally, to run the app, we point the web browser to: *http://my-ec2.amazonaws.com:3838/efficient-frontier/*.

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Financial Markets, Institutions, and Instruments: A Pedagogy for the 21st Century

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Our research explores a senior, undergraduate pedagogy for teaching a course on financial markets, institutions, and instruments. The course of instruction is designed as part of a finance major and integrates the goal of technical career preparation. The pedagogy includes a 13-chapter online text titled Financial Markets, Institutions, and Instruments published through MyEducator. The text is designed to be clear and concise, in a nontechnical tone. Active learning activities include three Excel exercises and five data analytics exercises. Basic VBA and Python are taught in the context of markets, institutions, and instruments. Student survey results provide quantitative insights of student evaluations, and a series of open-ended questions allow us to identify four key factors of the proposed pedagogy.

Key Words: Pedagogy Research; Curriculum Development; Professional Development; Teaching Innovations; Finance

Introduction

A course on financial markets, institutions, and instruments is ubiquitous in undergraduate curriculums across finance majors. In this paper, we present a new framework for a pedagogy in such a class, to include a new teaching resource. The authors have a combined 25 years of teaching this material, with various textbooks and approaches. The pedagogy described in this paper represents a consortium of the best practices through all our experiences.

We extend earlier research that proposes alternative methods for covering financial markets, institutions, and instruments in an undergraduate curriculum. For example, Gamble (1991) and Thornton, Ekelund, and DeLorme (1991) both present a graphical approach to teaching the specific concept of the money multiplier which is typically taught in a markets course. Our pedagogical approach subsumes their approaches to present many of the concepts in a graphical dimension. In addition, our pedagogy employs strategic real-world applications, extending articles such as Bofinger, Mayer, and Wollmerhauser (2006) who present the BMW model as a framework for teaching monetary economics. Furthermore, Walsh (2002) argues that instruction on inflation targeting is lacking and proposes a framework to make up the shortfall. We agree with Walsh (2002) along many dimensions of teaching this material in an undergraduate course and have designed a pedagogy to fill as many of the gaps as we could locate. In addition, we work to incorporate modern trends and extend the work of Strickler (1985) and Sihler (1993).

Our paper is similar to that of Brau, Brau, and Keith (2020) who introduce a new pedagogy for teaching a data analytics course at the undergraduate level using Python. The Brau et. al (2020) study also designs the pedagogy around a MyEducator online resource and teaches Python

programming, as we do in our structure. Other than these similarities, our paper differs in pedagogy and content.

Additional foundational literature includes articles that study factors relevant to student learning and performance. The curriculum and pedagogy we designed and present here rely heavily on this extant research. For example, Paulsen & Gentry (1995), Brau, Brau, Owen, and Swenson (2016), Brau, Brau, Rowley, & Swenson (2017), Brau, McKinley, Mohler, & Swenson (2021), Brau, Brau, Burton and Gaskin (2021), and Brau, Nielsen, Owen, and St. Clair (2022) all use large samples of undergraduate students to test for factors that influence student learning and grades in marketing, finance, and information systems classes. The design of our financial markets, institutions, and instruments curriculum is grounded in this thread of research.

Description of Pedagogy

Many universities have courses on financial markets, money and banking, and financial instruments. Adaptations for such courses typically varies across campuses, as well as among professors working in the same department. An example course description is:

> This course is a macroeconomic class with special emphasis on the US financial system. It offers both a qualitative and quantitative introduction to financial markets, institutions, and instruments. The goal of this course is to build a solid foundation of knowledge and understanding about the economy and how it applies to finance majors. We cover broad markets as well as specific instruments such as fixed-income, equities, and derivatives.

A typical main course objective is to help students build a solid foundation of how finance fits into a macroeconomics context prior to graduation, consistent with Howells (2009). Critical thinking skills about current events, markets, institutions, regulation, and other real-world applications are included in each discussion. In essence, a course on financial markets, institutions, and instruments is one that teaches students the language of business. In this pedagogical approach, students begin by learning the fundamentals of financial markets, institutions, and instruments. Topics include risk, time value of money, interest rates, term structure, bonds, equities, derivatives, international finance, foreign exchange, financial intermediation, industry structure, financial regulation, and cryptocurrencies.

Lecture Discussions

Lecture discussions for this course have been performed both in live classroom and live remote environments. (See Brau, Cardell, Holmes, & Wright (2017) for an analysis of online vs. in-class pedagogies.) Within each environment, the pedagogical approach has been well-received and is easily implementable in either format. Motivated by the findings of Kieft, Rijlaarsdam, & van der Bergh (2006) and the article of Clark (2014), we present the lecture material to students using a written lecture note approach, i.e., we only use PowerPoint sparingly and strategically. In section 3.4, we provide evidence from student feedback that the hand-written approach is meaningful, engaging, and positively impacts student opinion of lectures, knowledge retention, and overall learning outcomes from the pedagogy. By following such a strategy, the lecturer and students remain in sync throughout the lecture and student engagement in back-and-forth conversation also increases. In addition, students typically experience less distraction from phones and laptops.

Throughout each lecture, current and historical events are shared with the students to directly connect what is being taught to real-world situations. This connection is accomplished by showing students daily or weekly news articles related to current or past course material. In addition, images that connect the present to the past can be used to enhance student understanding and engagement. For example, when students are taught about the Federal Reserve Bank of the United States and monetary policy, an in-class Google search serves as a discussion base of news articles discussing current/previous investor sentiment, market behavior, and market reactions to Fed announcements.

During lectures, active learning exercises are also implemented. Introducing and showing students trading platforms such as Robinhood, TD Ameritrade, or brokerages help connect lecture material to real-world tools. DeMong, Pettit, and Campsey (1979) in as early as 1979 argued for the need to bridge academics and practitioners. We take this need to heart and incorporate real-world practice into every class discussion. Assisting students learn how to understand price movements, candlesticks, and options chains has been well received in enhancing student understanding of course material and connects the material to practice. Free charting sites such as bigcharts.com and tradingview.com are also utilized to enhance student engagement in lecture discussions and application to practice.

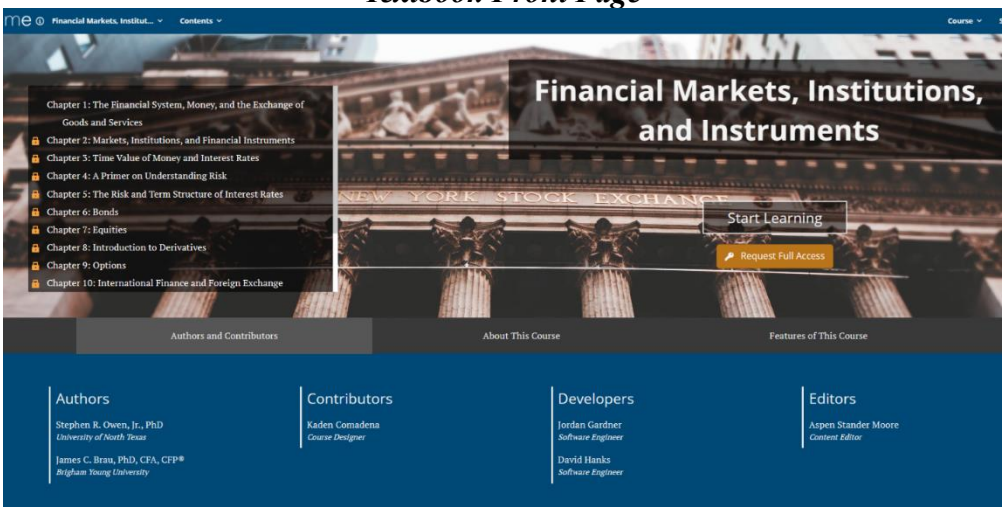
Our pedagogy strategically switches between various media throughout each lecture discussion. For example, a class may start with an on-screen flyer for a professional or club event on campus, then switch to the document camera for note taking, then switch to a smartphone for an example of Robinhood, then switch back to document camera for note taking, then switch to the in-class computer for the Google search mentioned above, then finally switch back to the document camera to finish the lecture discussion. We have found it is important to switch media frequently to keep student attention.

Textbook and Online Learning Platform

The textbook adoption for this course is *Financial Markets, Institutions, and Instruments* by Owen and Brau, a demonstration course can be explored at https://app.myeducator.com/reader/web/1833a/. Figures 1 and 2 provide two screenshots from the text. The figures illustrate the layout of the resource, as well as the navigation from within an example chapter.

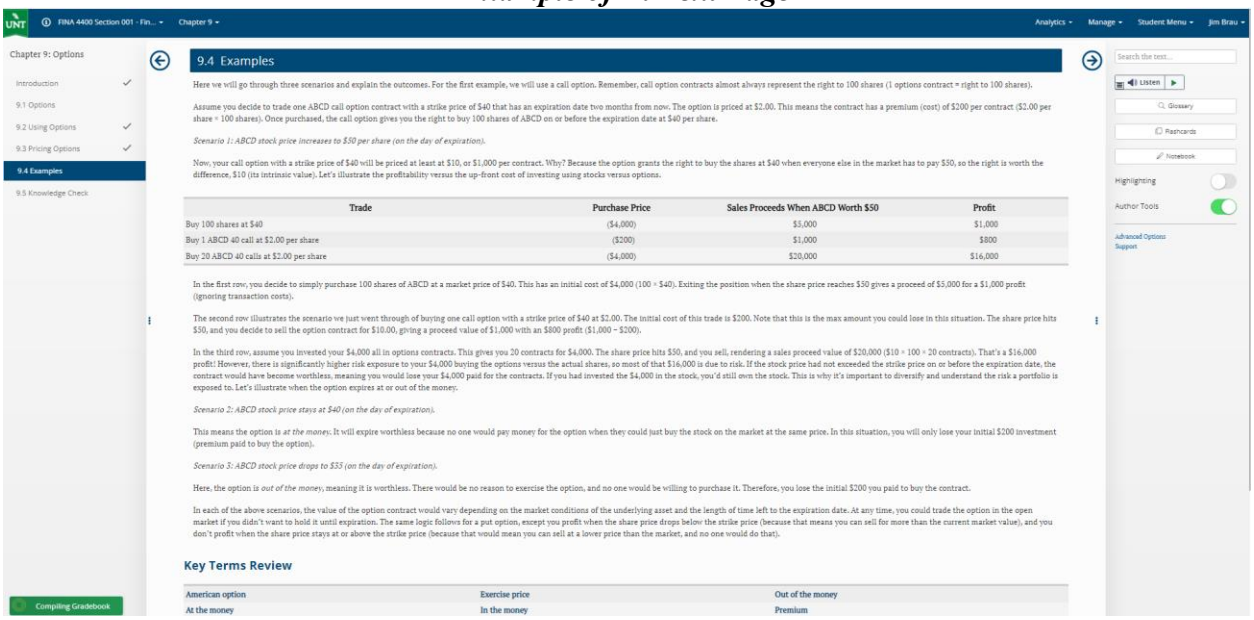
Figure 1

Textbook Front Page



The online material is specifically tailored to a financial markets class taught at the university level, primarily accessed online through a university's portal (e.g., Canvas) or directly through the publisher's in-house learning platform. Included with the digital lifetime access of the textbook, students may print a PDF version of the book and have access to an audio reading of the text material. Each chapter has a set of key terms defined by hovering the cursor over the word within the reading. Flashcards are also automated and integrated into the text. At the end of each chapter there are a series of questions that can be used as graded assignments or ungraded practice questions referred to as *knowledge checks*. The knowledge check questions have solutions provided that can be given as optional feedback to students upon completion. In addition, there are relevant examples provided throughout the text.

Figure 2
Example of In-Text Page



Assignments

Assignments for this pedagogical approach are designed to help students develop the ability to apply the material taught in the classroom to relative, constructive, and skill-building scenarios. In addition, the knowledge checks throughout the text are designed to help students solidify the concepts taught in lecture and the readings. Students are assumed to have no data analytics or regression analysis experience. Each exercise gives them a quick primer on how to understand and execute relevant applied data analytic assessments. The first set of hands-on learning assignments exploit the high demand of Microsoft Excel and spreadsheet skills in industry positions. Exercises estimating the relationship between bonds and macroeconomic variables such as inflation are key in providing students with applicable exposure to material covered in the class. Bond valuation and bond duration exercises are also included during the fixed income portion of the course. In addition, students are exposed to beta estimation via the Capital Asset Pricing Model (CAPM) using regression techniques. Such exercise can be implemented in Excel, Python, or another relevant data analytics program.

The purpose of Python integration with the course is to provide an opportunity for students to gain the necessary exposure that serves as a springboard to becoming proficient with Python programming (Brau, Brau, & Keith, 2020). With finance becoming more and more heavily reliant on data analysis, Python is a powerful tool that can assist students in their learning, understanding, and application of the material covered in the course. The method for teaching students Python who have no experience using the tool is simple and straight forward. Templates are prepared and shared with students. (The templates are available upon request from the authors.) Some suggested modules are as follows:

1. Introduction to Python
2. Pandas and NumPy Library Basics
3. Importing and Exporting Data
4. Summary Statistics and Reports
5. Linear Regressions/Multiple Linear Regressions
6. Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT)
7. Factor Models

Other optional modules provided are:

1. Random Variables
2. Confidence Intervals
3. Hypothesis Testing
4. Position Risk
5. Beta Hedging
6. Factor Risk Exposure
7. Text Scraping and Analysis

The purpose of each of the previously mentioned modules is to give students a primer in using Python for finance, import and export financial data, and perform both univariate analytics as well as regression analysis. Each module is motivated by industry recommendation and personal industry experience. Depending on instructor experience, other programming tools may be used to teach the modules.

An additional assignment, typically given as extra credit to help set the curve of the course and reward students who are willing to put in the work necessary to improve their grades outside of other assignments is offered throughout the semester. The additional assignment should be relevant to the course material and tie directly into the course objective. For example, for several years one of the authors has offered extra credit for students who read the book *A Random Walk Down Wall Stree*t by Malkiel and turn in a one-to-two-page summary for each chapter. The chapter summaries must be clear and concise excluding any form of superfluous language or content. A summary may cover the content of an entire chapter, or the summary may cover a specific topic or event from a chapter in more detail. Typically, each chapter is awarded one percentage point increase on an exam of the student's choice. The exercise is designed to give students practice writing in business, which can vary drastically from other areas of writing. In addition, the extra credit opportunity gives the professor a mechanism to keep students from begging for the next-highest grade. For example, a student who approaches a professor and says they were less than one point from the next letter grade is calmly asked by the professor if she or he took advantage of the extra credit. In our experience, virtually no students do all 15 chapters of the book. When the student indicates that they did not do the extra credit, then the professor kindly points out that they were so close to the next grade, if only they had done the extra credit. In our years of teaching this pedagogy and

using the extra credit approach, 100% of the students asking for grade increases have been satisfied with their assigned grade, once admitting they could have done the extra credit and earned the higher grade. In short, the extra credit mechanisms help students learn to take responsibility for themselves.

Student Surveys

In this section, we provide empirical and qualitative feedback from a questionnaire survey designed to measure the efficacy of the pedagogy and text, consistent with McWilliams & Pantalone (1994). Mean and median ratings are reported using a 5-point Likert scale, where 1 represents the worst rank and 5 represents the best rank. We recognize the limitations of the sampling process and that student perceptions impact these statistics (Krishnan, Bathala, Bhattarcharya, and Ritchey, 1999; Worthington, 2002) and include the results mostly as anecdotal information.

Quantitative Results

Students from two sections at an R1 University were polled on four questions regarding the pedagogy and text used for this pedagogical approach. Descriptive statistics of students who completed the survey are reported in Table 1. A total of 56 students responded to the survey, all of which are seniors or juniors in a finance or finance-related major. The 56 students represent a 70% response rate, a relatively high response rate for finance research (Brau & Fawcett, 2006). Approximately 54% of the students attended a morning section and 63% of all respondents were male. The four quantitative questions surveyed are:

1. Rate the overall usefulness of the textbook for this course.
2. Rate the overall ease of access of the textbook for this course.
3. Rate the readability of the textbook for this course.
4. Rate your preference of the textbook for this course relative to other textbooks you have used in the past.

Table 1 reports summary statistics for the student survey responses.

Table 1
Descriptive Statistics

Descriptive Statistics	
	Count
Total Students Responded to Survey	56
Number in Morning Section	30
Number in Afternoon Section	26
Number Male	35
Number Female	21

Ratings statistics for each question are presented in Table 2. The average overall *usefulness* rating is 4.54; the average ease of *access* of the textbook rating is 4.66; the overall *readability* of the textbook rating is 4.66, and the overall *preference* of the textbook rating is 4.55. Median scores for all four variables are 5.0. The means and medians indicate strong support for each category.

Table 2 reports the arithmetic mean, median, and standard deviation of student survey responses. Students rated the usefulness, ease of access, readability, and preference of the textbook relative to other courses using a 5-point scale where 1 is the lowest rating and 5 is the highest rating.

Table 2
Textbook Survey Analysis

Textbook Survey Analysis				
	Usefulness	Ease of Access	Readability	Preference
Mean	4.54	4.66	4.66	4.55
Median	5.00	5.00	5.00	5.00
StDev	0.69	0.58	0.55	0.74

Turning to frequency distributions, Table 3 reports that 64.3% of students feel the text is *very useful* with 25.0% marking *useful*, for a cumulative frequency of 89.3% judging the text to be in a useful category. Table 4 reports 71.4% marking *very easy* and another 23.2% indicating *easy* for the ease of use of the text, summing to 94.6%.

Table 3 reports the frequency distribution for the survey question, "Rate the overall usefulness of the textbook for this course."

Table 3
Frequency Distribution Usefulness Question

Usefulness			
Response	Frequency	Percent	Cumul %
Very Useful	36	64.3%	64.3%
Useful	14	25.0%	89.3%
Neutral	6	10.7%	100.0%
Not Useful	0	0.0%	100.0%
Very Not Useful	0	0.0%	100.0%

Table 4 reports the frequency distribution for the survey question, "Rate the overall ease of access of the textbook for this course."

Table 4
Frequency Distribution Ease of Access Question

Ease of Access			
Response	Frequency	Percent	Cumul %
Very Easy	40	71.4%	71.4%
Easy	13	23.2%	94.6%
Neutral	3	5.4%	100.0%
Hard	0	0.0%	100.0%
Very Hard	0	0.0%	100.0%

Table 5 has a cumulative rating of 96.4% for overall *readability* of the textbook, with 69.6% of students give the textbook a *very readable* rating and 26.8% giving the textbook a *readable* rating of 96.4%. Table 6 reports respondent assessment of the overall *preference* to the textbook used in the class versus other textbooks used in other classes. A total of 67.9% of respondents *highly prefer* the textbook used in the course over other textbooks used and *21.4%* report that they *prefer* this textbook to others. Taken together, 89.3% of students show preference to the textbook proposed and used within this paper to other textbooks used throughout their college careers. F-tests for each frequency distribution are statistically significant beyond the one percent level.

Table 5 reports the frequency distribution for the survey question, "Rate the readability of the textbook for this course."

Table 5
Frequency Distribution Readability Question

Readability			
Response	Frequency	Percent	Cumul %
Very Readable	39	69.6%	69.6%
Readable	15	26.8%	96.4%
Neutral	2	3.6%	100.0%
Not Readable	0	0.0%	100.0%
Very Not Readable	0	0.0%	100.0%

Table 6 reports the frequency distribution for the survey question, "Rate your preference of the textbook for this course relative to other textbooks you have used in the past."

