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Examining Student Performance in Face-to-Face, Online Synchronous and Online Asynchronous Instruction

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We study the effects of online modalities, both asynchronous and synchronous, on student performance in undergraduate Finance courses, and compare them to face-to-face (F2F) instruction. Specifically, we examine student performance in two courses for Finance majors, one core and one elective. We also survey our business school faculty for feedback on the pros and cons of the online asynchronous and online synchronous modalities. Based on factors identified in the literature such as flexibility, social interaction, online tools available, and initial student motivation, the courses were designed to use the online modality best suited for student learning outcomes in each course – synchronous for the core course and asynchronous for the elective. We find that student performance in online modalities is better than in the F2F modality for both the core and elective courses and provide plausible reasons for these findings.

Introduction

As online courses in business schools proliferate due to the pandemic, there is a need to study the effectiveness of online teaching methods, and specifically, the differences between online asynchronous and online synchronous teaching. There is little consensus in the literature on how to design an online course to create effective interactions and improve student learning. There is a significant amount of literature that compares online courses with face-to-face (F2F) courses, but without considering the differences between online synchronous and online asynchronous modalities. In her literature review on the subject, Gilpin (2020), notes that students have a lower rate of persistence - defined as completion with a grade - in online versus F2F courses (Hart, 2012; Xu & Jaggars, 2011). Paulsen & McCormick (2020) suggest that the reason for this may be the lack of meaningful interactions among students in the online versions of a course. Student success in learning the course content also depends to some degree on their success in becoming part of the social fabric of the institution (Joksimovic et al., 2015; Tinto, 1993), and online courses have thus far struggled to maintain the social fabric. This may be especially true of online asynchronous classes.

Interactions among students can be created in online asynchronous courses in text-based discussion boards, but these are a relatively weak form of interaction. Online synchronous courses offer a better sense of social interaction, in that students can see each other, albeit on a computer screen. Given that students meet online at the same time, breakout rooms and chat boxes offer the instructor another avenue to increase interactions among students, and interaction of the students with the professor can occur through direct conversation (oral), polling, or through a chat box. It would thus seem that online synchronous courses are more like F2F experiences than online

asynchronous courses. The downside of online synchronous courses is that students lose some of the flexibility that online asynchronous courses offer in terms of the timing of the learning. Wigfield & Eccles (2000) therefore suggest that different segments of the student population value different things, and the modality of the course must match what they value. Hannay & Newvine (2006) surveyed 217 students and found that adult learners indicated a preference for the flexibility offered by online courses and did not believe that they would lose out on the learning. Gilpin (2020) created a framework for the design of online courses in which three key factors must be considered - social presence or interactions, online learner characteristics, and the online tools available - to improve learner performance.

In this paper, we focus our attention on student performance among undergraduate finance majors taking courses in either F2F or online modalities. Specifically, we study the use of the online asynchronous and online synchronous modalities (based on the factors mentioned by Gilpin (2020)) keeping in mind the type of course (core vs elective). Design considerations led us to choose the online synchronous modality for the core course and the asynchronous modality for the elective course. The research question we aim to answer is whether student performance is significantly different between the F2F versus online synchronous modalities in the core course, and between F2F versus online asynchronous modalities in the elective course.

Literature Review

Several studies have attempted to discover the relative merits of online and F2F modalities. The results have generally been mixed. The literature is about equally divided between studies that found no significant difference between the modalities, and those that did. However, the online synchronous vs online asynchronous classification is largely ignored.

Studies suggesting lack of Difference in Effectiveness

Much of the distance education comparison literature can trace its roots to Russell (1999). Thomas Russell's book, *The No Significant Difference Phenomenon*, indexes 355 research reports dating from 1928 to 1998 that, according to Russell, demonstrate there are no significant differences in student learning between alternate modes of education delivery, either F2F or online. This somewhat controversial conclusion has inspired a vast array of academic research examining the issue in detail. For excellent reviews of this extensive literature, see Tallent-Runnels et al. (2006) and Tamim et al. (2011).

Fendler, Ruff, & Shrikhande (2018) study the suitability of the F2F vs online modalities for student success. In their study, they break down the literature on this topic into two distinct groups – those that find no significant difference between the two modalities, and those that do. Studies that suggest a lack of difference between the teaching effectiveness of the two modalities include Iverson, Colky and Cyboran (2005), Euzent, Martin, Moskal and Moskal (2011), Murdock, Williams, Bruce and Young (2012), and Means, Toyama, Murphy, Bakia and Jones (2013) and Stack (2015).

Iverson et al. (2005) report no significant difference in learning outcomes between delivery modes among graduate students. However, they found that the students considered online classes more difficult, yet had higher positive reactions to them, and a stronger intent to apply their learning. Euzent et al. (2011) found no significant difference in a large (n>300) introductory economics course in either performance or student satisfaction. Even in a course on counseling,

which would normally be thought of as requiring human interaction and experiential activities, Murdock et al (2012) found no difference in the skills students developed in online vs F2F modalities. Stack (2015) found no significant difference in performance in a criminology course between online and traditional classes.

Means, et al. (2013) conducted a meta-analysis of the literature on F2F, blended, and fully online classes, for classes that ranged from college or below, as well as graduate school and professional training, with student ages ranging from 13 to 44. The meta-analysis found that, on average, students in online learning conditions performed modestly better than those receiving F2F instruction. The advantage over F2F courses was significant only in those studies contrasting blended learning with traditional F2F courses but not in those studies contrasting purely online with F2F courses.

Studies finding Significant differences

Dutton, Dutton, and Perry (2002) find that students in an online computer science course performed significantly better than in the F2F counterpart. However, they also report that underperforming online students were more likely to drop the course than comparable students in the traditional course. In other words, some of the improvement found may have been the result of a bias in the sample due to weaker students dropping out of the online course. Connolly, MacArthur, Stansfield, and McLellan (2007) studied over 4600 students over a three-year period, in a graduate-level computing course and found that online students consistently outperformed F2F students. Bertus, Gropper and Hinkelmann (2006) report better performance in an online setting for graduate finance majors.

Interestingly, where significant differences were found in the literature, not all were in favor of online classes. While the studies mentioned above report that online learning is superior to F2F learning, other studies find the opposite effect. Controlling for a host of student characteristics including GPA, gender, age, grades on course prerequisites, math background, SAT scores, and outside distractions, Anstine and Skidmore (2005) conclude that learning outcomes for online students are significantly lower than for traditional F2F students. Bennet, Padgham, McCarty and Carter (2007) find that students in a F2F setting earned higher grades in a microeconomics class (a more quantitative class), yet online students performed better in a macroeconomics class (more qualitative content).

Online Asynchronous vs Online Synchronous classes

While most of the studies mentioned above compared F2F with online classes, and some also studied blends of the two, a distinction needs to be made within online classes – that of synchronous and asynchronous modes. Ogbonna, Ibezim, & Obi (2019) studied the effectiveness of the asynchronous and synchronous formats in teaching basic computing skills and found that students' cognitive abilities were improved more in the asynchronous mode, while their skill acquisition was higher in the synchronous setting. On the other hand, Somenarain, Akkaraju & Gharbaran (2010) found no significant difference in the performance of students in a biology course offered in both synchronous and asynchronous modes.

The design of a course thus must consider three possible modalities – F2F, online synchronous, and online asynchronous. As suggested by Gilpin (2020), the modality chosen should consider the three factors outlined in her framework.

On the effect of student choice

A point of debate in these studies and their conclusions is whether students have a choice over whether to take a particular course online or F2F. That is, the finding of no significant difference depends on students being directly placed in each learning environment. In fact, as Allen & Seaman (2014) suggest, much of the current growth in online course offerings occurs in large universities offering both an online section of a course as well as one in a traditional format. In such settings, students are free to choose which delivery mode they prefer.