Table 6
Frequency Distribution Preference Question

Preference			
Response	Frequency	Percent	Cumul %
Highly Preferred	38	67.9%	67.9%
Preferred	12	21.4%	89.3%
Neutral	5	8.9%	98.2%
Not Preferred	1	1.8%	100.0%
Highly Not Preferred	0	0.0%	100.0%

Next, we test for a section bias. In Table 7, we compare the morning and afternoon respondents and find no statistical difference in means for any of the questions, with the highest test statistic being 0.721. Next, we perform a statistical difference in mean test between male and female respondents. Results reported in Table 8 indicate that male and female respondent ratings are statistically indifferent from each other for each of the four questions presented in the survey.

Table 7 reports difference in means between morning and afternoon sections and their respective test statistic. Students rated the usefulness, ease of access, readability, and preference of the textbook relative to other courses using a 5-point scale where 1 is the lowest rating and 5 is the highest rating.

Table 7
Section Timing Statistics

Section Test Statistics				
	Usefulness	Ease of Access	Readability	Preference
Difference in Mean	0.067	0.085	-0.131	0.100
T-Stat	0.721	0.591	0.379	0.617

Our statistical tests provide helpful insight in the versatility of the pedagogy proposed in this paper. We document that respondents for both morning and afternoon classes, as well as both male and female respondents have no statistical difference in rating of the online resource or pedagogy structure.

Table 8 reports the difference in mean between genders and the respective test statistic. Students rated the usefulness, ease of access, readability, and preference of the textbook relative to other courses using a 5-point scale where 1 is the lowest rating and 5 is the highest rating.

Table 8
Gender Statistics

Gender Test Statistics				
	Usefulness	Ease of Access	Readability	Preference
Difference in Mean	0.095	0.067	0.067	-0.105
T-Stat	0.620	0.681	0.664	0.611

Qualitative Results

In addition to the quantitative survey questions, open-ended response questions were provided. Based on student responses, we identify four major factors that drive the proposed pedagogy: 1) Efficiency of Reading, 2) Ties to Lecture, 3) Real World Application, and 4) Practice Examples and Knowledge Checks.

Below we provide a series of student feedback and responses collected through the survey for each factor:

Factor: Efficiency of Reading

- The concise wording makes these topics seem simple.
- I believe that this is the best textbook I have ever utilized in college. It is absolutely perfect because of the conciseness. It is usually hard for me to follow the textbooks but this one is very straight forward.
- Short pages and to the point content. Much more readable than regular textbook, in terms of length and accessibility. Doesn't bore you.
- I like the conciseness of the book. Many other textbooks beat you over the head with information that you probably won't remember, and don't spend enough time on the information that you need to know. This textbook is straight to the point, includes relevant examples involving the formulas, and includes definitions that are easy to understand.
- I really like how this book is super concise when explaining topics. I can confidently say that I have no trouble reading through the entire chapters and understanding the content unlike other class textbooks where it's loads and loads of information that's hard to interpret in which I end up just skimming over.

Factor: Ties to Lecture

- I like how lectures are broken up. What I mean is that we don't spend the full hour and twenty minutes just straight-up lecturing, it is broken up by real-life examples as well as stories. It really helps to have these breaks from the lecture material because I've personally noticed it keeps me more engaged during the entire class when I'm not forced to sit and listen to a lecture for an hour and a half. Because of the breaks, I personally am more inclined to pay attention and as a result, I actually retain a lot more of this class material than I do in any other class, and it is definitely because of the breaks within the course of each lecture. I also like how you don't make us feel stupid for asking questions. I have social anxiety so it is not easy for me to ask questions in

class, but you make it feel like I can ask any question I have, no matter how basic the concept. I really appreciate that.
- The best thing I like about this class is that the professor essentially writes the notes with us. It makes concepts easier to digest.
- I appreciate the time is valuable attitude both from the professor and from the students where the class is focused on learning during the time set aside and doesn't take up too much extra time on other things.
- Lectures are not boring, in most of my pervious finance classes the teacher would literally read off a PowerPoint, so lectures felt pointless. I like how you engage with us, and it seems like you genuinely want us to learn the material.
- I like that you physically write out the notes with us in class. For me, this is a very good way for me to learn and stay engaged. It's easy to drift off if a professor just reads from a PowerPoint lecture and stalls out the block of time for the class.
- Writing the points together in class works extremely well. Also going on class related tangents while everyone finishes writing adds to the learning experience.

Factor: Real World Application

- The thing I like about this class the most is how we learn real world scenarios.
- The real world applications and examples given to show us what situations we may actually run into rather than a textbook example.
- I like that the information taught in class is related to real life examples. It is very helpful in comprehending the material and being able to apply it.
- My favorite thing about this class is how engaging it is. I really like how you connect the lecture content to real-life news and scenarios which helps make the learning experience more applicable and meaningful.

Factor: Practice Examples and Knowledge Checks

- I really like two things about the book. The first being that it is easily accessible through canvas, where all of our other work is as well. The second being the knowledge checks at the end of every chapter.
- Clear Examples and relative information extensions.
- I really like how it is to the point and straight forward. I also really like how it has problems that help the understanding of the topic in the books.
- The best thing is how concise the book is, it makes it easier to read and to study because you're not having to go through a ton of extraneous information and random "tips and tricks" and random questions thrown in the middle of what you're trying to read. The study questions are also good because it’s a variety of types of questions to prepare easier for tests.
- I love the amount of options represented in the book for different learning styles. For example there are options for flashcards, the book to read to you like an audiobook. The end of chapter quizzes help solidify the highlights of the chapter. It's also very concise with modern examples. Also very affordable.

Conclusion

This paper details a pedagogy and online learning resource for undergraduate courses on financial markets, institutions, and instruments. Extending extant literature as the foundation for the curriculum and textbook, we introduce a new approach for teaching the material. The online learning resource is written to be clear and concise, in a nontechnical tone. The pedagogy incorporates active-learning activities including various Excel exercises and Python exercises. The pedagogical structure teaches basic VBA and Python in the context of markets, institutions, and instruments. Student survey results provide quantitative insights of student evaluations, such as 96% reporting the text as clearly readable and 95% reporting ease of access of the course material. A series of open-ended questions results in four key factors of the pedagogy: 1) Efficiency of Reading, 2) Ties to Lecture, 3) Real World Application, and 4) Practice Examples and Knowledge Checks.

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Free Cash Flow Valuation: Pedagogical and Practical Implications[1]

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The focus of this paper is to present comprehensive free cash flow valuation for valuing an entire corporation and common equity based on the consolidated income and cash flow statements provided by publicly traded companies. After reviewing the standard textbook accounting, we present a more comprehensive approach examining Cisco, Berkshire Hathaway and IBM, and make available for download the accounting for 39 additional companies. Other uses of "free cash flow" calculated by corporations and third-party data providers are examined and compared to what we propose. These other measures have merit and are useful for certain applications, but are not appropriate when undertaking valuation.

Keywords: Free cash flow to the firm, free cash flow to equity, valuation

Introduction

In the 1980's firm valuation models based on free cash flow (FCF) began to be used in finance. Three decades later, corporate and equity valuation based on FCF has become widely adopted, both in the classroom and in practice. Here we focus on three parts of this analysis. First, we examine the typical FCF methods in "fundamentals of finance" and "valuation" textbooks. We find that students would not be able to undertake the comprehensive FCF calculations for valuing a company, as the actual calculations in practice are more complex. The main motivation for this paper is to provide a template and guidelines that students can use to calculate FCF in practice for valuation purposes.

Second, we consider the FCF calculations undertaken by corporations as part of the information provided to investors. The typical corporation is providing FCF information as a performance metric while we are focusing on valuation. In our sample, we find that there are no firms that calculate FCF according to what we propose in this paper. The third topic considered is FCF calculations undertaken by three internet-based financial data providers readily available to students. These calculations are useful in showing various aspects of available cash flow. However, these measures are not consistent with the comprehensive definition of FCF developed in this paper for valuation purposes.

The Review of Literature section examines the various textbook definitions and regulatory issues of free cash flow. In the third section we provide a review of the basic concepts and definitions related to "free cash flow to the firm" (FCFF) and "free cash to equity" (FCFE) and

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highlight the importance of these concepts for valuation. The fourth section examines the way that the typical textbook defines and calculates FCFF and FCFE. We then turn to examining the appropriate way in practice to define and calculate FCFF and FCFE for valuation purposes and undertake the calculation for 42 companies. Part six of the paper examines how various companies report "free cash flow", the different definitions these companies use, and how this compares to the calculations we propose in the fifth section of the paper. We then examine FCF reporting by other sources, including a brief review of the data of three popular finance web sites, and how this relates to the comprehensive methods we have presented. Finally, we provide a summary and conclusions.

Review of Literature

Free cash flow is defined in various ways depending on how this concept is being used. One of the first definitions was provided by Jensen (1986): "Free cash flow is cash flow in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital." Various definitions of FCF appear in textbooks, articles, company reports, vendor-supplied databases and finance web sites. Bhandari, Shvam B, and Adams M., (2017) find that there is no unanimity among them when applied to the financial data of a company. Many textbook authors have defined and presented a formula for FCF. Bhandari, et al (2017) lists a variety of definitions of textbook formulas for free cash flow. For example, Brealey, R., Myers, S. and Marcus, A., (2015) define FCF as cash available for distribution to investors after the firm pays for new investments or additions to working capital; their computation is simply cash flow from operations minus capital expenditures. Ross, S., Westerfield, R. and Jaffe, J. (2013) includes total cash flow or distributable cash flow and measures it as operating cash flow, earnings before interest and depreciation and less taxes, adjusted for capital spending and the change in net working capital. Brigham and Houston (2016) define FCF as the amount of cash that could be withdrawn without harming a firm's ability to operate and to produce future cash flows. We posit that if FCF is defined as cash available to be distributed to investors, all investments a firm undertakes must be included, not only capital expenditures.

From a regulatory standpoint, International Accounting Standard (IAS) 7 recommends that FCF should be recognized as cash from operations less the amount of capital expenditures required to maintain the firm's present productive capacity (Nunez 2014). Financial Accounting Standards Board (FASB) and the International Accounting Standards Board (IASB) both require companies to report Cash Flow from Operations (CFO) on the Statement of Cash Flows (SCF). While U.S. GAAP does not require firms to disclose FCF information, some firms voluntarily report and emphasize FCF in their financial statements. Some firms provide very detailed disclosures (including free cash flow definitions, quantitative free cash flow information, a reconciliation to GAAP measures, and explanatory discussion), while others provide more abbreviated disclosures (Adhikari, A., and Duru, A., 2006).

In November 1987, FASB issued FASB Statement No. 95, *Statement of Cash Flows*. Statement 95 was later codified in Topic 230, Statement of Cash Flows. Over time, FASB has received feedback from constituents indicating that there is diversity in practice regarding the application of Topic 230. The FASB and the IASB are concerned that requiring, or even encouraging, companies to report CFO per share may be construed by some that they are moving away from accrual-basis accounting toward cash-basis accounting (Maksy 2014).

At its April 1, 2015 meeting, FASB decided that clarifying certain existing principles within Topic 230 would only incrementally reduce diversity in practice about the classification of cash receipts and cash payments. Therefore, the Board decided to have the Emerging Issues Task Force (EITF) consider these cash flow issues with the goal of reducing the existing diversity in practice on a timely basis. Some guidance is provided by the International Accounting Standards Board (IASB) with International Accounting Standard (IAS) 7, which recommends that Free Cash Flow should be recognized as cash from operations less the amount of capital expenditures required to maintain the firm's present productive capacity (Nunez 2014). IAS 7 implies a capital maintenance approach; that is, capital expenditures should only represent those expenditures necessary to maintain the company's operational assets and expenditures beyond this amount should represent discretionary expenditures (Mills 2002).

Free Cash Flow Valuation

Our main focus is the calculation of FCF for the firm (FCFF) and FCF for equity (FCFE) for valuation purposes, so here we define these concepts within that framework. It is important to distinguish between FCFF and FCFE, as the former is used to value the entire corporation while the latter is relevant for valuing common equity. Definitions and uses of FCFF and FCFE for purposes other than valuation are discussed in the following sections.

For valuation models, FCFF is defined as the cash flow available for distribution to investors (of any type) after the firm has made all investments in working capital, net plant and equipment ("net capital expenditures"), acquisitions, direct investments in other companies and (in some cases) investments in publicly traded stocks.

By way of preview, the single most important point of our paper is that the common FCFF accounting includes only net capital expenditures while we incorporate other possible investments of a company. That is, FCFF is the cash from operations available for distribution to debt holders, common stockholders and preferred stockholders, or in the short run is invested in marketable securities (held as "cash"). By this definition, it is apparent that this is the relevant cash flow to be used in valuing the entire corporation. The generated FCFF can be used to (a) pay interest to debt holders and retire outstanding debt; (b) pay dividends to and buy back stock from preferred shareholders; (c) pay dividends to and buy back stock from common shareholders; and (d) invest in short-term marketable securities. However, FCFF is overestimated when one ignores capital expenditures made in a business acquisition and embraces only capital expenditures made in ordinary transactions (Ketz 2016).

In a similar manner, for valuation purposes FCFE is defined as the cash flow available for distribution to common shareholders after the firm has made all investments in working capital, net plant and equipment ("net capital expenditures"), acquisitions, direct investments in other companies and (in some cases) investments in publicly traded stocks. and payments to preferred stock and debt. The generated FCFE can be used to pay dividends to or buy back stock from common shareholders and invest in short-term marketable securities. Note that if a company undertakes net issuance of preferred stock or new debt, this is part of FCFE.

By the nature of the language, the two key parts of FCF are "free" and "cash flow". At first glance, this is straightforward. Cash is actual cash, i.e., noncash accounting aspects are ignored, and free must be cash not being used by the firm, so it is available for distribution to investors. The *uses* of free cash flow were outlined above. Calculating FCFF and FCFE from the financial statements focuses on the *sources* of free cash flow. In addition to the necessity of this focus for

calculation and valuation purposes, this perspective is central to three fundamental questions of the analyst:

1. What are a company's FCFF and FCFE?
2. What "adjustments" must be made to the reported accounting?
3. What are the key variables driving FCFF and FCFE?

In this paper we focus only on the first question. The second and third questions are typically part of the related topic of "financial statement analysis". We posit that once the correct FCFF and FCFE are calculated, the issues for questions two and three are the same as with traditional financial statement analysis.

Given that all items are in cash, by definition FCFF based on the *sources* is:

1c. FCFF = Sales revenue – operating costs – taxes – all corporate investments.
2c. FCFE = FCFF – payments to preferred stock and payments to debt.

From these straightforward definitions, we now turn to the typical FCF pedagogy found in textbooks.

Typical Textbook Free Cash Flow Valuation

As discussed above, the focus is to examine the *sources* of the FCFF, as an analyst wants to look at what a company is doing to generate FCFF. The idea is to take the existing calculations of the firm and do two things: adjust the numbers to get "true cash" and then subtract out from that number any of the cash that is not free. Typical calculations for FCFF is along the following lines:

Table 1
Textbook Components of FCFF

NI	Net Income
CFO	Cash flow from operations[2]
NCC	Net noncash charges[3]
DEP	Depreciation
AMT	Amortization
I	Interest
T	Tax rate
FCI	Fixed capital investment
WCI	Working capital investment[4]
AR	Accounts receivable
Inv	Inventories
AP	Accounts payable
ACC	Accruals
NB	Net borrowing[5]

3c. Using NI as the starting point: FCFF = NI + NCC + I(1 - T) - FCI - WCI.

[2] NI + NCC - WCI
[3] DEP + AMT
[4] ΔAR + Δ Inv + ΔAP + ΔACC
[5] New *net* debt plus *net* new preferred stock and change in notes payable plus change in long-term debt (and any cash flow in the rare case where new preferred stock is issued or repurchased).

4c. Using NI as the starting point: FCFE = NI + NCC - FCI - WCI + NB.

An example of basic financial statements in a typical textbook which is used for the following calculations is Figure 1.

Figure 1
Basic Financial Statements
(in $ millions)

Balance Sheet

Assets	12/31/2014	12/31/2015
Current Assets		
Cash and equivalents	$190	$220
Accounts receivable	560	620
Inventory	410	410
Total Current Assets	1160	1250
Gross fixed assets	2200	2600
Accumulated depreciation	(900)	(1180)
Net fixed asset	1300	1420
Intangible assets	200	200
Accumulated Amortization	(50)	(120)
Net intangible assets	150	80
Total Assets	$2,610	$2,750
Liabilities and Shareholders Equity		
Current Liabilities		
Accounts payable	$285	$300
Notes payable	200	250
Accrued taxes and expenses	140	150
Total current liabilities	625	700
Long-term debt	865	890
Common stock	100	100
Additional paid-in capital	200	200
Retained earnings	820	860
Total Liabilities and equity	$2,610	$2,750

Income Statement

Year-end December 31	**2015**
Total Revenues	$3,000
Operating costs and expenses	2200
EBITDA	800
Depreciation	(280)
Amortization	(70)
Operating income (EBIT)	450
Interest expense	(100)

Income before tax	350
Taxes (at 40 percent)	140
Net income	210
Dividends	170
Change in retained earnings	40

Statement of Cash Flows	
Year-end December 31	**2015**
Operating activities	
Net income	$210
Adjustments	
Depreciation	280
Amortization	70
Changes in working capital	
Accounts receivable	(60)
Inventories	0
Accounts payable	15
Accrued taxes and expenses	10
Cash flow from operations	$525
Investing activities	
Purchases of fixed assets	400
Cash used for investing activities	$400
Financing activities	
Notes payable	50
Long-term financing issuances	25
Common stock dividends	(170)
Cash used for financing activities	(95)
Cash and equivalents increase (decrease)	30
Cash and equivalents at start of year	190
Cash and equivalents at end of year	$220
Supplemental cash flow disclosures	
Interest paid	$100
Income taxes paid	$140

There are a number of points to note. The change in each of the four components of WCI on the balance sheet are exactly the same numbers shown on the cash flow statement. The only components of NCC are depreciation and amortization. We will see that in practice there are other noncash adjustments reported on the cash flow statement that must be incorporated. The only investments that the firm undertakes are in fixed capital investment and working capital investment. In practice, firms undertake many other investments than those included in FCI and WCI. FCI is exactly the same as the change in gross fixed assets shown on the BS.

Now we undertake the standard textbook FCFF and FCFE calculations.

NI = 210
DEP = 280
AMT = 70
NCC = 280 + 70 = 350
I = 100
T = 40%
FCI = 400
WCI = ΔAR + ΔInv + ΔAP + ΔACC = -60 + 0 + 15 + 10 = -35
NB = 50 + 25 = 75
FCFF = NI + NCC + I(1 - T) - FCI – WCI = 210 + 350 + 100(1 - .40) – 400 – 35 = 185
FCFE = NI + NCC - FCI - WCI + NB =
210 + 350 - 100(1 - .4) + 75 = 20
WCI = ΔAR + ΔInv + ΔAP + ΔACC = -60 + 0 + 15 + 10 = -35
NB = 50 + 25 = 75

Comprehensive Free Cash Flow Valuation in Practice

We now take the typical textbook calculations and examine how it relates to the actual consolidated financial statements. The focus is on the cash flow statement, which in practice is much more comprehensive than in valuation textbooks. We find a number of important issues and required modifications to arrive at a correct measurement of FCFF and FCFE for valuation purposes. It is important to once again emphasize that we are examining the *sources* of FCF, and most of the relevant numbers are in the cash flow statement. We also require two items, interest payments and taxes, from the income statement.