Gratton-Lavoie and Stanley (2009) investigate the characteristics of students who took an online versus a F2F introductory economics course. They report significant differences in age, gender, marital status, number of dependents, prior coursework, GPA, and projected major. Their raw data show that online students performed much better than F2F students. However, after controlling for individual characteristics, they find no significant difference in learning outcomes between the two groups.

The self-selection bias can manifest itself in terms of vast differences in inherent ability in the sections being compared. Johnson and Palmer (2015), compare the learning outcomes of students who were free to choose between taking a linguistics course either F2F or online and their study found that the online students performed significantly worse. Indeed, the course average for the online class was a full letter grade lower than for the F2F class. However, the average GPA of students in the online class was between 0.255 and 0.424 points lower than that of students who took the F2F class. A similar difference in GPAs was found by Helms (2014) in an introductory psychology course. Those students who chose to take the online section of the course had significantly lower GPAs. They also had more outside distractions (family and job) and time constraints than the students who chose to take the class in a traditional setting. Not surprisingly, the online students demonstrated significantly lower course performance. Both studies suggest that some students choose online courses because they believe an online version of a class will be easier than a F2F version. These students often have lower GPAs, or they are unable to devote the time needed to successfully complete a college level course. Unfortunately for these students, most do not realize that online learning is very challenging and will most likely require more time and discipline than a comparable F2F class (Stanford-Bowers, 2008). Indeed, as suggested by Helms (2014), improved advisement systems for online education are needed.

Chronology of the literature

Table 1 shows the literature over the past two decades that compared online and F2F student performance, in chronological sequence. A quick scan of Table 1 shows that when it comes to student performance across modalities, there is no systematic pattern in these studies to indicate that one modality progressively got better than another over time. No single modality was consistently found to be the best in these studies. This could be attributed to several factors such as student characteristics (ability, maturity and past knowledge of the subject, freedom to choose the modality), online technologies changing over time, and the effective use of the new technology by the instructor.

Table 1
Timeline of studies comparing online and F2F performance

Year	F2F Better	Online Better	Indifferent
1999			Russell
2001		Dutton et al	
2005			Iverson et al
2005	Anstine and Skidmore		
2006		Bertus et al	
2007	Bennet et al		
2007		Connolly et al	
2009			Gratton-Lavoie and Stanley
2011			Euzent et al
2012			Murcock et al
2013			Means et al
2014			Allen and Seaman
2014	Helms		
2015			Stack
2015	Johnson and Palmer		
2016			Girard, et al
2018		Batu et al	
2021		Jones et al	

Methodology

Course Design

This study involves a comparison of student performance across different course modalities in two different undergraduate business courses. The first was a core course for Finance majors, *Valuation of Financial Assets*, while the second was an elective, titled *Foundations of International Finance*. In the core course, we examine the difference between sections delivered F2F with those delivered online in a synchronous format, and in the elective course, we examine the difference between sections delivered F2F with those delivered online in an asynchronous format.

Holden & Westfall (2008) in their guide to instructional media selection, discuss various technologies, and the nature of discourse in different learning environments. They suggest that online synchronous courses are better suited to environments where symmetric (two-way) interaction between the instructor and students is more important, and there is a need for immediate, real-time clarification of concepts. Online asynchronous courses, on the other hand, are best when such interactions are not critical, and students can benefit from imagery and narration. Similarly, Gilpin's (2020) framework suggests the idea of designing the course based on three factors, namely, student motivation, degree of interaction desired, and the flexibility offered to students.

The core course is primarily quantitative and generally more challenging (as a foundational, solitary six-credit course in the curriculum) and therefore requires significant interaction between the instructor and the students. Immediate feedback to the students from the instructor as well as working together in teams during class to solve problems is essential for effective student learning in this course. In addition, it is typically assumed that a student's intrinsic motivation is lower in a mandatory core course than in an elective (Nargundkar & Shrikhande, 2012). The lower level of intrinsic motivation also suggests that greater levels of instructor-student interactions are necessary for student learning. For the online version of this course, the choice was therefore made to deliver it in a synchronous format. Table 2 highlights some of the key features of this course, namely, the course structure, assignments, examinations, and the assessment.

Table 2
FI4000 – Online Synchronous (Core Course)

Aspect	**Face-to-Face**	**Online Synchronous**
Class structure	• Lecture with single/paired exercises • Role-playing or Group-thinking • Problem-solving and Q&A	• Video recordings provided • Breakout exercises; Polls • Bi-weekly problems review
Assignments	• Problem-set submission biweekly • Quantitative group-project analysis • Project report; Excel spreadsheet	• Problem-set submission biweekly • Quantitative group-project analysis • Project report; Excel analysis
Examinations	• Proctored, in-class examinations • Help-sheet, financial calculators • 150-minute duration exams	• Proctored in zoom, with cameras on • Help-sheet, financial calculators • 150-minute duration exams
Assessment	• Self-study and questions in-class • Quality of analysis & accuracy • Rubrics for grading examinations	• Self-study and Chat sessions • Quality of analysis & accuracy • Rubrics for grading examinations

As shown in Table 2, the goal was to make the delivery of both the F2F and the online sections as similar to each other as possible within the constraints of the modalities. The class structure was primarily lecture based, interspersed with single or paired-student learning opportunities in class, and group learning (through breakout rooms in Zoom) in the online sections. Role play was also occasionally used, both in the F2F and the online setting. For example, it was employed to demonstrate time-value-of-money techniques for valuing the investment potential of an MBA or MS-Finance program for the aspirant student. As a quantitative course, regular problem-solving sessions are used at the end of each topic. Polling was another technique used both in the F2F and in the online setting to test student understanding and get periodic feedback. In both modalities, the examinations were of a similar structure and level of difficulty (see Appendix A1 for sample examination questions for FI 4000 from sections offered in each modality). This was true across all semesters used in the study. The group projects and individual examinations were graded manually by the instructor (no teaching assistant was used) in both modalities. Note that the same instructor taught all the sections used in this study.

For the elective course, the assumption was that since students choose this course on their own, their intrinsic motivation to learn would be sufficiently high to make it possible for them to learn without as much direct interaction with the instructor. Here, the benefits of flexibility in timing could trump the need for interaction. Further, the qualitative nature of the course also meant that students could research and discuss material offline, making imagery and narration more important

for conceptual clarity (Holden & Westfall, 2008). For the online version of this course, therefore, the choice was made to deliver it in an asynchronous format, ensuring greater flexibility for the students. Table 3 outlines the structure of this elective course.

Table 3
FI4040 – Online Asynchronous (Elective Course)

Aspect	**Face-to-Face**	**Online Asynchronous**
Class structure	• Lecture with single/paired exercises • Role-playing or Group-thinking • Problem-solving and Q&A	• Videos in classroom setting • E-book written for course • Weekly quizzes, readings
Assignments	• Practice problem-sets with solutions • Case-discussion and analysis • Case-reports	• Weekly quizzes, exercises • Case-discussion and analysis • Case-reports
Examinations	• Proctored, in-class examinations • Help-sheet, financial calculators • 75-minute or 150-minute duration	• Proctored in zoom, with cameras on • Help-sheet, financial calculators • 150-minute duration exams
Assessment	• Self-study and questions in class • Quality of analysis with accuracy • Rubrics for assessing examinations	• Self-study and Chat sessions • Quality analysis & accuracy • Rubrics for assessing exams