There are four items to point out before undertaking the FCF calculations. First, the depreciation expense reported on the cash flow statement is different than that reported on the balance sheet. In addition, the changes in assets and liabilities on the balance sheet are different than those reported on the cash flow statement. There are two main reasons for these differences.

First, in an acquisition, the current assets and current liabilities of the acquired firm are included on the balance sheet, but the (acquiring) firm may regard some of these as investments and therefore not include these as adjustments to get cash flow from operations. Also, currency translations of foreign subsidiaries often result in differences between balance sheet items and those shown on the cash flow statement. This is due to the all-current translation methodology for the balance sheet where the foreign exchange rate changes at the end of each period.

Second, on the cash flow statement, we observe that the complete NCC is “adjustments to reconcile net income to net cash provided by operating activities” and includes many other items besides depreciation and amortization. These adjustments must be included. All the elements of the complete NCC are reported on the consolidated statement of cash flows, so students (and analysts) simply need to incorporate what is reported.

Third, what is called WCI in standard textbook accounting is replaced by a broader category, “the change in operating assets and liabilities”, that includes the four components of WCI as well as other items. Students will see the relevant items that the firm has reported on the statement of cash flows.

Fourth, firms undertake many other investments than those included in WCI and FCI. Disposition of fixed assets (i.e., sales of assets from previous FCI), acquisitions and divestitures, partial-ownership investments in other businesses and sales of partial-ownership in other businesses, and any transactions involving publicly traded stock of other companies must be included.

When we look at a firm in practice, most of the relevant information is in the cash flow statement. We do not need to use the balance sheet but do require two items, interest and taxes, from the income statement. In some cases, other parts of a firm's annual report must be examined. The key issue is incorporating all the investments undertaken by a company.

When we include all the possible investments a firm might undertake, as well as receipts from sales of past investments, for valuation purposes the comprehensive calculations for FCFF:

5c. FCFF = Net income + Noncash adjustments to net income + Interest(1 – T) + Change in operating assets and liabilities – (Investment in property and equipment – Sales of property and equipment) – (Acquisitions – Divestitures) – (Investments in other businesses – Sales of other businesses) – (Purchase of public equities – Sales of public equities) + Other.

All entries after the noncash charges are components of total net investment of *all types,* including net FCI, i.e., capital expenditures.

Comprehensive FCFE is found by:

6c. FCFE = Net income + Noncash adjustments to net income + Change in operating assets and liabilities – (Investment in property and equipment – Sales of property and equipment) – (Acquisitions – Divestitures) – (Investments in other businesses – Sales of other businesses) – (Purchase of public equities – Sales of public equities) + Other + Net borrowing.

All firms will undertake FCI in a given period, but the other types of fixed investments, i.e. the last four items in (5), will vary from firm to firm. As will be discussed, other items will turn up on the cash flow statement on a case-by-case basis and the analyst must determine how these relate to "free" cash flow and make sure to include any unusual items only if they relate to the *sources* of FCF. Various examples are shown when accounting for the 42 firms is examined.

In the general case, complete FCFF calculation involves the accounts listed in Table 2.

Table 2
Complete Components of FCFF

NI	Net income
I	Interest
T	Tax rate (taxes/income before taxes)
CFO	Cash flow from operations[6]
NCA	Noncash adjustments[7]
OAL	Changes in operating assets and liabilities
FAI	Fixed property and equipment investments
FAS	Fixed property and equipment sales
NFAI	Net fixed property and equipment investment[8]
ACQ	Acquisitions
DIV	Divestitures
NAD	Net acquisitions[9]
PCI	Private company investments in other businesses
PCS	Private company sales of other businesses
NIPC	Net investment in private companies[10]
PEI	Public equity investments
PES	Public equity sales
NIPE	Net investment in public equity[11]
NB	Net borrowing

First, NCC used in typical textbook accounting includes only DEP and AMT. Here in place of NCC we use "adjustments to reconcile net income to net cash provided by operating activities" which, by definition, are all the noncash adjustments reported by the firm (NCA). This includes DEP and AMT for every firm, and various other entries that vary from firm to firm.

Second, there is no exact list of what enters OAL in addition to the four standard components of WCI. However, every entry in OAL must be included as the firm is using these to calculate CFO. The OAL reporting enters cash increases as a positive number and cash decreases as a negative number. We calculate OAL from the entries on the cash flow statement and enter the actual values, which can be positive or negative. If OAL is positive, this indicates the firm has more cash on hand, while a negative value indicates less cash on hand. Therefore, in the FCF calculation below, OAL is added in the calculations that start with NI.

Third, FCI as used in the third section of the paper is only "capital expenditures" (CapEx). Any receipts from the sale of fixed assets (FAS) must be included to get NFAI. Most textbooks are not clear if FAI or NFAI is being reported, as there is no discussion of asset sales and net expenditures. We include the receipts from FAS as this is a source of cash for the firm. The three information providers we examine include only FAI in their FCF calculations.

[6] NI + NCA + OAL
[7] Adjustments to reconcile net income to net cash provided by operating activities.
[8] FAI - FAS
[9] ACQ – DIV
[10] PCI - PCS
[11] PEI - PES

Fourth, calculating FCFF and FCFE must also include net acquisition expenditures (NAD), net investment expenditures in equity in privately held companies (NIPC) and net investment expenditures in public equity (NIPE). In other words, all net investment undertaken by the firm must be included: in the firm itself, buying other companies, and investing in other private and public companies. One of the main points of this paper is to include investments in assets other than FCI in calculating cash flow that is indeed free to investors.

In the complete case, we now have the following:

7c. FCFF = NI + NCA + I(1 - T) + OAL - NFAI - NAD - NIPC - NIPE.
8c. FCFE = NI + NCA + OAL - NFAI - NAD - NIPC - NIPE + NB.

Here we present the FCFF and FCFE calculations for Cisco, Berkshire Hathaway and IBM. We have also made calculations for 39 diverse group of companies to show that our FCFF and FCFE calculations are not restricted to any one industry. (Please contact the authors for the 39 company zip file) These calculations can be implemented with a wide variety of industries.

Table 3
Companies Sorted by SIC

SIC Code	Companies	SIC Code	Companies
0762	Monsanto	5149	Coca-Cola
2099	Kraft Foods Group; PepsiCo.	5172	Kinder Morgan
2834	Johnson & Johnson	5251	Home Depot
2899	Merck	5311	Walmart
3089	International Paper; Kimberly Clark	5441	Hershey
3312	U.S. Steel	5571	Harley Davidson
3572	San Disk Corp.	5734	Hewlett Packard; IBM
3674	Intel	5812	McDonald's
3714	General Motors	5912	Pfizer
3721	Boeing	6411	CVS
3841	Boston Scientific Corporation	6719	Berkshire Hathaway; Deere & Co.
3999	Procter & Gamble	7371	Adobe; Lam Research Corp.
4213	FedEx	7372	Apple; Cisco Systems
5063	Linear Technology Corp.	7374	Amazon; Seagate
5064	Whirlpool Corporation	8099	Abbott Labs
5082	Caterpillar Financial Services	8711	Honeywell International Inc.
5099	Texas Instruments	8741	Lilly (Eli) and Company
5141	General Mills; Hormel Foods		

We first examine Cisco. From the Cisco financial statements we obtain the following information.

Table 4
Cisco's Components of FCFF and FCFE

NI	7,853
I	564
T	.1917[12]
NCA	2,764[13]
OAL	1,715[14]
CFO	12,332[15]
FAI	1,275
FAS	232
NFAI	1,043[16]
ACQ	2,989
DIV	0
NAD	2,989
PCI	384
PCS	213
NIPC	171[17]
PEI	0
PES	0
NIPE	0
NB	4,723[18]

There are three items that require additional explanation. First, Purchases of investments, Proceeds from sales of investments and Proceeds from maturities of investments are not relevant here, as these are marketable securities. These three items are *uses* of free cash flow, while we are calculating the *sources*.

Second, in Cisco's 2014 Annual Report, we find a discussion of the company's holding of public equities and related data such as cost and realized/unrealized gains and losses. However, information is not provided on the purchase and sale of public equities in the fiscal year, presumably because these amounts are not material. Therefore, we are unable to include this component (NIPE) in the FCF calculations. Third, we include the "Other" cash flow from investing activities of 24 in the calculations.

[12] T = 1,862/9,715 = .1917
[13] NCA = 2,432 + 1,348 + 79 – 678 – 118 – 299 = 2,764
[14] OAL = 340 - 109 – 119 + 33 – 23 + 191 – 42 + 659 + 785 = 1,715
[15] CFO = 7,853 + 2,764 + 1,715 = 12,332
[16] NFAI = 1,275 – 232 = 1,043
[17] NIPC = 384 – 213 = 171
[18] NB = Net borrowing = Issuance of debt + Short-term borrowings - Repayments of debt = 4,723

Now we can calculate FCFF and FCFE using equations (7) and (8).

7c. FCFF = 7,853 + 2,764 + 564(1 - .1917) + 1,688 - 1,043 - 2,989 – 171 - 0 + 24 = 8,582.

8c. FCFE = 7,853 + 2,764 + 1,688 - 1,043 - 2,989 - 171 - 0 + 24 + 4,723 = 12,849.

Next let's examine Berkshire Hathaway. From the Berkshire financial statements, we get the following data.

Table 5
Berkshire Hathaway's Components of FCFF and FCFE

NI	20,170
I	456
T	.2823[19]
NCA	3,454[20]
OAL	8,386[21]
CFO	32,010[22]
FAI	15,185
FAS	0
NFAI	15,185[23]
ACQ	7,824[24]
DIV	0
NAD	7,824
PCI	0
PCS	0
NIPC	0
PEI	7,014
PES	8,896
NIPE	(1,882)[25]
PLFR	181
CLFR	885
NB	3,996[26]

There are three things to note. First, as is well known, Berkshire has significant holdings equity of other publicly traded companies, hence NIPE is an important item. The negative value of NIPE indicates receipt of cash from net sales of public equities in 2014. Second, the cash flow statements include the investing activities "purchases of loans and financial receivables" (PLFR) and "collections of loans and financial receivables" (CLFR). The Berkshire Annual Report (page 65) identifies these items as: "Loans and finance receivables are predominantly installment loans

[19] T = 7,935/28,105 = .2823
[20] NCA = -3,575 + 7,370 – 341 = 3,454
[21] OAL = 7,404 – 3,413 + 1,159 – 1,890 – 520 + 4,905 + 741 = 8,386
[22] CFO = 20,170 + 3,454 + 8,386 = 32,010
[23] NFAI = 1,275 – 0 = 15,185
[24] ACQ = 3,000 + 4,824 = 7,824
[25] NIPE = 7,014 – 8,896 = -1,882
[26] NB = 845 + 5,765 + 1,148 + 932 – 1,289 – 1,862 – 1,543 = 3,996

originated or acquired by our manufactured housing business." In our view, this represents regular investments undertaken by Berkshire to support some of their business units and must be incorporated in the FCF calculation. In 2014 there was a net of 885 – 181 = 704 of cash that came in from this category, so 704 is added in the FCF calculations. Third, we include the "Other" cash flow from investing activities of 336 in the calculations.

Now we can calculate FCFF and FCFE using equations (7) and (8).

7b. FCFF = 20,170 + 3,454 + 456(1 - .2823) + 8,386 – 15,185 – 7,824 – 0 – (-1,882) + 336 + 704 = 12,250.

8b. FCFE = 20,170 + 3,454 + 8,386 – 15,185 – 7,824 - 0 – (-1,882) + 336 + 704 + 3,996 = 15,919.

Finally, we examine IBM. Table 6 has the relevant accounting components from the IBM financial statements.

Table 6
IBM's Components of FCFF and FCFE

NI	13,190
I	468
T	.1619[27]
NCA	6,262[28]
OAL	(2,444)[29]
CFO	17,008[30]
FAI	4,151[31]
FAS	370
NFAI	3,781[32]
ACQ	3,349
DIV	(401)
NAD	3,750[33]
PCI	0
PCS	0
NIPC	0
PEI	0
PES	0
NIPE	0
NOFR	398
NB	19[34]

[27] T = 2,581/15,945 = .1619
[28] NCA = 2,662 + 1,193 + 468 + 1,387 + 481 + 71 = 6,262
[29] OAL = 812 – 22 + 133 – 3,448 + 81 = -2,444
[30] CFO = 13,190 + 6,262 + (-2,444) = 17,008
[31] FAI = 3,579 + 572 = 4,151
[32] NFAI = 4,151 – 370 = 3,781
[33] NAD = 3,349 – (-401) = 3,750
[34] NB = 5,540 – 5,622 + 101 = 19

There are four things to note. First, investment in software, an internal IBM investment, is grouped with investment in plant and equipment. Second, the cash flow statement includes "Non-operating financial receivables—net" (NOFR) in the cash flows from investing activities section. IBM argues that "management considers Global Financing receivables as a "profit-generating investment", so this is counted as an investing activity of 398 in the cash flow statement. Accordingly, we include this as an investment in the FCF calculation. Third, divestiture of businesses usually involves a cash inflow, but in 2015 it is a cash outflow.

We now can calculate FCFF and FCFE using equations (7) and (8).

7i. FCFF = 13,190 + 6,262 + 468(1 - .1619) + (-2,444) – 3,781 – 3,750 – 0 – 0 - 398 = 9,471.
8i. FCFE = 13,190 + 6,262 + (-2,444) – 3,781 – 3,750 - 0 – 0 - 398 + 19 = 9,098.

We have chosen IBM, Cisco and Berkshire Hathaway to illustrate differences among companies related to investments undertaken that are not WCI and FCI. The accounting for these three companies is summarized in Table 7. We have identified four main areas where FCFF and FCFE calculations in practice differ from that in textbooks. First, there are various noncash adjustments to net income in addition to depreciation and amortization. Second, what is typically called WCI is a broader category, "changes in operating assets and liabilities" which is reported on the cash flow statement. Third, all of the forty-two firms that we have examined undertook investments in their own fixed capital (NFAI) as would be expected. Regarding the three other types of investment "complexities" not covered in typical textbook accounting: acquisitions and divestitures of other companies (NAD), equity investments in other private companies (NIPC), and acquisitions, and investments in publicly traded stocks (NIPE), thirty-five of the firms had NAD in 2013. Sixteen firms had NIPC in 2013, and only one, Berkshire Hathaway, had NIPE. Fourth, as seen with Berkshire and IBM, special items related to the sources of FCF are often reported on the cash flow statement and must be incorporated in the calculations. Special items will be company-specific, and how to address these requires an analyst, based on our analysis of the three companies here and the additional thirty-nine in the downloadable file, to carefully examine the cash flow statement and the related notes and discussion in the annual report.

Table 7
Cisco, Berkshire Hathaway, and IBM Summary

Company	Cisco	Berkshire Hathaway	IBM
NI	7,853	20,170	13,190
I	564	456	468
T	.1917	.2823	.1619
NCA	2,764	3,454	6,262
OAL	1,715	8,386	(2,444)
CFO	12,332	32,010	17,008
FAI	1,275	15,185	4,151
FAS	232	0	370
NFAI	1,043	15,185	3,781
ACQ	2,989	7,824	3,349
DIV	0	0	(401)
NAD	2,989	7,824	3,750
PCI	384	0	0
PCS	213	0	0

NIPC	171	0	0
PEI	0	7,014	0
PES	0	8,896	0
NIPE	0	(1,882)	0
PLFR	0	181	0
CLFR	0	885	0
NOFR	0	0	398
NIN	0	704	0
NB	4,723	3,996	19

Free Cash Flow as Reported by Firms

Out of our sample of 42 companies, 14 include "free cash flow" in their annual report. Amazon, Cisco, Gap, Oracle, Proctor and Gamble, Texas Instruments, Walmart and Whole Foods calculate FCF as CFO – FAI. Note that this does not correspond to FCFF or FCFE as interest payments to debt holders have already been subtracted in calculating CFO from NI. In addition, other uses of cash flow besides FAI are not considered.

Let's focus on Cisco as an example.
From the Cisco 2014 Annual Report, pages 60-61:

> "*As part of our capital allocation strategy, we intend to return a minimum of 50% of our free cash flow annually to our shareholders through cash dividends and repurchases of common stock.*
>
> *We define free cash flow as net cash provided by operating activities less cash used to acquire property and equipment. The following table reconciles our net cash provided by operating activities to free cash flow (in millions):*

Years Ended	**26-Jul-14**	**27-Jul-13**	**28-Jul-12**
Net cash provided by operating activities	$12,332.00	$12,894.00	$11,491.00
Acquisition of property and equipment	-$1,275.00	-$1,160.00	-$1,126.00
Free cash flow	$11,057.00	$11,734.00	$10,365.00

> *We consider free cash flow to be a liquidity measure that provides useful information to management and investors because of our intent to return a stated percentage of free cash flow to shareholders in the form of dividends and stock repurchases. We further regard free cash flow as a useful measure because it reflects cash that can be used to, among other things, invest in our business, make strategic acquisitions, repurchase common stock, and pay dividends on our common stock, after deducting capital investments. A limitation of the utility of free cash flow as a measure of financial performance and liquidity is that the free cash flow does not represent the total increase or decrease in our cash balance for the period. In addition, we have other required uses of cash, including repaying the principal of our outstanding balances. Free cash flow is not a measure calculated in accordance with U.S. Generally Accepted Accounting Principles and should not be regarded in isolation or as an alternative for net income provided by operating activities or any*

other measure calculated in accordance with such principles, and other companies may calculate free cash flow in a different manner than we do."

The explanation of Cisco's FCF is clear. As it spells out exactly what the firm can do with its FCF, this additional information voluntarily provided by Cisco is useful for analysts and investors. However, Cisco's calculation is not FCFF or FCFE for valuation purposes. As the starting point is CFO, after-tax interest payments have been subtracted in calculating NI, so the calculated free cash flow is a "version of FCFE" as distributions to debt holders in the form of interest have already been paid. In addition, the only investment considered is gross capital expenditures (FAI), i.e. net acquisitions and net business investment is ignored. In other words, the calculation ignores FAS (hence NFAI), NAD and NIPC.

In sum, we have not found a company that reports FCF that calculates FCFF or FCFE using the complete method we have presented. We are not arguing that the data provided by these firms is "incorrect", as they are choosing to undertake certain calculations to provide an additional performance metric. We believe that this additional information is valuable for investors and analysts.

Free Cash Flow as Reported by Other Sources

In our experience, it is common for students to turn to free-of-charge internet-based financial data service providers to obtain information about companies. Here we examine FCF as reported by marketwatch, ycharts, and gurufocus. All three calculate "free cash flow" as FCF = CFO – FAI, so the focus is neither FCFF nor FCFE as we have defined in this paper. These service providers, as many of the companies reported in the previous section, include only gross capital expenditures as "investments", i.e., they ignore receipts (cash inflows) from the disposition of plant and equipment. Net acquisitions, net business investments and net investments in public equities are not considered. In addition, special items (as with Berkshire and IBM) are not considered. Presumably, these three service providers are doing this for three reasons. First, as discussed previously, they are relying on the standard textbook calculations. Second, they may simply be using the International Accounting Standard (IAS) 7 recommendation. Third, and probably most importantly, for practical purposes they want to have an automated program to calculate FCF in a manner that does not require a detailed look at the thousands of firms in their database. It is much easier for these providers to apply the same formula using two items, CFO and FAI, that are reported by all companies.