As shown in Table 3, the course structure was lecture based in F2F sections, interspersed with single or paired student opportunities following the introduction of a new topic, for example, currency markets or taxation of foreign source income. Role playing was employed to enable students to take on the role of the IRS or that of senior financial managers working for multinational corporations while deciding what is a fair transfer price. Group discussion was used to motivate students to develop approaches for analyzing a case- study on currency risk management and hedging techniques. As a largely qualitative course, regular problem-solving sessions are used at the end of each topic to discuss a smaller case study on the discussed topic. The asynchronous course essentially used creatively produced videos in classrooms or in specially designed recording rooms to simulate a classroom setting or to simulate a tutorial session. An e-book tailor-made for this asynchronous course was written by the instructor and used regularly for weekly quizzes, exercises, and readings on the respective topics discussed in class. The students received practice exams in the online course in lieu of the opportunity to discuss the detailed structure of the exams and practice problems that students had available in the F2F course. As with the core course, in both modalities, the examinations were of a similar structure and level of difficulty (see Appendix A2 for sample examination questions for FI 4040 from sections offered in each modality).

Data Collection

The sample used in this study included 182 students from the core course across five sections from 2017 to 2020, and 225 students from the elective course across six sections, also between 2017 to 2020. Table 4 shows when the sections were taught for each course, their modalities, and the class sizes. It should be noted that the choice of enrolling in a F2F section or an online section was left entirely to the students.

Table 4
Sample Data

Panel A: Core Course (Valuation of Financial Assets)				
Year	Semester	Face-to-Face	Synchronous Online	Asynchronous Online
2017	Fall	1 section (n=38)		
2018	Summer	1 section (n=24)		
2019	Fall	1 section (n=28)		
2020	Summer		1 section (n=54)	
2020	Fall		1 section (n=38)	
Total Sample Size		**90**	**92**	
Panel B: Elective Course (Foundations of International Finance)				
Year	Semester	Face-to-Face	Synchronous Online	Asynchronous Online
2017	Fall			1 section (n=55)
2018	Spring	1 section (n=36)		1 section (n=37)
2019	Fall			1 section (n=37)
2020	Spring	1 section (n=29)		1 section (n=31)
Total Sample Size		**65**		**160**

As shown in Table 4, the data for the core course was collected from Fall 2017 onwards. It was taught F2F for three semesters, following which, it was taught in an online synchronous modality for two semesters. For the elective course, the modalities were F2F and online asynchronous. In two of the semesters, two sections of the course were taught. In each of those semesters, one of the sections was F2F and the other was online asynchronous. In each of the two remaining semesters, one online asynchronous section was offered.

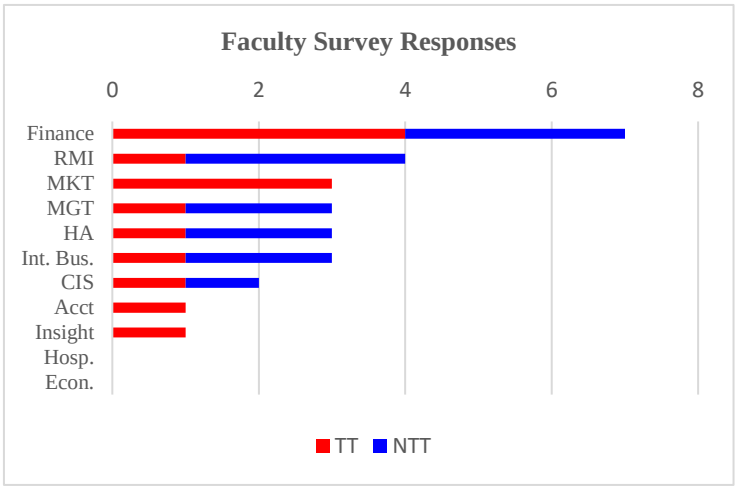
Faculty survey

In addition to comparing student performance between F2F and the online modalities, we wanted to get qualitative input from faculty in the business school regarding their experiences with the different modalities, especially their experiences with the online synchronous versus the online asynchronous modalities. Given the changes in technology in recent years, we wanted to get some social validation for the ideas presented in the literature, in the specific context of our own business school. We surveyed 48 faculty members from 10 different departments, of which 27 faculty members from 8 different departments (Finance, Risk Management, Management, and Marketing, International Business, and CIS, Health Administration, and Accounting) responded with detailed observations. The survey was kept simple, with three broad, open-ended questions:

1. What are pros and cons of the online synchronous and online asynchronous modalities?
2. Which one of the two would you recommend for future use in classrooms?
3. How do the online modalities compare with the F2F experience?