The reporting by ycharts is especially noteworthy. As indicated above, this service calculates FCF as:

$$FCF = CFO - FAI.$$

Ycharts provides the following definition: "*Free cash flow is the amount of cash generated by a business that is available for distribution among its security holders. Security holders include debt holders, equity holders, preferred stockholders, and convertible security holders. Specifically, free cash flow is used to pay dividends, make acquisitions, develop new products, invest in new property, plant, and equipment, pay interest expenses, and reduce debt."* The first two sentences of this definition require that all net investment (not just FAI) is subtracted from CFO in order to identify what is left for distribution to security holders. In addition, the ycharts definition is contradictory, as the amount "available for distribution to security holders" is not equal to the amount "used to pay dividends, make acquisitions, develop new products, invest in new property,

plant and equipment, pay interest expenses, and reduce debt." If a company uses cash to make acquisitions, develop new products and invest in new property plant and equipment, then this cash is not available for distribution to investors. Finally, the third sentence of the definition makes no mention of preferred and common stock repurchases. In sum, the definition of FCF by ycharts is clearly not FCF as used for valuation purposes, but rather is cash that is "free" after operations to be used by management and the board of directors at their discretion. The key takeaway is to be careful about using statistics from internet-based financial data providers as there may not be consistency regarding terminology and definitions.

Summary and Conclusions

Our focus is to fill a gap between the FCF calculations provided by textbooks and the comprehensive free cash flow calculations for valuation purposes. The single most important point is that we include all the business investments a firm undertakes, whereas every other source includes only some of a firm's investments, usually subtracting out only gross capital expenditures. Our comprehensive calculation is completely consistent with the definition provided by Jensen (1986), as all business investment expenditures on "projects" must be incorporated. Based upon the three companies examined here and the thirty-nine available on-line, we provide a comprehensive template for students (and analysts) to undertake practical FCF calculations using a company's consolidated financial statements.

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Comparing Accounting and Finance Journal Quality Metrics

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This paper compares four journal ranking metrics, namely the Australian Business Deans Council (ABDC) journal quality list, Cabells' Classification Index, Journal Impact Factor, and CiteScore, commonly used by the business school community. Using multiple statistical analyses, such as distribution box plots, correlation analysis and mean-comparison t-tests, of a sample of 138 ABDC journals in the field of accounting and finance, our results show that there is a significant correlation between Cabell Classification Index, the Journal Impact Factor or CiteScore and the benchmark ranking, the ABDC rating. We find fewer differences between the ABDC benchmark journal ranking and the Cabells' Classification Index when the cutoff is 31% versus 50%. The Journal Impact Factor and CiteScore, however, are more similar to the benchmark ranking. Given the inconsistency in journal ranking metrics, business schools and departments are recommended not to rely on a single ranking measure for assessing faculty publication quality.

Keywords: journal quality metrics, ABDC, Cabell, accounting, finance

Introduction

This paper provides empirical evidence of commonly used journal ranking metrics for accounting and finance journals. For many tenure-track faculty, assessing the quality of academic journal publications is vital in making promotion decisions, evaluating the quality of intellectual contributions, and submitting research for publication. It is common practice to assign more points for research published in higher-ranked journals relative to lower-ranked journals. Therefore, assessing the quality of academic journals is very important to both university administration and individual faculty. Colleges use different classification schemes to rank and indicate journal quality. For example, one metric uses expert rating to indicate journal quality, while another scheme uses a metric to represent the number of citations (usually from 0 to 12), and yet another uses a percentile ranking with a complex index. A natural question is whether we consistently evaluate the intellectual contribution of research papers using these different classification metrics.

We use the 2018 Australian Business Deans Council (ABDC) Journal Quality List as the benchmark to provide empirical evidence of equivalent ranges of accounting and finance journal quality metrics. Many educational institutions around the globe use the ABDC Journal Quality List as their standard for journal quality. We compare ABDC to Cabells' Classification Index, Clarivate Analytics' (formerly Thomson Reuters) Journal Impact Factor, and Elsevier's CiteScore to assess the different classification schemes to rank various accounting and finance journals. ABDC ranks journals based upon an A*, A, B, and C classification scheme; A* being the best. Cabells' Classification Index (CCI) uses a percentile to determine the influence of a journal; the higher the CCI, the higher the quality journal. The Journal Impact factor (JIF) measures the importance of a journal by calculating the times its articles are cited; that is, the higher the impact factor, the more highly ranked the journal. Elsevier's CiteScore metric reflects the yearly average number of citations to recent articles published in that journal. The higher CiteScore, the more impressive the journal. The objective of this study is to determine the equivalent journal ranking metrics for the different commonly applied metrics used to evaluate Accounting and Finance (A&F) faculty publication quality.

A concern common to surveys and studies of accounting journals is that only about one-third of the accounting journals in Cabells appear in journal quality ratings (Bean & Barnardi 2005). Alexander, Scherer and Lecoutre (2010) find a low degree of agreement across business journal ranking systems from 6 countries. Additionally, papers in various journals are assigned different weights in tenure evaluation based on the quality of the journals (Reinstein & Calderon, 2006). Our results may make it easier for administration and faculty to evaluate those other A&F journals listed in Cabells, but which do not appear in ABDC journal quality ratings. We attempt to reach consensus across multiple A&F journal ranking systems.

We present the literature review and hypotheses development in the next section. This is followed by the methodology and data analysis, discussion of results, and the conclusion, respectively.

Literature Review of Journal Ranking Metrics

Ranking of peer-reviewed journals has been widely used as a proxy for judging the impact and quality of faculty research, which is a critical indicator of faculty performance that is at high stake with recruitment, promotion, and tenure decisions as well as allocation of teaching loads and research funding (Beattie & Goodacre 2006). There are several approaches to academic journal ranking: 1) the stated preference rankings approach (also termed survey-based, perception, peer-reviewed, expert, or opinion-based studies), for example, the Australian Business Dean Council (ABDC) journal ranking; 2) the revealed preference rankings approach (or citation-based), for example, the Cabells' Almetric Journal list; 3) the market-based ranking approach; and 4) the download frequency-based ranking approach (Moosa, 2011). In this research, we will focus on the first two approaches, using Accounting and Finance journals as an example.

Journal Impact Factor

The citation-based approach, often using the impact factor (IF), was long the most widely applied measure of journal quality. The IF, published annually in the Journal Citation Report (JCR) of Thomson Reuters, was developed in the 1960s by Eugene Garfield and Irving Sher (Garfield, 2006). It is a measure of the frequency with which the journal article is cited in a particular year.

Different disciplines have very varied scales for journal impact factor analysis. Journals must apply for inclusion in the JCR database; there are some, but not a lot of good journals that have not done so. Therefore, the JCR database is the most selective, but also the narrowest. A commonly cited critique of rating systems relying solely on citations is that they discriminate against academic niches, and generalists over specialists. It is not common for top journals in very small niches to be excluded from the JCR listing. The calculation is based on a two-year period and involves dividing the number of times articles were cited by the number of articles that are citable. For example, Impact Factor in 2010=A/B (A = the number of times articles published in 2008 and 2009 were cited by indexed journals during 2010; B = the total number of "citable items" published in 2008 and 2009.)

CiteScore

Similarly, CiteScore is an average of the sum of citations received in a given year to publications published in the previous three years divided by the sum of publications in the same previous three years. CitesScores are also provided by a rolling average of citations but over four years. However, CiteScores use a larger but less selective data base than Journal Citation Reports (and the accompanying impact factors). CiteScores are generally similar or somewhat higher than impact factors. While CiteScores are not as prominently used as impact factors as a designation of journal quality, Scopus generates a four-quadrant list of journals that is frequently used as a quick way to categorize journals.

Cabell's Almetric Journal

The Cabells' list has over 11,000 journals. Cabells' Scholarly Analytics includes the impact factor from Journal Citation Reports, the Almetric score, and its own (Cabells') classification index (CCI). The CCI is citation-based, using Scopus as its data source where available to measure influence and quality in a subject area. A journal can have multiple CCIs if it encompasses multiple disciplines or multiple topics in the disciplines. The CCI is calculated using the average citation rate across three years and standardized in a discipline or topic. Because journals must achieve a certain threshold for citation activity to be included in the underlying citation database, any journal ranked by the CCI is considered to exhibit a relatively high level of influence, such as high (1-80%), significant (81-90%), and premier (91-100%). Journals with insufficient citation activity to be included in the citation database are marked as either "Qualified" or "Novice," depending on how long they have been publishing (see https://www2.cabells.com/metrics).

Australian Business Dean Council (ABDC) Journal Ranking

The ABDC, with a journal list of less than 3000, is constantly changing its review methodology. Every time they create a new list, they modify and use feedback from their last compiled list. Australian and international experts are appointed to review the methodology for the ABDC Journal Quality List. Their Journal quality ratings are validated by expert panels, informed by globally recognized and externally validated journal ranking lists, appropriate and select citation metrics (e.g., SCImago), and, if required, expert peer review. Because of its use of expertise, ABDC is able to address a criticism discussed above regarding academic niches. While relying on citation information for their general basis of decision, experts sometimes make

adjustments to accommodate specialist journals and other exceptional factors. To be included in ABDC Journal Quality List, a journal must 1) Have reached the necessary quality threshold level as above; 2) Adhere to general scholarly principles, including scholarly peer review; 3) Be relevant to the discipline areas of the ABDC, which include management, accounting, economics, information systems, business and taxation law and other agreed Fields of Research (FoRs); and 4) Not be a predatory journal (see https://abdc.edu.au/research/abdc-journal-list/2019-review/).

Prior Empirical Studies

Prior studies used various methods to assess journal rankings. For example, Wu, Hao and Yao (2009) used department chairs' responses to a survey asking to assess relative journal quality and provided quantitative standards to measure research productivity. Some studies develop a model to estimate relative publication quality (Matherly & Shortridge 2009). Currie and Pandher (2011) employed respondent data from a web-based survey of active finance scholars (45% response rate from 37 countries) to endogenously rank 83 finance journals by quality and importance. Nine years later, they updated their database to rank 102 finance journals. Similar to prior studies, Currie and Pandher (2020) found a consistent ranking of premier finance journals, the ranking of quality B journals shifted positions, and there was less consistent agreement in the ordering of the remaining journals. Cabells' metrics were not used in the comparison. Krueger (2017) compared Cabell, ABDC and Chartered Association of Business School (ABS) journal ranking systems and found that Cabell is the most lenient. Chan, Chang and Chang (2013) developed finance journal rankings based on a database of citations for all articles from a set of 23 finance journals during 1990–2010.

Some prior studies used journal ranking as a way to rank accounting programs or accounting authors. For example, Barrick, Mecham, Summers, and Wood (2019) ranked accounting journals disaggregated by topical area (AIS, audit, financial, managerial, tax, and other) and methodology (analytical, archival, experimental, and other). Zamojcin and Bernardi (2013) used 13 journals that published accounting education papers in order to rank accounting authors, not the journal. Bernardi, Zamojcin and DeLande (2016) examined the sensitivity of journals used to rank accounting authors and departments in accounting education. Bernardi and Collins (2019) ranked accounting programs based on their faculty members' publications in accounting-education journals. Reinstein and Calderon (2006) examined how accounting programs actually assess the quality of accounting journals. They documented rankings used by both doctoral-granting and non-doctoral-granting accounting programs and confirmed the existence of an elite set of journals whose rankings are invariant to school type, faculty size, resource base, or mission. Chen and Huang (2007) studied the pattern of authorship/co-authorship across journals to develop a new method to rank finance journals. They found that co-authorships among top 80 programs is more common in top-tier journals.

We expect consistent ranking among accounting and finance journals. Specifically, we anticipate:

H1: Cabells' Almetric index is correlated to ABDC journal ranking in regard to accounting and finance journals.

H2: Impact Factor is correlated to ABDC journal ranking in regard to accounting and finance journals.

H3: CiteScore is correlated to ABDC journal ranking in regard to accounting and finance journals.

Method

Data Collection

We used the ABDC journal list as our benchmark, then identified Accounting or Finance journals from the list by searching for the words "accounting," "auditing," "tax," or "financ" in the journal titles. This search resulted in 327 journals. Next, we manually collected the Cabells' Classification Index (CCI) scores for each journal in our ABDC list. A journal can have multiple CCI scores if it encompasses multiple disciplines. We obtained the CCI scores for Finance or Accounting disciplines for 138 journals. These journals are listed in Appendix I. Among these 138 journals, 132 have a CCI score for Finance, and 118 have a CCI score for Accounting. Also, 112 of these journals contain CCI scores for both Finance and Accounting. Finally, we manually collected the Journal Impact Factor 2018 or CiteScore. We found the 2018 Journal Impact Factor for 63 journals and the CiteScore for 156 journals. Table 1 summarizes our selection process and the number of journals by the ABDC journal ranking.

Table 1
Summary of Journal Selection

Selection Criteria	Number left after selection	Percentage of ABDC List	ABDC Rating			
			A*	A	B	C
Accounting and Finance Journals on ABDC List	327	100%	23	52	94	158
Accounting and Finance Journals on ABDC List not found in Cabells	189	58%	6	16	42	125
Cabell or 2018 Journal Impact Factor or CiteScore found	138	42%	17	36	52	33
Cabells Finance only found	132	40%	14	35	50	33
Cabells Accounting only found	118	36%	16	34	43	25
Cabells Finance & Cabells Accounting found	112	34%	13	33	41	25
2018 Journal Impact Factor found	63	19%	16	26	14	7
CiteScore found	156	48%	15	39	57	45
Cabells & ABDC & 2018 Journal Impact Factor & CiteScore found	47	14%	10	23	10	4

Sample Characteristics

Table 2 reports the summary statistics for each journal ranking type. For our analysis, we convert the ABDC journal ranking of alphabetical ratings to numeric values, where A*, A, B, and C are equal to 1, 2, 3, and 4, respectively. The mean ABDC ranking is 3.183 (falls between an A* and A letter ranking), and the standard deviation is 0.945. For our sample of journals, the CCI

ranges from 0.190 to 0.990. The mean Accounting CCI score is 0.487, with a standard deviation of 0.224. The mean Finance CCI score is 0.470, with a standard deviation of 0.209. The 2018 Journal Impact Factor ranking in our sample ranges from 0.167 to 5.397, with a mean and standard deviation of 1.708 and 1.149, respectively. Lastly, the CiteScore ranges from 0 to 10.9 in our sample. The mean CiteScore is 2.024, with a standard deviation of 1.819. Overall, the summary statistics indicate that there is significant variation among these journal ranking systems.

Table 2
Summary Statistics

Variable	Observations	Mean	SD	Min	Max
ABDCRating*	327	3.183	0.945	1.000	4.000
Cabells Accounting	118	0.487	0.224	0.190	0.990
Cabells Finance	132	0.470	0.209	0.190	0.990
2018 Journal Impact Factor	63	1.708	1.149	0.167	5.397
CiteScore	156	2.024	1.819	0.000	10.900

** ABDCRating (A*= 1, A =2, B=3, C=4)*

Results

Data Analysis

This study compares the ABDC ranking to the other three journal ranking systems, namely, Cabells' Classification Index, 2018 Journal Impact Factor, and CiteScore. Specifically, we investigate whether high and low ratings within each journal ranking system are comparable. Ideally, we expect that there is a certain degree of consistency among the ABDC rating, Cabell's Classification Index, Journal Impact Factor and CiteScore. For example, whether a C ranked journal under the ABDC rating is roughly equivalent to a Cabells' Classification Index value, or a Journal Impact Factor, or a CiteScore ranking. Such cross-comparison can provide insights about the consistency and variations among different ranking metrics.

Table 3 reports the distribution of each journal ranking by the ABDC ratings. This table indicates that Cabells' Classification Index, Journal Impact Factor, and CiteScore varied with the ABDC ratings. On average, journals with an A* or A ranking have a CCI greater than 50%, while B journals have an average CCI score below 50% for both Finance and Accounting classifications. On average, journals with an A*, A, or B ranking have a 2018 Journal Impact Factor or CiteScore greater than one.

Table 3
Distribution of Cabells' Classification Index, Journal Impact Factor, and CiteScore by ABDC Ratings

ABDC	**Cabells' Classification Index – Finance**							
	Observations	Mean	Standard Deviation	25th Percentile	50th Percentile	75th Percentile	Min	Max
A*= 1	14	.896	0.088	0.850	0.900	0.980	0.710	0.990
A = 2	35	.557	0.136	0.450	0.570	0.650	0.240	0.870
B = 3	50	.391	0.134	0.310	0.370	0.440	0.200	0.900
C = 4	33	.319	0.091	0.260	0.300	0.360	0.190	0.590
ABDC	**Cabells' Classification Index – Accounting**							
	Observations	Mean	Standard Deviation	25th Percentile	50th Percentile	75th Percentile	Min	Max
A* = 1	16	0.900	0.092	0.860	0.910	0.980	0.700	0.990
A = 2	34	0.551	0.139	0.440	0.560	0.650	0.240	0.830
B = 3	43	0.385	0.139	0.310	0.360	0.440	0.200	0.960
C = 4	25	0.310	0.087	0.250	0.280	0.350	0.190	0.550
ABDC	**2018 Journal Impact Factor**							
	Observations	Mean	Standard Deviation	25th Percentile	50th Percentile	75th Percentile	Min	Max
A* = 1	16	3.033	1.373	2.057	2.230	4.171	1.260	5.397
A = 2	26	1.463	0.596	1.079	1.419	1.730	0.597	3.182
B = 3	14	1.064	0.479	0.693	0.964	1.467	0.350	2.032
C = 4	7	0.879	0.486	0.750	0.775	1.083	0.167	1.788
ABDC	**CiteScore**							
	Observations	Mean	Standard Deviation	25th Percentile	50th Percentile	75th Percentile	Min	Max
A* = 1	15	5.660	2.589	4.100	4.300	7.900	2.300	10.900
A = 2	39	2.731	1.327	1.900	2.500	3.400	0.500	7.200
B = 3	57	1.516	0.884	0.800	1.400	2.000	0.000	4.000
C = 4	45	0.844	0.544	0.400	0.800	1.200	0.000	2.000

Additionally, we graphically report the distribution of each journal ranking using box plots. First, we plot the Finance CCI by ABDC Ranking in Figure 1 to examine the distribution of this journal ranking. The dashed line indicates a CCI score of 50%, and journals above this score have an ABDC ranking of either A*, A, or B. However, there is a significant overlap between the A*, A, B, and C ratings. Next, we examine the distribution of the Accounting CCI by ABDC ranking in Figure 2. Similar to Figure 1, journals with a CCI score of 50% and above have an ABDC ranking of either A*, A, or B but there is a significant overlap between the A*, A, B, and C ratings. However, A* is distinct from the B and C ratings. Importantly, in both Figures 1 and 2, the interquartile ranges are more distinct for these journals while the ranking for journals outside the interquartile range is more subjective.

Further, most of the B journals have a Finance or Accounting CCI score below 50%, consistent with Table 2. The results in the boxplots and Table 2, suggest that using the Finance or Accounting

CCI score for 25th percentile for B ranking journals will capture more of these B ranking journals and better classify them as high ranking under the Cabell journal ranking system. Thus, we suggest that journals with a CCI score greater than 31% can be considered to be high ranking.

Figure 1
Finance Cabell's Classification Index by ABDC Rating

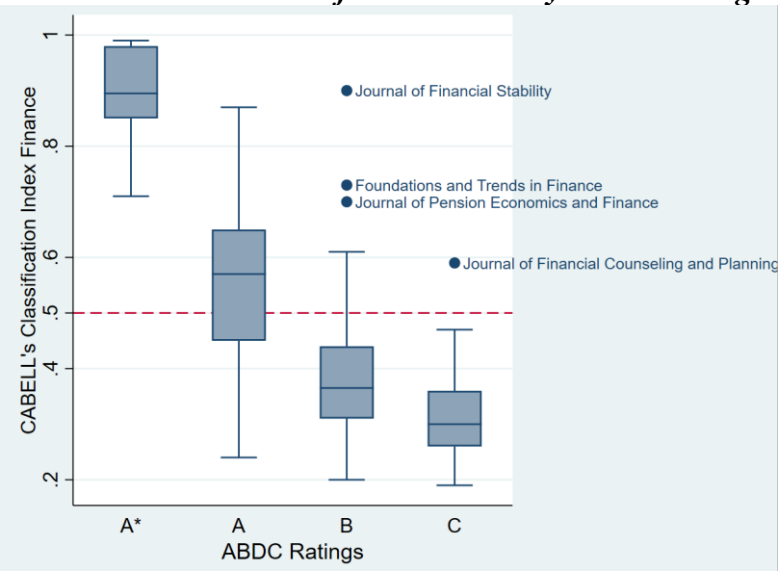
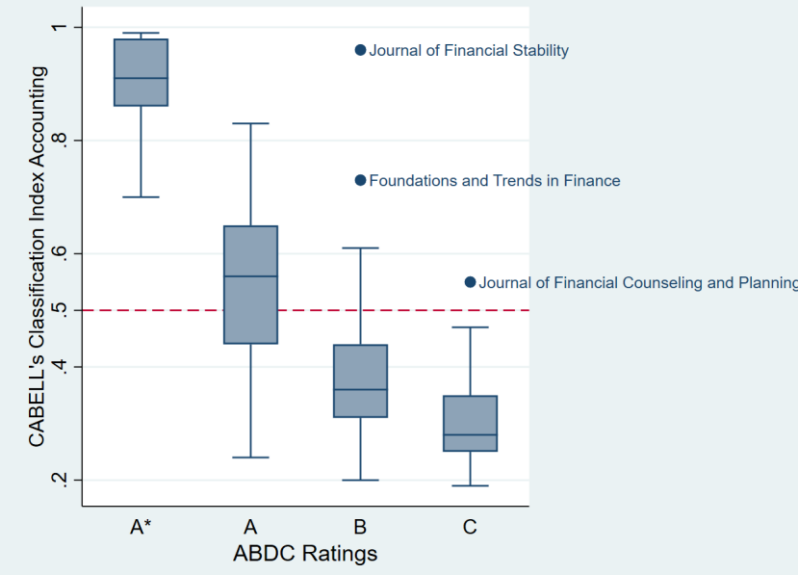


Figure 2
Accounting Cabell's Classification Index by ABDC Rating



Next, we plot the distribution of Journal Impact Factor and CiteScore by ABDC rating in Figures 3 and 4. The dashed line in both figures distinguishes between journals with a Journal Impact Factor or CiteScore greater than one. Figure 3 shows that most journals with an Impact Factor greater than one had an A*, A, or B rating. The interquartile range for A* ranked journals

is distinct for the Journal Impact Factor while there is more overlap for the A, B and C journals. Figure 4 shows that most journals with a CiteScore greater than one had either an A*, A, or B rating. For CiteScore, the interquartile ranges are more distinct and the overlap between journal rankings occurs mostly for the top and bottom quartiles. Moreover, while most B journals had a Journal Impact Factor and CiteScore greater than one, we also find that a small number of C rated journals also have a Journal Impact Factor and CiteScore greater than one. These findings suggest that Journal Impact Factor and CiteScore provide a more consistent matching to the ABDC ratings compared to the Cabell ranking system.

Figure 3
2018 Journal Impact Factor by ABDC Rating

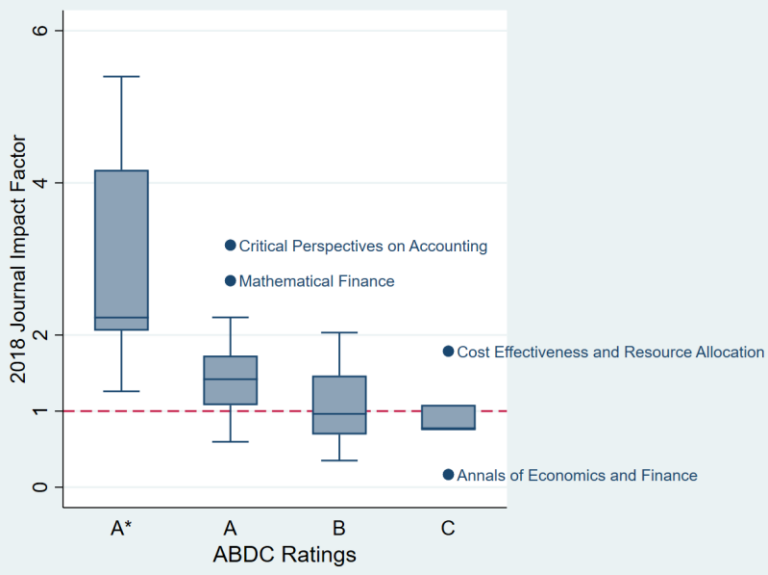
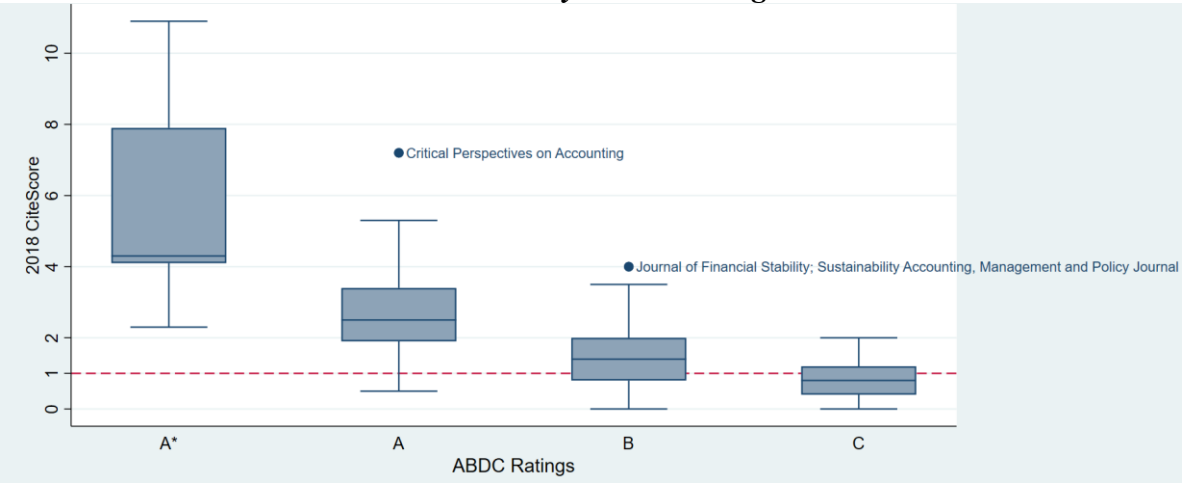


Figure 4
CiteScore by ABDC Rating



Finally, as indicated in the Figures above, there are a few outliers. We conducted sensitivity analysis by removing the outliers from our sample and reperforming our analysis. The deletion of outliers from the sample did not change the results.

To conduct further analysis, we use indicator variables to identify the high and low rankings within each journal ranking system where high rankings are equal to one, and low rankings are equal to zero. Our preliminary definition of a high rating is an A*, A, or B under the ABDC rating, a Cabell's Classification Index value of 50% and above, a Journal Impact Factor of one and above or a CiteScore of one and above. A low rating is defined as a C under the ABDC rating, a Cabells' Classification Index value below 50%, a Journal Impact Factor less than one, or a CiteScore less than one. Using these recoded variables, we conduct several tests. First, we test the correlation between the ABDC rating and the other three journal ranking systems in Table 4, Panel A. We find that the Cabells' Classification Index, the 2018 Journal Impact Factor, and the CiteScore positively correlate with the ABDC rating, and these correlations are statistically significant. Particularly, the CiteScore has the highest correlation value of 0.450, while the Journal Impact factor has the lowest correlation value of 0.318 with the ABDC ratings. It is important to note that the Journal Impact Factor has the smallest sample size which could bias the results using this journal ranking system.

Table 4
Comparison of Journal Ranking Systems

Panel A: Comparison using initial classifications of high and low rankings					
Journal Ranking Systems		N	Correlation (p-value)	t- test (p-value)	Wilcoxon (p-value)
ABDC	Cabells Finance	132	0.378 (0.000)	9.238 (0.000)	7.216 (0.000)
ABDC	Cabells Accounting	118	0.364 (0.000)	8.658 (0.000)	6.788 (0.000)
ABDC	2018 Journal Impact Factor	63	0.318 (0.001)	3.214 (0.002)	0.239 (0.999)
ABDC	CiteScore	156	0.450 (0.038)	-0.169 (0.866)	-0.169 (0.866)
Panel B: Comparison using new high and low classification for the CCI (cutoff of 31%)					
Journal Ranking Systems		N	Correlation (p-value)	t- test (p-value)	Wilcoxon (p-value)
ABDC	Cabells Finance	132	0.423 (0.0000)	-0.377 (0.707)	-0.378 (0.706)
ABDC	Cabells Accounting	118	0.442 (0.000)	0.000 (1.000)	0.000 (1.000)

Next, we use the t-test to compare the mean difference between the journal rankings and report the t-statistics for each comparison in Table 4, Panel A. The results indicate statistically significant differences between the CCI scores for both Finance and Accounting and the ABDC rating. There is also a statistically significant difference between the ABDC Rating and the Journal Impact Factor. However, the difference between the ABDC Rating and the CiteScore journal rankings are not statistically significantly different from zero. To account for possible non-normality, we also report the results of the Wilcoxon signed rank sum test in Table 4. These results are consistent with

the t-test findings. Overall, these tests show significant differences between the Cabells' Classification Index and Journal Impact Factor with the ABDC rating, but there are no significant differences between the ABDC rating and the CiteScore.

Our findings suggest that a CCI score of 31% is more consistent with the A*, A or B ratings. We repeat the tests above using this new classification and report the results in Table 4, Panel B. The results show that the correlations between the Cabell and ABDC rankings increase. Also, the t-tests and Wilcoxon tests show that there is no significant difference between the Cabell and the ABDC journal ranking systems.

Finally, in Table 5 we report the cross tabulation between the Cabell and ABDC journal ranking system to compare the 50% and 31% cutoffs. Using the 50% cutoff, 55 journals for the Finance CCI and 49 journals for the Accounting CCI were identified as low under Cabells and high under the ABDC. The number of misidentified journals is reduced to 13 and 11 for the Finance and Accounting CCI, respectively, using the 31% CCI cutoff. However, the number of journals identified as low under ABDC and high under Cabell increases from 1 to 15 for the Finance CCI and from 1 to 11 for the Accounting CCI. In developing this new benchmark, we chose to focus on correctly identifying the high-ranking journals.

Table 5
Comparison of Cabell and ABDC journal ranking systems

Panel A: Cross tabulation using a CCI score of 0.50 as a cutoff				
ABDC	Cabells Finance		Cabells Accounting	
	Low CCI <0.50	High CCI >=0.50	Low CCI <0.50	High CCI >=0.50
Low	32	1	24	1
High	55	44	49	44
Panel B: Cross tabulation using a CCI score of 0.31 as a cutoff				
ABDC	Cabells Finance		Cabells Accounting	
	Low CCI <0.31	High CCI >=0.31	Low CCI <0.31	High CCI >=0.31
Low	18	15	14	11
High	13	86	11	82

The objective of this study is to determine whether there are differences between journal rankings. We use the ABDC rating as our benchmark ranking and compared this journal ranking to the Cabells' Classification Index, the 2018 Journal Impact Factor, and CiteScore. Our findings indicate that the benchmark journal ranking significantly correlates with the Cabells' Classification, the Journal Impact Factor, and CiteScore. Comparison tests indicate that the ABDC ranking system differed from the Cabells' Classification Index, however using a new benchmark we find that this difference becomes negligible. Also, the ABDC ranking system is more similar to the CiteScore journal ranking systems using the initial benchmark.

Implications

Business education institutions around the globe, especially those accredited by AACSB or similar accreditation systems, are increasingly in need of evaluating faculty performance in terms of research accomplishment. The existence of an extensive array of journal quality ranking metrics, though sometimes helpful, may lead to controversy and bias in such evaluations. This study establishes a strong base for colleges of business, accounting departments, and finance departments to properly compare journals and rank their faculty's research productivity in terms of quantity and quality. The study also provides a guide to accounting and finance faculty in the search and choice of journals in which they may want to publish their work. Moreover, the overlapping of different journal ranking metrics points to a very important lesson: in the lack of a unified ranking of journals, it is critical that business schools and departments consider developing various ranking approaches that reflect the institutional mission and strategic directions, the researchers' intended contributions and impact, and the commitment to advance the field, rather than using a single ranking measure. For example, empirical evidence shows that the accounting discipline has very low citation patterns relative to other disciplines (Wood, 2016), thus using citation-based metrics alone for journal quality will not be fair to accounting faculty when their performance is compared with those from other disciplines.

Limitations

We note that the sample size of our data limits our study. Our analyses show that less than 60% of ABDC journals are Cabells listed. More data on the ABDC listing and Cabells may provide a clearer picture of the relationship between the journal ranking types. We concede that findings on the Impact Factor may be biased because those variables in our data represent fewer observations. Another limitation of our study is that we examine only four journal ranking systems for accounting and finance journals. It is conceivable that other journal ranking types exist that may provide a plausible relationship between those journal ranking types and the ABDC listing. Also, the findings may differ for journals in other fields.

Conclusion

We compare four commonly used metrics for assessing journal quality using accounting and finance journals as an example. Journal quality will always be an important component of faculty performance assessment. Our analysis of comparable journal quality ranking metrics can help faculty, promotion and tenure committees, and university administrators evaluate the quality of journals where accounting and finance faculty publish. The overlapping of various journal ranking metrics warns those involved in faculty performance assessment about the risk of relying on a single measure. Our results support that Cabells' CCI score of 31% and above is comparable to ABDC high rating of A*, A, or B accounting and finance journals. Our results provide insight on accounting and finance journals' ranking and may not be generalizable to refereed journals in other disciplines. We selected the most widely used four metrics by business education institutions, yet other indices of journal quality point to a need to confirm our findings with other journal quality indices.

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Appendix I

List of ABDC journals that were matched to Cabell Classification Index (n=138)

Journal Title	ABDC Rating	Cabell's Classification Index - Finance	Cabell's Classification Index - Accounting	2018 Journal Impact Factor	CiteScore
Accounting Review	A*		0.99	2.245	5.8
Accounting, Organizations and Society	A*		0.98	3.147	5.1
Auditing: A Journal of Practice and Theory	A*	0.85	0.85		
Contemporary Accounting Research	A*		0.93	2.065	4.1
Journal of Accounting Research	A*	0.98	0.98	4.542	8.7
Journal of Accounting and Economics	A*	0.99	0.99	3.753	6.0
Journal of Banking and Finance	A*	0.85	0.85	2.205	4.1
Journal of Corporate Finance	A*	0.89	0.89	2.215	4.2
Journal of Finance	A*	0.99		5.397	10.9
Journal of Financial Intermediation	A*	0.88	0.88	2.098	4.1
Journal of Financial Markets	A*	0.87	0.87	1.260	2.3
Journal of Financial and Quantitative Analysis	A*	0.92	0.92	2.049	3.6
Management Accounting Research	A*	0.97	0.97	3.800	7.9
Review of Accounting Studies	A*	0.71	0.71	1.588	3.6
Review of Finance	A*	0.9	0.90	2.023	4.3
The European Accounting Review	A*	0.75	0.70		
The Review of Financial Studies	A*	0.99	0.99	4.975	
Accounting Horizons	A	0.65	0.65	1.730	4.4
Accounting and Business Research	A	0.57	0.57	1.271	3.5
Accounting and Finance	A	0.61	0.56	1.537	2.5
Behavioral Research in Accounting	A	0.47	0.47		2.1
British Accounting Review	A	0.87	0.83	2.232	5.0
Critical Perspectives on Accounting	A	0.65	0.65	3.182	7.2
European Financial Management	A	0.67	0.67	1.182	2.5
Finance and Stochastics	A	0.62	0.62	1.750	3.2
Financial Analysts Journal	A	0.51	0.47	1.413	1.9
Financial Management	A	0.61	0.56	0.968	2.3
Foundations and Trends in Accounting	A	0.48	0.48		1.5
International Journal of Accounting Information Systems	A		0.75	0.969	3.1
International Journal of Auditing	A	0.53	0.50		1.9
International Review of Finance	A	0.62	0.57	0.633	1.1

International Review of Financial Analysis	A	0.60	0.60	1.566	3.4
Issues in Accounting Education	A	0.36	0.36		1.5
Journal of Accounting Auditing and Finance	A	0.60	0.56		
Journal of Accounting Literature	A	0.37	0.37		4.4
Journal of Accounting and Public Policy	A	0.83	0.83	1.796	4.1
Journal of Behavioral Finance	A	0.44	0.44	0.722	1.4
Journal of Contemporary Accounting and Economics	A	0.55	0.51	1.079	2.2
Journal of Empirical Finance	A	0.61	0.61	0.946	2.1
Journal of Financial Econometrics	A	0.65	0.65	1.686	3.8
Journal of Financial Research	A	0.40	0.40	1.265	1.1
Journal of Financial Services Research	A	0.66	0.66	1.426	2.7
Journal of International Accounting Research	A	0.57	0.57		1.8
Journal of International Financial Markets, Institutions and Money	A	0.73	0.73	1.836	3.3
Journal of International Money and Finance	A	0.73	0.73	1.623	3.4
Journal of Management Accounting Research	A	0.38	0.38		3.0
Journal of Real Estate Finance and Economics	A	0.50	0.50	1.136	2.0
Journal of the American Taxation Association	A	0.40	0.40		2.0
Mathematical Finance	A	0.62		2.714	5.3
National Tax Journal	A	0.45	0.42	0.597	2.1
Pacific-Basin Finance Journal	A	0.52		1.603	2.2
Quantitative Finance	A	0.42	0.42	1.170	2.6
eJournal of Tax Research	A	0.24	0.24		0.5
Accounting Historians Journal	B	0.26	0.26		0.7
Accounting History	B	0.38	0.38		1.8
Accounting History Review (formerly Accounting, Business and Financial History)	B	0.35	0.34		
Accounting Research Journal	B	0.34	0.34		0.7
Accounting and the Public Interest	B	0.31	0.31		0.4
Accounting in Europe	B	0.42	0.42		2.3
Advances in Accounting	B	0.39	0.39		1.4
Advances in Accounting Behavioral Research	B	0.24	0.24		
Advances in Management Accounting	B	0.23	0.23		
Advances in Taxation	B	0.25	0.25		0.7