Figure 1
Faculty Survey Responses

Dept	TT	NTT	Total Resp	Total Sent
Finance	4	3	7	14
RMI	1	3	4	4
MKT	3	0	3	5
MGT	1	2	3	5
HA	1	2	3	3
Int. Bus.	1	2	3	5
CIS	1	1	2	4
Acct	1	0	1	4
Insight	1	0	1	2
Hosp.	0	0	0	1
Econ.	0	0	0	1
	14	**13**	**27**	**48**



TT = Tenure Track Faculty; NTT = Non-Tenure Track or Clinical Faculty

Outcome Measures

For the quantitative analysis of student performance, students were evaluated in each course in two ways. First, they were given three modular examinations during the semester in both the core and elective courses. There was no cumulative final exam. Instead, there was a group project in the core course, and a team case analysis in the elective. For this study, it was important to analyze both individual and team performances by comparing them across the two modalities offered within each course. Teamwork poses a different set of challenges in different modalities. For instance, group projects require students to interact with their team members, and such interaction is more challenging online than in F2F groups (Paulsen & McCormick, 2020). As mentioned before, social interaction among students tends to suffer in online environments (Tinto, 1993). However, online meetings offer students greater flexibility in scheduling than F2F meetings.

To assess individual student performance, we averaged the scores on the three modular examinations. The exams consisted of questions at the knowledge, comprehension, and application levels of learning per Bloom's (1956) taxonomy. They included multiple choice questions, numeric computations, and short answer questions to assess conceptual understanding and application of the principles.

Team performances were assessed through their scores on the group projects and the team case analyses, in the core and elective courses, respectively. The team assignments in both courses required students to synthesize concepts from the course and apply them as appropriate (critical thinking levels of learning, per Bloom's taxonomy).

To ensure that the comparisons were meaningful across sections, we collected data on the cumulative GPAs of the students in each section, at the point of entry. Student gender was also noted to check for differences in performance by gender. Further, it should be noted that all the sections listed in Table 1 were taught by the same instructor, to eliminate the variation in student performance due to different instructors.

Analysis

The analysis of the data was conducted in two steps. First, pivot tables (crosstabulations) were created to compute the means and standard deviations of student performance scores and GPAs across sections, segmented by gender and modality.

One way ANOVA was conducted to compare the GPAs of students across all the sections for a given course. The GPA comparison was to ensure that the students in each section being compared were of similar ability over time as well as in the segments being compared. For each course, sections were aggregated into larger segments by modality and by gender. Independent two-sample t-tests were conducted to compare performance (both individual and team) and GPAs across the modalities and genders.

The qualitative survey responses from our faculty colleagues were analyzed to identify common themes that emerged. We elaborate on these themes in the results section.

Results

The results are organized by course, modality, and gender – core course (FI 4000) results are presented in Tables 5a & 5b and Tables 6a & 6b, while the elective course (FI 4040) results are presented in Tables 7a & 7b and Tables 8a & 8b. Tables 5a and 7a answer the question "does modality matter for performance?", while Tables 6a and 8a answer the question "does gender matter for performance"? Tables 5b, 6b, 7b, and 8b all compare GPAs for the relevant segments to check for differences in initial ability.

Table 5a shows the results of student performance by modality for the core course (FI 4000). In Panel 1 of Table 5a, the two modalities are compared for all students, while Panel 2 and Panel 3 break down the comparison by gender. Table 5b is structured in the same way, but compares student GPAs instead of performance, to check if initial student abilities were equal.