Annals of Finance	B	0.34	0.34		1.1
Asia-Pacific Journal of Accounting and Economics	B	0.25	0.24		1.0
Asian Review of Accounting	B	0.37	0.37		1.3
Australian Accounting Review	B	0.44	0.44	0.661	1.6
Current Issues in Auditing	B	0.25	0.25		0.6
Emerging Markets Finance and Trade	B	0.35	0.35	0.828	1.5
Finance Research Letters	B	0.42	0.42	1.085	2.1
Financial History Review	B	0.28	0.28		1.0
Financial Markets and Portfolio Management	B	0.36	0.36		0.5
Financial Markets, Institutions and Instruments	B	0.37	0.35		1.8
Foundations and Trends in Finance	B	0.73	0.73		1.5
Global Finance Journal	B	0.43	0.40		1.7
International Finance	B	0.34	0.33	0.710	1.0
International Journal of Accounting and Information Management	B		0.31		2.0
International Journal of Finance Economics	B	0.48	0.45	0.636	
International Journal of Managerial Finance	B	0.32			1.6
International Journal of Theoretical and Applied Finance	B	0.35			1.1
International Tax and Public Finance	B	0.49	0.46	0.967	1.6
Journal of Accounting Education	B	0.31	0.31		2.6
Journal of Accounting and Organizational Change	B	0.37	0.37		2.0
Journal of Economics and Finance	B	0.28	0.28		1.0
Journal of Emerging Market Finance	B	0.31	0.31		0.5
Journal of Financial Stability	B	0.90	0.96	2.032	4.0
Journal of International Accounting, Auditing and Taxation	B	0.57	0.54		2.5
Journal of International Financial Management and Accounting	B	0.61	0.61	1.478	2.2
Journal of Multinational Financial Management	B	0.43		1.283	2.6
Journal of Pension Economics and Finance	B	0.70			2.5
Journal of Public Budgeting, Accounting and Financial Management	B	0.26	0.25	0.350	
Journal of Taxation	B	0.20	0.20		0.1
Managerial Auditing Journal	B	0.46	0.46	0.693	2.2

Managerial Finance	B	0.30			1.0
Pacific Accounting Review	B	0.39	0.39		1.9
Public Finance Review	B	0.33	0.33		1.2
Qualitative Research in Accounting and Management	B		0.50		2.5
Quarterly Review of Economics and Finance	B	0.48			1.7
Research in International Business and Finance	B	0.54	0.50	1.467	2.6
Review of Behavioral Finance	B	0.41			0.8
Review of Financial Economics	B	0.44	0.44		1.4
Review of Pacific Basin Financial Markets and Policies	B	0.30			0.7
Review of Quantitative Finance and Accounting	B	0.41	0.41		1.8
Studies in Economics and Finance	B	0.34			1.4
Sustainability Accounting, Management and Policy Journal	B	0.47	0.44	1.745	4.0
ATA Journal of Legal Tax Research	C	0.19	0.19		0.1
Accounting Perspectives	C	0.26	0.25		0.7
Advances in Accounting Education: teaching and curriculum innovations	C	0.25	0.25		
Advances in Public Interest Accounting	C	0.22	0.22		
Afro-Asian Journal of Finance and Accounting	C	0.26	0.26		0.7
Agricultural Finance Review	C	0.33			1.5
Annals of Economics and Finance	C	0.36	0.34	0.167	0.4
Applied Finance Letters	C	0.28			
Applied Financial Economics Letters	C	0.28			
Asia-Pacific Financial Markets	C	0.25			0.5
Asian Academy of Management Journal of Accounting and Finance	C	0.34	0.32		0.8
China Finance Review International	C	0.25	0.24		0.8
China Journal of Accounting Research	C	0.47	0.47		1.5
Czech Journal of Economics and Finance	C	0.31	0.31		
International Journal of Accounting, Auditing and Performance Evaluation	C	0.26	0.26		0.5
International Journal of Islamic and Middle Eastern Finance and Management	C	0.46		0.750	1.7

International Journal of Managerial and Financial Accounting	C	0.26	0.26		2.0
International Journal of Monetary Economics and Finance	C	0.24	0.24		0.8
International Journal of Sport Finance	C	0.40	0.40	0.775	1.5
Journal of Applied Accounting Research	C	0.39	0.39		1.7
Journal of Computational Finance	C	0.35	0.35	0.758	1.2
Journal of Emerging Technologies in Accounting	C	0.30	0.30		1.7
Journal of Financial Counseling and Planning	C	0.59	0.55		1.2
Journal of Financial Crime	C	0.28	0.28		1.0
Journal of Financial Management of Property and Construction	C	0.36			1.2
Journal of Financial Regulation and Compliance	C	0.27	0.27		0.6
Journal of Islamic Accounting and Business Research	C	0.46	0.43		1.4
Mathematics and Financial Economics	C	0.43		1.083	1.7
Public Budgeting and Finance	C	0.36	0.36		1.2
Qualitative Research in Financial Markets	C	0.36	0.34		1.6
Real Estate Taxation	C	0.19	0.19		0.1
Research in Finance	C	0.21			0.2
Review of Accounting and Finance	C	0.30	0.28	0.830	1.0

The Importance of Economics Education: An Examination of College Students' Financial Anxiety

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Financial stress is a significant source of anxiety for young Americans. In this paper, we provide insight into the potential impact of economics education on university students' financial anxiety. We conduct a two-phase experiment, measuring university students' financial anxiety before and then again after course coverage of observed savings behavior among Americans and the level of the national debt. We find a significant increase in reported financial anxiety after course coverage of this important topic. In contrast, an information prime has no significant impact on perceptions. We argue that more detailed course coverage increases the salience of the information and enhances student retention.

Keywords: financial economics education, financial anxiety, national debt, student debt

Introduction

> American millennials are approaching middle age in worse financial shape than every living generation ahead of them, lagging behind baby boomers and Generation X despite a decade of economic growth and falling unemployment. Hobbled by the financial crisis and recession that struck as they began their working life, Americans born between 1981 and 1996 have failed to match every other generation of young adults born since the Great Depression. They have less wealth, less property, lower marriage rates and fewer children, according to new data that compare generations at similar ages.
>
> Adamy and Overberg, 2019

As this *Wall Street Journal* excerpt illustrates, Americans are barraged with dire news about their future. The current global pandemic, COVID-19, can only add to concern about what lies ahead. Millennials, or individuals born between 1981and 1996, are falling behind and are the first generation of Americans expected to have a lower standard of living than their parents. The anticipated life span for Americans fell for three years in a row, with higher suicide rates and increases in drug overdoses playing a role (Solly, 2018). Anxiety levels have skyrocketed to such an extent that it is now common to hear about a "quarter-life crisis," as it is becoming more and more difficult for younger generations to face the future (Piskorz, 2018). This anxiety is likely to be multiplied for the generation following Millennials, Gen Z born between 1997 and 2012, who are increasingly fighting depression (Horowitz and Graf, 2019).

It might be easy for some to conclude that younger Americans are entitled and self-centered (e.g., Twenge, 2014), but the reality is that they face new, more difficult challenges compared to earlier generations. Staying in the middle class is becoming harder for a number of reasons (Leatherby, 2017). Fewer Millennials are employed compared to their parents at the same age, and they are earning less. Today, young Americans are less likely to own a home and carry a larger student loan burden. This will make it more difficult for younger generations to accumulate wealth. And, while they are down in terms of their ability to weather income shocks, some argue the next recession will wipe them out because they are in debt and have little in savings to cushion a blow (Lowrey, 2019).

The goal of this paper is to provide insight into the potential impact of economics education on university students' financial anxiety. To this end, we conduct a two-phase experiment. First, we measure the level of anxiety among a sample of American university students at the beginning of a required economics course. Specifically, we use survey methods to elicit students' financial anxiety during scheduled course time, as well as their optimism, self-efficacy, and financial knowledge. Self-reported student perceptions are insightful because they inform us about students' beliefs, which in turn impact their actions. Later in the course, a unit covers observed savings behavior among Americans and the level of the national debt. Subsequent to this class discussion, we complete the second phase of the experiment by again measuring students' financial anxiety. To examine whether course coverage changes students' perceptions of their financial situations, we test whether a change in financial anxiety is evident.

Understanding how young people cope with financial challenges is important if society is to promote the future well-being of the next generation. Financial anxiety plays an important role in how students visualize their future, including the ability to succeed. We argue that universities are poised with the opportunity to encourage student success through education. We recognize that some question the appropriateness of financial education because proper execution may be expensive and could impede individual autonomy (Willis, 2011). Nonetheless, we, as well as others, see an investment in financial knowledge as a foundation which supports the growth in students' human capital (Lusardi and Mitchell, 2014; Lusardi, 2019). Furthermore, there is evidence that economic knowledge informs public opinion (Walstad, 1997). Though many factors --- including age, income, and gender --- impact economic knowledge, Walstad (1997) reports that education through university coursework has a lasting influence. LaBorde and Mottner (2016) provide evidence of gains in financial literacy through university education and, importantly, these gains close knowledge disparities in knowledge across gender, age, and ethnicity. We believe that through education universities can increase the salience of financial and economic information. Students better understand the current condition of the average American and, importantly, they retain this information. In the United States, a significant percentage of university students (40%) completes at least one economics course (Siegfried, 2000; Siegfried and Walstad, 2014). We find that even a relatively short unit on the state of the national economy and savings behavior has a significant impact on students' financial anxiety.

The remainder of the paper is organized as follows. Section I provides a general framework for our investigation. Section II describes the survey methodology, including the data collection and sample descriptive information. Section III reports descriptive information on college students' mental states. Section IV reports the results of our analysis of economics education and anxiety among American university students. Section V summarizes our findings and discusses the implications of our results.

Survey Framework

Government information releases, the popular press, and social media posts suggest that student loan debt has grown over time, and so has the national debt of the United States. This concerning news could result in financial stress, a significant source of overall anxiety for young Americans. A recent survey of university students by Chan, Huang and Lassu (2017) reports that 97% of their respondents indicate they have financial stress. Younger Americans are more financially stressed than older generations and this stress has an important impact on life choices including marriage, home ownership, and saving behavior. Furthermore, this stress has contributed to a decline in mental and physical health among college-aged Americans. Much research provides evidence that stress and pessimistic mental states impact mental and physical health negatively (e.g., Segerstrom, Taylor, Kemeny, and Fahey, 1998; Souri and Hasanirad, 2011).

In recent years as income inequality grew and young Americans fell farther behind, financial stress has likely ballooned. To shed light on the current mental state among American university students, we recruited student participants who were registered in an introductory economics course at a large American state university.[1] This course is a general education requirement at the university so all students must complete it. We use a 2x2 design to examine the impact of information presentation and economics education on students' anxiety. The first experimental manipulation allows us to provide insight into the impact of economics education. Students in the course were asked to complete a survey prior to coverage of the national debt and savings behavior in the United States. Later, after a unit on these topics, students completed the survey again. This two-phase design allows us to measure financial anxiety among students before and after coverage of the current American savings and national debt position. We believe that course coverage increases the salience of economics information, impacting students' views of their financial situation.

Our second manipulation allows us to examine whether a situational cue changes the perceptions of students. Some students received a survey that included summary information relating to the American experience (the information cue or prime), whereas others received a survey without this information. Priming is used in psychology and economics to study whether manipulation of information shapes behavior (Cohn and Maréchal, 2016). While young Americans are deluged with information, a prime may trigger a negative mental image of debt and savings, increasing measured financial anxiety. The survey with national debt information provides students with descriptive information on the total debt of the United States, national debt per taxpayer, total debt per American family, and average family savings. For convenience, here we will refer to the descriptive figures provided to students as "national debt" information but, in all cases, it includes both national debt as well as debt and savings per American family.

Across class sections, the two versions of the survey (with and without information pertaining to the American experience) were randomly assigned to students in the group. The actual figures provided in the survey for the American experience were from the on-line version of the U.S. Debt clock at https://www.usdebtclock.org/. Sources for the on-line data include the Congressional Budget Office, The Federal Reserve, the U.S. Census, and the U.S. Treasury. This same U.S. Debt Clock was featured in class discussion of the U.S. economy in all sections of the introductory economics course.

To summarize, recall that our 2x2 design allows us to examine the impact of information presentation and economics education on students' financial anxiety. In our design, students in a

[1] The research was reviewed and approved by the university's Institutional Review Board.

required economics course completed the same survey twice, once before the course coverage of American savings and national debt experience (ND) and a second time after the course coverage of these topics. In both cases (early and later in the course), the survey included priming information regarding the American savings and debt experience (With ND) in half of the class sections. The other half of the class sections did not receive the prime (Without ND), thus resulting in a 2x2 design.

Survey Methods and Descriptive Statistics

Participants, who are business as well as non-business majors, were asked to complete a survey requiring approximately 15 minutes of time.[2] Students completing the survey received extra credit toward test grades, but those who did not wish to complete the survey for whatever reason were given the opportunity to earn the extra credit points through an alternative activity requiring approximately the same time commitment.[3] Our survey includes demographic information such as year of university study, gender, age, and major. In addition, we ask students to indicate their means of financial support, including whether they are self-supported or receive financial support from a parent or other relative, spouse or partner, financial aid or loans, or scholarship funding. Next, we ask students to report the total amount of student debt taken by themselves or others to fund their education. Others have provided evidence of differences across race, so we ask respondents to indicate their race (Tran, Mintert, Llamas, and Lam, 2018). In addition, we ask students whether they are currently employed and for how long as current work success may impact financial anxiety (e.g., Li, Li, Fay, and Frese, 2019).

Table 1 provides summary information on the observed characteristics of our participants. In total, 1,284 surveys were completed. Of these, 728 (556) of the surveys were given before (after) the course unit covering the national debt and American's financial situation. Of the surveys given prior to course coverage, 409 (319) excluded (included) the national debt information and, of the surveys given after course coverage, 209 (347) excluded (included) the national debt information. Note that we do not strictly have a pooled, cross-sectional sample.

Most often a respondent completes two versions of the survey, before and after course coverage. However, we do not match responses at the level of the individual to ensure anonymity. Students who complete the survey are those present in class on the day the survey is given. In addition, we do not have equal numbers of respondents for each of the 4 surveys. We attempted to administer the survey to relatively similar numbers. However, survey participation is completely voluntary, though incentivized, and class attendance is a factor outside our control. We have no evidence to suggest that these procedures are a limitation of our study. We have a random, convenience sample and the evidence suggests respondents are representative of the student body.

Descriptive statistics reported in Table 1 give a similar picture of respondent characteristics across the four treatments. Though the economics course is designated as freshman level, some students take it later in their college career at, on average, the beginning of the second year of study. Of our respondents, 60.7% are men, reflecting the fact that some sections of the course included a large number of engineering majors. For the full sample of 1,284 respondents, average age is 21.59 years, and age ranges from 18 to 59. Students are primarily supported by themselves,

[2] The complete survey is included in the Appendix.
[3] No student chose the alternate activity.

Table 1
Descriptive Statistics

			Survey prior to course coverage		Survey after course coverage	
		Total Sample	**National debt information excluded**	**National debt information included**	**National debt information excluded**	**National debt information included**
Total number of respondents		1,284	409	319	209	347
Year in university (mean)		2.03	2.05	2.02	2.08	1.98
Men (percentage)		60.7%	58.9%	62.4%	68.9%	56.5%
Age (mean)		21.59	21.94	21.50	20.89	21.66
	Engineering	50.5%	46.7%	52.7%	58.4%	48.4%
Major (percentage)	**Business**	14.8%	16.1%	11.9%	12.4%	17.3%
	Others	34.7%	37.2%	35.4%	29.2%	34.3%
	Self-supported	20.1%	21.5%	18.5%	21.1%	19.3%
Financial	**Parent/relative**	40.6%	36.7%	44.8%	42.1%	40.3%
support	**Spouse/partner**	3.8%	5.6%	2.2%	1.4%	4.6%
(percentage)	**Aid/loans**	27.2%	25.9%	26.3%	29.2%	28.2%
	Scholarship	8.3%	10.3%	7.8%	6.2%	7.5%
Total student loans (mean)		$ 6,640	$ 7,087	$ 7,040	$ 5,779	$ 6,262
	White	58.3%	62.3%	53.3%	53.1%	61.7%
Race (percentage)	**Black/African American**	25.0%	22.0%	29.5%	29.7%	21.6%
	Other	16.7%	15.6%	17.2%	17.2%	16.7%
Currently employed (percentage)		55.8%	56.2%	53.6%	56.9%	56.8%
	Less than 1	25.9	23.2%	26.6%	30.6%	25.6%
	1-2 years	22.1	21.5%	24.5%	22.5%	20.5%
Work	**3-4 years**	25.7	27.1%	24.1%	23.4%	26.8%
experience	**5-9 years**	15.4	16.1%	14.4%	14.8%	15.9%
(Percentage)	**10-15 years**	5.5	6.4%	5.0%	4.3%	5.5%
	16-20 years	2.9	3.2%	2.5%	2.4%	3.2%
	21 or more	2.5	2.4%	2.5%	1.9%	2.6%

This table reports descriptive information for survey participants. One group of students in an introductory economics course was asked to complete a survey prior to course coverage of debt in the United States, with some receiving a survey that has no discussion of the American experience and others receiving summary information including the total U.S. debt, the national debt per taxpayer, total debt per American family, and average family savings. A second survey is given in an introductory economics course subsequent to course discussion of debt and savings behavior among Americans.

parents, and student loans. With an average of $6,640, student loans outstanding are already significant, particularly keeping in mind that these students are still early in their time at the university. Respondents are asked to report their race and the form of the question follows U.S. Census Bureau and OMB standards.[4] The majority of our respondents report their race as white (58.3%), though a significant percentage are black or African-American (25.0%). More than half of the students are currently employed, with most having less than 10 years of work experience.

[4] The race categories are from https://www.census.gov/topics/population/race/about.html.

Descriptive statistics suggest that our sample respondents are a diverse group, as is the population of American college students. In the next section, we turn from demographics to measurement of psychological attributes and perceptions.

College Students and their Mental States

As described previously, young people face significant financial pressure. Psychologists have long recognized that how a person faces the future will be impacted by his or her mental state. Earlier research suggests that optimism, self-efficacy, knowledge, and anxiety are central. Optimistic people are better able to cope with adversity because they address challenges, taking a proactive approach. As a result, they achieve improved well-being (Carver, Scheier, and Segerstron, 2010). Similarly, those who believe they are capable of succeeding are more likely to succeed. A belief in self-efficacy has been shown to promote well-being (Bandura, 1994). Further, when it comes to life outcomes, financial knowledge promotes economic success (Lusardi, 2019). In contrast, anxiety potentially has serious long-terms effects, including a decline in physical and mental well-being (Carver, Scheier, and Segerstron, 2010; Tran, Mintert, Llamas, and Lam, 2018). Importantly, these mental states are not necessarily distinct. For example, Heckman, Lim, and Montalto (2014) argue that optimism and self-efficacy correlate with stress. Recall that our goal is to better understand the impact of economics information on student anxiety, so, we seek to control these variables as they are important moderators of behavior (Chemers, Hu, Garcia, 2011). Before turning to a multiple regression approach, we first consider simple descriptive statistics.

Table 2 reports descriptive information for respondents' mental states across the four treatments, beginning with optimism. The table includes mean values, as well as differences in means across manipulations. Psychologists have proposed a number of methods to elicit optimism, but in the interest of time and in order to avoid losing students' attention, we chose a single, direct question. Students were asked to rate whether they are optimistic about the future, given their current financial situation following Heckman, Lim, and Montalto (2014). Students responded on an 11-point scale where 1 is least optimistic and 11 is most optimistic. We do not observe significant differences across treatment groups in optimism.