Table 5a
FI 4000 (Core) Performance on Exams, by Modality

Panel 1: All Students, across genders

	Face-to-face	Online	p-value
Average	72.23	80.61	0.000 ***
Standard Deviation	12.9	7.82	
Sample Size	90	92	

*** P < 0.01

Panel 2: Females only

	Face-to-face	Online	p-value
Average	70.3	79.81	0.003 ***
Standard Deviation	14.7	9.65	
Sample Size	31	40	

*** P < 0.01

Panel 3: Males only

	Face-to-face	Online	p-value
Average	73.3	81.23	0.000 ***
Standard Deviation	11.9	5.86	
Sample Size	59	52	

*** P < 0.01

Panel 1 shows that the overall performance (average exam scores) in FI 4000 was significantly higher in the online sections compared to the F2F sections. From Panels 2 and 3, we see that this was true also for Female students and Male students considered separately.

Table 5b
FI 4000 (Core) GPAs by Modality

Panel 1: All Students, across genders

	Face-to-face	Online	p-value
Average	3.20	3.20	1.00 (NS)
Standard Deviation	0.52	0.55	
Sample Size	90	92	

NS = not significant

Panel 2: Females only

	Face-to-face	Online	p-value
Average	3.14	3.16	0.87 (NS)
Standard Deviation	0.48	0.54	
Sample Size	31	40	

NS = not significant

Panel 3: Males only

	Face-to-face	Online	p-value
Average	3.22	3.23	0.925 (NS)
Standard Deviation	0.55	0.57	
Sample Size	59	52	

NS = not significant

As seen from the three panels above, there was no significant difference between the GPAs of the students in the two modalities, whether considered overall or split by gender.

In summary, Tables 5a and 5b show that while the students were of similar ability in both modalities, the performance was better in the online modality for both females and males separately as well as when combined across genders.

Table 6a shows the results of student performance by Gender for the core course (FI 4000). In Panel 1 of Table 6a, performance of the two genders is compared for all students, while Panel 2 and Panel 3 break down the comparison by modality. Table 6b is structured in the same way, but

compares student GPAs instead of performance, to check whether initial student abilities were equal.

Table 6a
FI 4000 (Core) Performance by Gender

Panel 1: All Students across modalities

	Female	Male	p-value
Average	75.65	77.00	0.460 (NS)
Standard Deviation	12.93	10.33	
Sample Size	71	111	

NS = not significant

Panel 2: Face-to-face students only

	Female	Male	p-value
Average	70.3	73.3	0.333 (NS)
Standard Deviation	14.7	11.9	
Sample Size	31	59	

NS = not significant

Panel 3: Online Students only

	Female	Male	p-value
Average	79.81	81.23	0.415 (NS)
Standard Deviation	9.65	5.86	
Sample Size	40	52	

NS = not significant

Table 6a shows that there is no significant difference in performance between Male and Female students overall and within each modality. In other words, the modality does not affect the performance of one gender differently from the other. Therefore, performance outcome is not a reason for either gender to prefer one modality over another.

Table 6b
FI 4000 (Core) GPA by Gender

Panel 1: All Students, across modalities

	Female	Male	p-value
Average	3.15	3.23	.318 (NS)
Standard Deviation	0.51	0.55	
Sample Size	71	111	

NS = not significant

Panel 2: Face-to-face students only

	Female	Male	p-value
Average	3.14	3.22	.478 (NS)
Standard Deviation	0.48	0.55	
Sample Size	31	59	

NS = not significant

Panel 3: Online Students only

	Female	Male	p-value
Average	3.16	3.23	.549 (NS)
Standard Deviation	0.54	0.57	
Sample Size	40	52	

NS = not significant

Table 6b shows that there is no significant difference in initial ability between Male and Female students across modalities and within each modality. In other words, male and female students are randomly distributed by ability across the modalities.

In summary, tables 6a and 6b demonstrate that students of both genders were of equal initial average ability, and that their performances were likewise equal in each modality and across modalities.