We also measure self-efficacy and financial knowledge using simple, direct questions with 11-point scales. Students were asked to report their perception of whether they will be able to support themselves after graduation and to rate their level of financial knowledge. A person who feels more equipped will have greater success (Bandura, 2010; Archuleta, Dale, and Spann, 2013). We observe a significant decline in self-efficacy after the coverage of national debt in the classroom. We will return to this finding in the following section of the paper. For financial knowledge, we see similar responses across treatments with no significant differences.

To measure financial anxiety, we adopt the Financial Anxiety Scale (FAS) proposed by Archuleta, Dale, and Spann (2013) who adapt the Generalized Anxiety diagnostic criteria outlined by the American Psychological Association (APA, 2000). The FAS asks respondents to rate their evaluation of 7 items on a 7-point Likert scale with 1 indicating never and 7 indicating always. The items on the FAS elicit respondents' feelings, including anxiety about their financial situation, sleeplessness, and irritability.[5] In each case, a high value reflects greater concern or anxiety. We observe a significant increase in financial anxiety after the coverage of national debt in the classroom. As with self-efficacy, we will return to this finding in later sections of the paper.

[5] For the complete anxiety instrument, see question 12 of the survey included in the Appendix to the paper.

Table 2
Measures of Mental States before and after course coverage

		National debt information included			National debt information excluded		
		Before course coverage (N= 319)	After course coverage (N= 347)	Means Differences	Before course coverage (N= 409)	After course coverage (N= 209)	Means Differences
Optimism		7.51	7.30	-0.21	7.51	7.51	0.00
Self-efficacy		8.11	7.70	-0.41**	8.14	7.94	-0.20
Financial knowledge		6.83	6.79	-0.04	7.03	6.86	-0.18
Concern about the level of the national debt		7.40	7.03	-0.36	-	-	-
Concern about the level of the family savings		8.11	7.73	-0.37	-	-	-
Financial anxiety	Anxious about financial situation	3.76	4.31	0.54***	4.00	4.22	0.22
	Difficulty sleeping	5.40	5.46	0.06	5.55	5.70	0.15
	Difficulty concentrating	5.35	5.34	-0.01	5.40	5.56	0.16
	Irritable	5.24	5.30	0.06	5.24	5.30	0.05
	Difficulty controlling worry	5.02	5.15	0.13	5.08	5.30	0.22
	Muscles tense	5.75	5.58	-0.17	5.71	5.80	0.09
	Fatigue	5.50	5.49	-0.01	5.59	5.60	0.01
	Financial anxiety index	36.01	36.62	0.61	36.58	37.48	0.91

This table reports measures of financial optimism and anxiety expressed by survey participants. As described previously, some introductory economics students completed the survey prior to course coverage of debt in the United States, and some after. Also, some were given information concerning the recent American data relating to level of national debt and family savings, and others were not. All figures are mean values, with scales of 1 to 11 for the first five measures and scales of 1 to 7 for financial anxiety. In each case, the high value reflects greater concern or anxiety. The financial anxiety index is constructed by adding the scores of the seven related questions. The index range should be from 7 to 49, with higher scores indicating higher financial anxiety. Significant differences in means for 2-tailed Z-tests are indicated with *** = $p < 0.01$; ** = $p < 0.05$; *= $p < 0.10$.

Table 3 reports descriptive information for respondents' mental states across demographics. The table includes mean values, as well as differences in means across each specific characteristic. As have others, we see differences across gender (Brougham, Zail, Mendoza, and Miller, 2009; Tran, Lam, and Legg, 2018). Men report higher optimism, self- efficacy, financial knowledge, and financial anxiety. Interestingly, unlike Brougham, Zail, Mendoza, and Miller (2009) we find than men report more anxiety, as compared to women. Also, in contrast to previous research by Tran, Mintert, Llamas, and Lam (2018) who report ethnicity is important, we find no differences across race.[6] We also observe that students without loans who are earlier in their college careers, younger, engineering majors, and less experienced report higher financial anxiety. Students without loans are more optimistic and have more belief in their self-efficacy, perhaps because they have a lower debt burden. We also observe that students without loans report significantly greater financial anxiety. It is possible that students with loans have less anxiety because they envision a brighter future after acquiring a university education. We conducted extensive additional analysis of students with and without loans. Not surprisingly, students who are older and farther along in their studies have greater outstanding student loan balances. While we also observe that students with loans have less financial anxiety, we cannot provide insight into this relationship with our design. Students with loans may have less anxiety because of the loans, or it may be that students with less

[6] Though not reported, no significant difference in measurements of mental states between African-Americans and all other races in the Others category.

Table 3

Differences in financial anxiety measures across demographics

	Before course coverage			After course coverage			Difference in before/after course coverage	
Gender	**Male**	**Female**	**Difference**	**Male**	**Female**	**Difference**	**Male**	**Female**
N	440	288	-	340	216	-	-	-
Optimism	7.75	7.15	0.59***	7.66	6.94	0.73***	0.09	0.22
Self-efficacy	8.35	7.79	0.56***	8.18	7.18	1.00***	0.17	0.61**
Financial knowledge	7.06	6.76	0.30*	6.97	6.57	0.40**	0.09	0.19
Financial anxiety index	37.10	35.16	1.94**	38.37	34.70	3.67***	-1.27	0.46
Academic Level	**Freshman/ Sophomore**	**Junior/Senior**	**Difference**	**Freshman/ Sophomore**	**Junior/Senior**	**Difference**	**Freshman/ Sophomore**	**Junior/Senior**
N	496	232	-	382	174	-	-	-
Optimism	7.45	7.65	-0.20	7.41	7.30	0.11	0.04	0.35
Self-efficacy	8.11	8.18	-0.07	7.84	7.68	0.16	0.27	0.50*
Financial knowledge	6.86	7.11	-0.24	6.78	6.89	-0.11	0.08	0.22
Financial anxiety index	37.65	33.50	4.14***	38.53	33.47	5.06***	-0.88	0.04
Work Experience	**≤ 2 years**	**> 2 years**	**Difference**	**≤ 2 years**	**> 2 years**	**Difference**	**≤ 2 years**	**> 2 years**
N	346	382	-	271	285	-	-	-
Optimism	7.25	7.75	-0.50**	7.18	7.56	-0.38*	0.06	0.19
Self-efficacy	7.80	8.43	-0.62***	7.54	8.03	-0.49**	0.26	0.40*
Financial knowledge	6.45	7.38	-0.93***	6.45	7.16	-0.71***	0.00	0.22
Financial anxiety index	39.04	33.87	5.17***	39.12	34.87	4.25***	-0.08	-1.00
Race	**White**	**Non-White**	**Difference**	**White**	**Non-White**	**Difference**	**White**	**Non-White**
N	425	303	-	325	231	-	-	-
Optimism	7.60	7.39	0.22	7.30	7.48	-0.18	0.30	-0.10
Self-efficacy	8.22	8.00	0.22	7.76	7.84	-0.08	0.46**	0.17
Financial knowledge	7.06	6.78	0.27	6.84	6.78	0.06	0.21	0.00
Financial anxiety index	36.79	35.68	1.12	36.42	37.67	-1.25	0.37	-1.99**
Age	**<20**	**≥20**	**Difference**	**<20**	**≥20**	**Difference**	**<20**	**≥20**
N	357	371	-	288	268	-	-	-
Optimism	7.46	7.56	-0.09	7.45	7.31	0.14	0.02	0.25
Self-efficacy	8.08	8.18	-0.09	7.88	7.70	0.18	0.21	0.48**
Financial knowledge	6.66	7.22	-0.56***	6.64	7.00	-0.36**	0.02	0.21
Financial anxiety index	39.02	33.74	5.29***	39.97	33.69	6.28***	-0.95	0.05

Engineering Major	**Engineering**	**Others**	**Difference**	**Engineering**	**Others**	**Difference**	**Engineering**	**Others**
N	359	369	-	290	266	-	-	-
Optimism	7.94	7.10	0.84***	7.63	7.10	0.53***	0.30	0.00
Self-efficacy	8.63	7.64	0.99***	8.29	7.25	1.04***	0.34*	0.39*
Financial knowledge	7.04	6.85	0.19	6.87	6.76	0.10	0.17	0.09
Financial anxiety index	37.97	34.73	3.24***	39.30	34.37	4.94***	-1.33	0.36
Business Major	**Business**	**Others**	**Difference**	**Business**	**Others**	**Difference**	**Business**	**Others**
N	104	624	-	86	470	-	-	-
Optimism	7.22	7.56	-0.34	7.53	7.35	0.18	-0.31	0.21
Self-efficacy	8.11	8.13	-0.03	7.55	7.84	-0.29	0.56	0.30*
Financial knowledge	7.57	6.84	0.73***	6.99	6.79	0.20	0.58*	0.05
Financial anxiety index	33.11	36.87	-3.76***	34.77	37.34	-2.57**	-1.66	-0.48
Student loans	**With student loans**	**No Student loans**	**Difference**	**With student loans**	**No Student loans**	**Difference**	**With student loans**	**No Student loans**
N	340	388	-	260	296	-	-	
Optimism	7.05	7.92	-0.87	7.15	7.58	-0.43**	-0.10	0.34*
Self-efficacy	7.81	8.41	-0.60	7.64	7.93	-0.29	0.17	0.49***
Financial knowledge	6.84	7.03	-0.20	6.77	6.86	-0.10	0.07	0.17
Financial anxiety index	32.97	39.27	-6.31	34.15	39.39	-5.24***	-1.19	-0.12

This table presents the before and after course coverage means for optimism, self-efficacy, financial knowledge and financial anxiety index. The financial anxiety index is constructed by adding the scores of the seven related questions. The index range is from 7 to 49, with higher scores indicating higher financial anxiety. The survey sample is partitioned using students' demographics. Significant differences in means for 2-tailed Z-tests are indicated with *** = $p < 0.01$; ** = $p < 0.05$; *= $p < 0.10$."

Table 4
Correlation matrix

	Financial Anxiety	Before After	With without ND	Academic Year	Gender	Age	Engineer-ing	Business	Debt	Race	Employ-ment	Work experience	Optimism	Self-efficacy	Financial knowledge
Financial Anxiety	1														
Before After	0.027	1													
With without ND	-0.024	0.184***	1												
Academic Year	-0.229***	-0.008	-0.029	1											
Gender	-0.124***	0.000	0.036	0.192***	1										
Age	-0.134***	-0.031	0.000	0.405***	0.104***	1									
Engineering	0.174***	0.028	-0.002	-0.127***	-0.394***	-0.058**	1								
Business	-0.100***	0.016	-0.002	0.029	0.110***	0.034	-0.421***	1							
Debt	-0.280***	0.002	0.005	0.239***	0.119***	0.186***	-0.038	0.024	1						
Race	0.004	0.001	-0.016	0.034	0.014	-0.028	-0.101***	0.027	-0.075***	1					
Employment	0.148***	-0.007	0.012	-0.249***	-0.228***	-0.217***	0.210***	-0.132**	-0.076***	-0.054	1				
Work experience	-0.186***	-0.022	-0.001	0.394***	0.156***	0.668***	-0.088***	0.091***	0.136***	0.084***	-0.342***	1			
Optimism	0.423***	-0.026	-0.021	-0.004	-0.131***	0.077***	0.136***	-0.015	-0.135***	0.009	0.010	0.069**	1		
Self-efficacy	0.311***	-0.063**	-0.034	-0.031	-0.141***	0.148***	0.189***	-0.021	-0.090***	0.017	-0.018	0.153***	0.637***	1	
Financial knowledge	0.099***	-0.028	-0.037	0.032	-.075***	0.228***	0.034	0.079***	-0.018	0.041	-0.102***	0.239***	0.448***	.400***	1

Significant correlations for 2-tailed tests are indicated with *** = $p < 0.01$; ** = $p < 0.05$; *= $p < 0.10$.

anxiety take more loans. We leave this interesting question to future research. Here our goal is to examine the impact of university education on students' financial anxiety. See Nonis, Hudson, Philhours, & Hu (2015) on the perceived costs and benefits of student loan debt.

The initial descriptive results suggest that economics education has a significant impact on students' mental states. However, as noted earlier, the demographic and psychological measures are not necessarily distinct. Thus, we estimate a regression of financial anxiety with control variables to shed light on the impact of our experimental manipulations, while holding other variables constant. Table 4 presents a correlation matrix which indicates significant correlation between many of the variables of interest.

College Students and Financial Anxiety

To provide insight into the potential impact of economics education on university students' financial anxiety, we estimate multiple regressions, reported in Table 5. The dependent variable is the financial anxiety index (described above). The table reports coefficient estimates with two-sided p-values below each estimated coefficient. Our primary variables of interest are the two regressors measuring treatment effects. First, the dummy variable Before_After takes the value of 0 for surveys conducted before course coverage of the national debt (ND) and 1 if after course coverage. The dummy variable With_without_ND takes the value of 1 for surveys with the national debt information prime and 0 for surveys without this information.

The next few variables control for demographic differences and other mental states across respondents. Year measures the student's academic year, Gender is a dummy variable with 1 for female and 0 for male, Age is the student's age in years, Engineering is a dummy variable with 1 for students who are engineering majors and 0 otherwise, Business is a dummy variable with 1 for students who are business or economics majors and 0 otherwise, Debt is the natural log of the dollar value of student loans with the variable taking the value of 0 for students with no reported loans, Race is a dummy variable equal to 1 for white and 0 otherwise, Employment takes the value 1 for an employed student and 2 otherwise, and Work_experience is a categorical variable taking values from 1 to 7 depending on the years of experience with 1 for less than 1, 2 for 1-2, 3 for 3-4, 4 for 5-9, 5 for 10-15, 6 for 16-20, 7 for 21 or more. The final three variables are measures of mental state including optimism, self-efficacy, and financial knowledge. All three take values from 1 to 11, as described before.

Table 5

Regression of Factors Affecting Financial Anxiety

Independent Variables	Full Sample
Constant	27.190 (0.000)***
Before_After	0.959 (0.084)*
With_Without_ND	-0.642 (0.243)
Academic_Year	-1.276 (0.000)***
Gender	0.836 (0.171)
Age	0.049 (0.439)
Engineering	1.459 (0.028)**
Business	-1.281 (0.130)
Debt	-0.437 (0.000)***
Race	0.329 (0.555)
Employment	0.936 (0.089)*
Work_experience	-1.027 (0.000)***
Optimism	1.662 (0.000)***
Self-efficacy	0.404 (0.003)***
Financial_Knowledge	-0.372 (0.010)***
F-Statistic	38.586 (0.000)***
Adjusted R^2	0.291
Observations	1284

The table reports the results of three OLS regressions coefficient estimates using the financial anxiety index (described above) as the dependent variable. The regressors are: A dummy variable called "Before_After", with 0 for before course coverage and 1 for after course coverage of national debt (ND). A "With_without_ND" dummy variable taking value of 1 for surveys with the national debt questions and 0 for surveys without the national debt questions. Variable "Academic_Year" measures the student academic year. Variable "Gender" is a dummy variable with 1 for female and 0 for male. Variable "Age" represent the student age in years. The variable "Engineering" is a dummy variable with 1 for students in engineering related majors and 0 otherwise. The variable "Business" is a dummy variable with 1 for students in business or economics majors and 0 otherwise. The variable "Debt" is the natural log of the dollar value of the reported student loans; otherwise, this variable is 0 for students with no reported loans. The variable "Race" is a dummy variable equal to 1 for white and 0 otherwise. The variable "Employment" takes the value 1 for employed student and 2 otherwise. The variable "Work_experience" is a categorical variable taking values from 1 to 7 depending on the years of experience with 1 for less than 1, 2 for 1-2, 3 for 3-4, 4 for 5-9, 5 for 10-15, 6 for 16-20, 7 for 21 or more. The last three variables reflect the last three questions in the survey measuring optimism, self-efficacy and financial knowledge and taking values from 1 to 11 with 1 for 'Strongly Disagree' and 11 for 'Strongly Agree. The 2-tailed significance for a test of a difference from zero are presented in parentheses below the coefficients estimates and indicated as follows: *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

First, we consider the impact of demographics and other mental states on financial anxiety, returning later to our primary variables of interest, the experimental manipulations. While age and

academic year are highly correlated, only the year of academic study significantly impacts financial anxiety. Financial anxiety increases for engineering majors. Higher debt and more work experience lead to lower financial anxiety. In contrast to Heckman, Lim, and Montalto (2014) who find that optimism and self-efficacy correlate negatively with stress, we find that students who are more optimistic and view themselves as more able report greater financial stress. However, those with more financial knowledge have less financial anxiety.[7]

Returning to the experimental manipulations, we find a significant impact of course coverage of the national debt and Americans' current financial circumstances on students' financial anxiety. The dummy variable Before_After is significantly positive indicating that economics education about rising debt at both the national and individual levels increases student anxiety about their financial future. Recall that in the previous section we reported that students reported significantly less self-efficacy after the national debt coverage in class. It is possible that the course coverage induced a negative emotional response and led to students to question their ability to succeed. In contrast, we do not find a significant effect of the manipulation of the information prime (With_Without_ND) on financial anxiety.[8] In the final section we summarize and discuss the implications of these results.

Summary and Discussion of Results

In this paper, we provide insight into the impact of economics education on university students' financial anxiety. We conducted a two-phase experiment, measuring financial anxiety before and then again after course coverage of observed savings behavior among Americans and the level of the national debt. We find a significant increase in reported financial anxiety after course coverage of this important topic. We should note that this was a single and relatively short unit in the middle of a semester-long required economics course covering many topics. Yet, the impact is lasting and significant. We might wonder, though, is an increase in anxiety a good thing?

As we described earlier, anxiety levels for young Americans are sky-rocketing and more find it difficult to envision a bright future. Psychologists recognize that stress and anxiety can have important negative consequences for people.[9] However, psychologists also recognize that anxiety can be motivating, and this is where economics education has the potential to play an important role (Dhabhar, 2014; Strack, Lopes, Esteves, and Fernandez-Berrocal, 2017). The coverage of the current financial position of Americans in our required economics course is one unit, requiring less than a week of class time. Yet, our evidence suggests that this presentation increased the salience of a poor financial position characterized by debt and a lack of savings. The impact of the course unit was lasting and resulted in an increase in anxiety among students regarding their future financial position.

[7]In Table 5, the variable Debt is the natural log of the dollar value of debt. We replaced the current specification with a dummy variable equal to 0 for no student loans and 1 otherwise. The estimated coefficient remains negative and highly significant.

[8]The inclusion in the regression of an interaction term between the variables: "Before_After" and "With_without_ND" did not yield a significant coefficient.

[9]Both anxiety and stress are emotional responses, with stress typically being triggered in the short-term by a stimulus and anxiety being a more persistent mental state (APA, 2019). In our study, we measure financial anxiety which encompasses stress in the shorter run.

Americans are immersed with information. We believe that our information prime failed to significantly change students' perceptions of their future financial position *precisely because* students are constantly barraged with negative information. With so much information to process, the impact on students of each information bite is minimal. However, more detailed course coverage increases the salience of the information and enhances student retention.

Students would naturally have a negative emotional response upon seeing that their financial future is potentially quite bleak. Perhaps the anxiety produced by a negative emotion will lead to anxiety that, in turn, leads to change. As Chan, Huang, and Lassu (2017) argue, financial stress alone will not push students to seek help with financial decisions. Young Americans move toward financial health by understanding their financial situation. This is the hope and promise for financial economics education.

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Appendix
Financial Survey

The complete survey with the National Debt context follows. The first version of the survey does not include this context (i.e., questions 10-11 below) but is, otherwise, identical.

Thank you for your participation in this survey. Your responses are very important to us and we appreciate the time and effort you take to carefully answer the questions. Please be assured that your responses are strictly confidential and stored anonymously, with no identifying information.

1. What year are you in university (e.g., 3rd, 4th)? _
2. What is your sex? (check one) male ___ female _____
3. What is your age? (in years)
4. What is your primary means of financial support (check one)?
   __ self-supported
   __ parent or relative
   __ spouse or significant other
   __ financial aid or other loans
   __ scholarship
5. What is your major or concentration (e.g., marketing, music, etc.)? If you are undecided, please indicate undeclared. ____
6. Right now, what is the total amount (by yourself or another on your behalf) borrowed from any lender for you to attend college? Please enter zero if there are no student loans taken on your behalf. $___
7. What is your race? (check as many as apply)
   __ White
   __ Black or African American
   __ Asian
   __ Native Hawaiian or Other Pacific Islander
   __ Other
8. Are you currently employed either full-time or part-time? ____ Yes, _ No
9. How many years of full-time or part-time work experience do you have?

___ Less than 1, ___ 1-2, ___3-4, ___ 5-9, ___10-15, ___16-20, ___21 or more

10. Currently, the national debt of the United States exceeds $22 trillion. According to recent U.S. Treasury and Federal Reserve data, this is a debt per taxpayer above $185,000. Does this concern you? (Circle the appropriate number).

Not a **Very**
Concern Concerning
1-----2-----3-----4-----5-----6-----7-----8-----9-----10-----11

11. Also, according to recent U.S. Treasury and Federal Reserve data, the total debt outstanding per American family is above $875,000; whereas the average family has savings below $12,000. Does this concern you? (Circle the appropriate number).

Not a **Very**
Concern Concerning
1-----2-----3-----4-----5-----6-----7-----8-----9-----10-----11

12. Please rate each of the following on a 7-point scale, where 1=always and 7=never.

	Rating (1=always, 7=never)
I feel anxious about my financial situation.	
I have difficulty sleeping because of my financial situation.	
I have difficulty concentrating on my school or work because of my financial situation.	
I am irritable because of my financial situation.	
I have difficulty controlling worrying about my financial situation.	
My muscles feel tense because of worries about my financial situation.	
I feel fatigued because I worry about my financial situation.	

13. How would you rate your financial knowledge level? (Circle the appropriate number).

Very Little **Very**
Knowledge Knowledgeable
1-----2-----3-----4-----5-----6-----7-----8-----9-----10-----11

14. When I think about my financial situation, I am optimistic about my future. (Circle the appropriate number).

Strongly **Strongly**
Disagree Agree
1-----2-----3-----4-----5-----6-----7-----8-----9-----10-----11

15. I will be able to support myself after I graduate. (Circle the appropriate number).

Strongly **Strongly**
Disagree Agree
1-----2-----3-----4-----5-----6-----7-----8-----9-----10-----11

Transfer Pricing Case Study: Computing Devices, Inc. Intercompany Loan

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This case study is a modified version of a real intercompany loan situation. Multinational enterprises ("MNEs") utilize intercompany loans to move money around their global network of subsidiaries. Computing Devices, Inc. is a fictitious company, however, the interest rate and debt capacity analyses are simplified versions of what international tax and transfer pricing practitioners are hired to develop, interpret, and analyze. This case study introduces students to transfer pricing regulations and the importance of developing ample support for intercompany transactions. According to United States and international transfer pricing tax legislation, all intercompany transactions must be priced at arm's length. MNEs must keep records of quantitative and qualitative analyses defending their intercompany transactions in case tax authorities request evidence of due diligence. This case presents an application of a practitioner database, Bloomberg Terminal database technology, to generate arm's length interest rates. Students, taking the role of a staff analysts with a large international consulting firm, will analyze financial statements to perform a cash flow analysis in order to determine if the affiliate can service the debt stemming from the transferred funds.

Keywords: International tax, transfer pricing, intercompany loans, interest rates, debt capacity

Introduction

Computing Devices, Inc. ("Computing Devices") manufactures state-of-the-art components for computing systems. The company is best known for manufacturing video and graphics cards for laptops and tablets. The C-corporation was founded in 1990 by brothers James Faunt and Wilbur Faunt in Milwaukee, Wisconsin, where the company is still headquartered. The company has several foreign subsidiaries including a manufacturing plant, research and development center, and distribution centers.

As the company expands its footprint in Western Europe, Spain specifically, management expects to need additional distribution space at their current European warehouse. Computing Devices' Spanish affiliate currently does not generate enough income in to support the investment needed. In order to accomplish the distribution warehouse expansion, management would like to explore funding its Spanish operations with an intercompany loan from another affiliate.

Product and Company Overview

Computing Devices designs and manufactures internal components for computers, laptops, and tablets. The company's unique design and manufacturing processes allow it to develop and produce user-specific video and graphics cards for use in laptops and tablets. The company has the capability to modify its video and graphics cards to fit various styles and inputs of computing devices, thereby allowing it to manufacture products for virtually any company and individual user. The company has many wholesale accounts with large computer companies and a robust direct-to-consumer market for individuals customizing their computing devices. While Computing Devices does not have the name recognition as some of its competitors, the company is known for manufacturing high-quality products at a lower price point than their more well-known competitors.

The international popularity of the company's products and its growth potential, along with the Faunt brothers desire for a personal "liquidity event," resulted in the company becoming publicly traded in in 2007. The Company's shares are thinly traded on the NASDAQ. As of June 30, 2019, 10,654,238 common shares were outstanding at $8.56 per share for a total market capitalization of over $91 million. James Faunt and Wilbur Faunt each own 32% of the outstanding common shares and remain active on the Company's Board of Directors. Computing Devices manufactures its products in plants in Cleveland, Ohio and Frankfurt, Germany. Computing Devices also owns a research and development center in Tianjin, China, and operates distribution entities in several developed countries.

While management is planning on expanding into many new markets, the company has annual revenues of approximately $200 million in the following regions: North America (50% of sales), Europe (30%), Asia (15%), and Central and South America (5%).

Intercompany Agreement

Since its initial public offering, Computing Devices largely has been profitable and cash flow positive. The popularity of smaller computing devices, such as smart phones, has both decreased the demand for laptops and increased the number of competitors that expect increased profitability in manufacturing and distributing computer devices. This increase in competition has pushed Computing Devices to enter new markets to expand its reach. Management identified Spain as a market for expansion given its proximity to other successful European markets for the Company (e.g., Germany, France, Italy).

The company's expansion into the Spanish market entailed creating a distribution warehouse in the country, as well as a small office that houses local sales and advertising personnel which receive direction from management in the United States office. Warehouse and sales and marketing employees are housed under the same limited liability Spanish affiliate, Computing Devices Spain, S.L. ("CDES"). CDES, as a distributor, has little or no strategic marketing responsibility and is therefore considered a limited-risk entity. A limited-risk distributor is a common term for a supply chain entity that does not bear substantial risk. CDES does not take title to the inventory it distributes to Computing Device customers, nor does CDES provide substantial value-added services to the Computing Device customer experience.

To fund the expansion in the Spanish market, the company's Chief Financial Officer (CFO), Wendy Hudson, plans to issue an intercompany loan from one of CDES' affiliates. Management is deciding between issuing the loan from either Computing Devices, Inc. (the United States parent

company) or the German affiliate, Computing Devices Germany DE ("CDDE"). The functional currency of Computing Devices, Inc. is United States Dollar ("USD"), the functional currency of CDES and CDDE is Euro ("EUR"). Management is leaning towards having CDDE as the lender.

The company forecasts that CDES needs approximately EUR 450,000 (USD 513,000) for the expansion of the distribution center (i.e., property, plant, and equipment). The intercompany loan is expected to have a five-year term with simple interest payable at the end of each year. The intercompany loan is expected to be issued January 1, 2020 and the principal will be repaid at the end of the five-year term.

Transfer Pricing Regulations and Background

Given that the company typically does not draw the attention of revenue service authorities in the jurisdictions in which they operate, management has elected to perform a limited debt capacity analysis with the help of your consulting firm. The debt capacity analysis will consider whether CDES will be able to afford the loan interest and principal repayment. An intercompany transaction of this nature falls under the practice of transfer pricing. Transfer pricing is the practice of pricing intercompany transactions.

The US, and other developed nations, have transfer pricing regulations written into their tax codes. In the US, the standards are laid out though the United States Internal Revenue Code Section 482 and the Treasury Regulations promulgated thereunder (Section 482 Regulations). These regulations require all intercompany transactions to be priced at "arm's length." The arm's-length principle requires that the conditions imposed between two associated enterprises in their commercial or financial relations should not differ from those that would have otherwise be made between independent enterprises engaging in similar transactions under similar circumstances. These regulations prevent multinational entities (MNEs) from artificially increasing or decreasing revenue and costs of their affiliates to alter reported profit in the jurisdictions in which they operate. If an MNE artificially raised profit in low-tax jurisdictions and lowered profit in high-tax jurisdictions, this could lower the global effective tax rate of the MNE. Revenue service authorities hold intercompany transactions up to an arm's-length standard in order to ensure a market-based allocation of profit.

When it comes to intercompany debt arrangements, revenue authorities require an evaluation of the projected availability of free-cash flows of the borrower, on a standalone basis, to service principal and interest over the proposed lending horizon, given proposed terms and conditions. Specifically, according to United States Treasury Regulation §1.482-2(a)(2)(i) all relevant factors shall be considered, including principal and duration of the loan, security involved, credit standing of the borrower, and interest rate(s) prevailing in the jurisdiction of the lender or creditor for comparable loans between unrelated parties.

In essence, revenue authorities ask the question, "[c]an the borrower be expected to service its obligations (including repayment of interest and principal) for the stated level of debt?" If the answer is "yes", then the debt arrangement may be considered arm's length.

There could be many reasons why an MNE may wish to achieve funding through intercompany means as opposed to external lenders. If Computing Devices were to use an external funding source (e.g., a bank) there would have to be substantial communication with the bank and Computing Devices' management. Given the limited role CDES plays within Computing Devices' supply chain, this communication would have to be with the parent company in the United States. It may not be practical or efficient for an MNE to have this type of external interaction on behalf of every

affiliate. Additionally, when an affiliate of an MNE issues an external interest payment, the bank benefits. With intercompany lending, the MNE organization keeps the interest in-house. Assuming that an MNE abides by the applicable treasury authorities' regulations, transfer pricing, including financial transactions, also can be a tool to achieve a lower global effective tax rate.

Debt Capacity Analysis

In your role as a new associate on the transfer pricing team of a large international consulting firm, you will be preparing an analysis to determine if CDES, as the borrower, can generate sufficient cash flows to service its obligations (i.e., repayment of interest and principal) for the stated level of debt.

The CFO has provided financial statements for 2019 and growth rate assumptions for CDES. Your manager has provided an Excel template document which you can use as a starting point for the analysis. The manager has entered current year financial information, forecasted growth rate assumptions, and other notes related to the financial statements that might be useful as you construct the high-level debt capacity analysis. The anticipated growth rates and current financial information are presented in Tables 1 and 2, respectively.

Given the information from the CFO, the anticipated intercompany debt (in EUR), and assuming a placeholder five-percent interest rate on new intercompany debt, complete the debt capacity analysis for the forecast period of 2020 through 2024. Using this analysis, determine if CDES is expected to have the capacity to service the ongoing interest costs and repay the proposed intercompany loan principal at the end of the term. Your manager also mentions that of particular importance is the final row of the Excel file, "Cumulative Free Cash Flow % of LT Debt," that denotes if the cumulative free cash flow generated is sufficient to support the intercompany loan.

Interest Rate Analysis

While the model developed used a five-percent interest rate on the new debt, Section 482 Regulations, requires that an arm's-length interest rate must be applied to the intercompany debt transaction. Computing Devices' management is looking to perform an interest rate benchmarking analysis to support an arm's length interest rate for the intercompany loan. The questions at issue for the interest rate analysis revolve around determinants of comparability between the intercompany transaction and comparable, independent, market transactions. Your manager notes that determinants of comparability often relate to the credit worthiness of the borrower, industry, currency, and tenor (duration) of the transaction.

The credit rating consideration is intended to indicate the riskiness of the entity borrowing the funds. However, most MNEs do not independently determine a credit rating for each of their affiliates. Your manager also indicates that since the Company is interested in a high-level analysis, you should explore a notching approach to arrive at a suitable range of comparable credit ratings for CDES. A notching approach is an efficient, not a robust, method to determine the credit rating of affiliates within an MNE. The notching approach begins with the parent company's credit rating and "notches down" various credit rating bands based on the role of the affiliate within the organization.

Through your research you understand that CDES's parent company, Computing Devices, Inc., has a BBB+ rating from S&P and a Baa1 rating from Moody's. Given the role of CDES within the company, a notch or two below the parent company rating would be appropriate. Therefore, CDES

could be met with a range of credit ratings a notch or two below the parent company rating of BBB+/ Baa1. As such, an appropriate credit rating band could be BBB through BB+ (Baa2 through Ba1).

Further, given that functional currency of CDES (and Spain) is the Euro, and that the Euro and the United States Dollar are two of the most liquid currencies in the world, debt issuances in both currencies can be considered comparable. There are two common interest rate pricing mechanisms, fixed and floating rate. Fixed rate pricing constitutes one flat, fixed, rate (e.g., 5%) applicable for each year the loan is outstanding. The fixed rate is an all-in rate reflective of the applicable currency and credit risk of the borrower. However, many loans, and lines of credit, are instead set with a floating rate (i.e. a base plus margin format). With this format, the margin above the applicable currency base rate will vary based on the creditworthiness of the borrower. Floating rate pricing is used to pass currency risk to the borrower. Meaning, as the currency base rate increases, the interest the borrower pays will also increases. The base rate is often based off a common interest rate such as the London Interbank Offered Rate ("LIBOR"). When analyzing comparable transactions, it is important to understand if the pricing is based on a fixed or floating interest rate.

CDES is incorporated in Spain, a developed nation. Other comparable nations to consider could be North American and major European countries. Also, given the expected five-year term, comparable debt transactions should have a five-year term from the loan's anticipated inception. In the event of limited five-year observations, the search can be expanded to include comparable debt transactions with maturity between four and six, or three and seven years.

Further, while the borrower's industry of the comparable debt transactions typically does not drive material interest rate differences, banking, real estate, and utility industry transactions are often deemed incomparable to this type of intercompany operational debt. This is due to a variety of factors generally related to these specialized industries such as the characteristics of collateral or asset backed loans.

Additional common Bloomberg screening criteria for fixed income searches are as follows:

- Security Status: Active
- PCS List: Exchange Traded (EXCH), FINRA – Trace (TRAC)
- Maturity Type: Bullet, Callable. Excluding Putable, Convertible, Sinkable, Pass Thru

Your manager has provided you with an Excel file with the Bloomberg download for further screening. Utilizing the comparable transaction data you screen, calculate the interquartile range of interest rates observed. United States Treasury Regulation §1.482-1(e)(1)—similar to vast majority of developed nations' transfer pricing regulations—states that a taxpayer will not be subject to adjustment if the implemented rate falls within the interquartile range (i.e., the arm's-length range) of comparable transactions, and, thus, any point within this range is a reliable target. It is important to note that if the revenue service authority were to adjust the rate the taxpayer applied, they would typically be adjusted to the median of the arm's length range. The interquartile range is a commonly used statistical descriptor of a dataset. In the transfer pricing context, the interquartile range is utilized because it removes the top 25% and bottom 25% of observations when calculating an arm's length range. This allows the middle 50% of data to be applicable. One potential reason this range is precedent in the transfer pricing landscape is that there could be extraordinary businesses, political, or other events that impact certain companies in the dataset. Analyzing the middle 50% of data removes any potential outliers or extreme cases.

Consider if you have sufficient (e.g., more than 10) comparable debt observations under what you might consider a narrow definition of comparability. If you have insufficient observations,

begin to relax your factors of comparability to achieve an appropriately sized sample. Transfer pricing is not a hard science—it is an art. Keep in mind that you will be expected to justify and defend your comparability choices from an economic and financial perspective. Once you have arrived at an appropriate interquartile range, apply an arm's length interest rate to the Cash Flow Analysis to determine feasibility.

Proposal

In order to convey your recommendations to your manager, and subsequently to Computing Devices' CFO, prepare a proposal that describes your analysis along with the financial analysis support (i.e., Debt Capacity Analysis and Interest Rate Benchmarking Analysis). Specifically, be sure to highlight the information you were provided from Computer Devices, the assumptions made, the data analyzed, as well as your recommendation regarding the feasibility of the loan (Debt Capacity Analysis) and the determination of the arm's-length interest rate.

Excel File Download:
https://docs.google.com/spreadsheets/d/1PPpskEwT_qCWsnl3C2LvQcg82Ntb5T2N479j_ieDCEI/edit?usp=sharing

Table 1
Growth Rate Assumptions

Assumptions	Rate
Revenue Growth - First 5 years	10.00%
Gross Profit Margin Growth - First 5 years	0.85%
Operating Expense Growth - First 5 years	9.06%
Interest Rate on Intercompany Debt	5.00%

Table 2
Current Year Summary Financial Statements

Income Statement	2019
Revenue	1,324,056
Cost of Revenue	(983,248)
Gross Profit	340,808
Gross Profit Margin	*25.74%*
Research and Development	-
Selling and Marketing	(125,368)
General and Administrative	(223,697)
Operating Expenses	(349,065)
EBIT	(8,257)
Operating Margin	*-0.6%*
Interest Expense	-
Interest Expense (new intercompany debt)	-
Total Interest Expense	-
Other Expenses	-
Other Income	-
Taxable Income	(8,257)
Tax Rate	25.0%
Income Tax Expense	-
Net Income	(8,257)
Depreciation Expense	(12,000)
Depreciation Expense as % of PPE, net	*7.1%*
EBITDA	3,743
EBITDA as % of Revenue	*0.3%*

Table 2
Current Year Summary Financial Statements (continued)

Balance Sheet	2019
Cash and Cash Equivalents	125,126
Restricted Bank Deposit	9,200
Trade Receivables	37,851
Other Receivables and Prepaid Expenses	823
Inventory	89,165
Total Current Assets	262,165
CA as % of Revenue	*19.8%*
Total PP&E, net	169,000
Total Assets	431,165
Trade Payable	146,972
Other Accounts Payable and Accrued Expenses	4,144
Total Current Liabilities	151,116
CL as % of OpEx	*43.3%*
Existing LT Debt	-
New Intercompany Debt	-
Total LT Debt	-
Total Liabilities	151,116
Equity (Book)	280,049
Cash Flow Statement	**2019**
EBITDA	3,743
Changes in working capital	23,159
Changes in working capital as % of TA-TL	8.3%
Capital Expenditures	(1,697)
Free Operating Cash Flow	25,205
Interest Expense (existing debt)	-
Interest Expense (new intercompany debt)	-
Principal Repayment (new intercompany debt)	-
Annual Free Cash Flow	25,205
Cumulative Free Cash Flow	125,126
Cumulative Free Cash Flow % of LT Debt	-

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