As with Table 5a, Table 7a shows the results of student performance by modality, but for the elective course (FI 4040). In Panel 1 of Table 7a, the two modalities are compared for all students, while Panel 2 and Panel 3 break down the comparison by gender. Table 7b is structured in the same way, but compares student GPAs instead of performance, to check whether initial student abilities were equal.

Table 7a

FI 4040 (Elective) Performance on Exams, by Modality

Panel 1: All Students, across genders

	Face-to-face	Online	p-value
Average	76.41	81.09	0.000 ***
Standard Deviation	8.14	7.32	
Sample Size	65	160	

*** P < 0.01

Panel 2: Females only

	Face-to-face	Online	p-value
Average	78.46	81.44	0.030 ***
Standard Deviation	5.52	6.78	
Sample Size	26	74	

*** P < 0.01

Panel 3: Males only

	Face-to-face	Online	p-value
Average	75.04	80.78	0.001 ***
Standard Deviation	9.31	7.79	
Sample Size	39	86	

*** P < 0.01

A comparison of the overall performance in FI 4040 showed that the average score was significantly higher in the online sections compared to the F2F sections. This was true for all students combined as well as for Female students and Male students considered separately.

Table 7b
FI 4040 (Elective) GPAs by Modality

Panel 1: All Students, across genders

	Face-to-face	Online	p-value
Average	3.24	3.18	0.331 (NS)
Standard Deviation	0.40	0.46	
Sample Size	65	160	

NS = not significant

Panel 2: Females only

	Face-to-face	Online	p-value
Average	3.31	3.25	0.522 (NS)
Standard Deviation	0.41	0.40	
Sample Size	26	74	

NS = not significant

Panel 3: Males only

	Face-to-face	Online	p-value
Average	3.20	3.12	0.335 (NS)
Standard Deviation	0.39	.50	
Sample Size	39	86	

NS = not significant

There was no significant difference between the GPAs of the students in the two modalities, whether considered overall or split by gender.

In summary, Tables 7a and 7b show that while the students were of similar ability in both modalities, the performance was better in the online modality for both females and males as well as when combined across genders.

As with Table 6a, Table 8a shows the results of student performance by Gender, but for the elective course (FI 4040). In Panel 1 of Table 8a, performance of the two genders is compared for all students, while Panel 2 and Panel 3 break down the comparison by modality. Table 8b is structured in the same way, but compares student GPAs instead of performance, to check whether initial student abilities were equal.

Table 8a
FI 4040 (Elective) Performance by Gender

Panel 1: All Students, across modalities

	Female	Male	p-value
Average	80.67	78.99	0.100 (NS)
Standard Deviation	6.58	8.68	
Sample Size	100	125	

NS = not significant

Panel 2: Face-to-face students only

	Female	Male	p-value
Average	78.46	75.04	0.068 *
Standard Deviation	5.52	9.31	
Sample Size	26	39	

*P < 0.10

Panel 3: Online Students only

	Female	Male	p-value
Average	81.44	80.78	0.567 (NS)
Standard Deviation	6.78	7.79	
Sample Size	74	86	

NS = not significant

Table 8a shows that there is a significant difference (at a 90% confidence level, or alpha = 0.10) in performance between Male and Female students in the F2F sections. Females performed slightly better than males, though the difference is marginal. However, there was no difference in performance in the online sections or when compared overall.

Table 8b
FI 4040 (Elective) GPA by Gender

Panel 1: All Students, across modalities

	Female	Male	p-value
Average	3.27	3.14	.026 **
Standard Deviation	0.40	0.47	
Sample Size	100	125	

** p < 0.05

Panel 2: Face-to-face students only

	Female	Male	p-value
Average	3.31	3.20	.285 (NS)
Standard Deviation	0.41	0.39	
Sample Size	26	39	

NS = not significant

Panel 3: Online Students only

	Female	Male	p-value
Average	3.25	3.12	0.07 *
Standard Deviation	0.54	0.57	
Sample Size	40	52	

*P < 0.10

Table 8b shows that there is a significant difference in initial ability between Male and Female students overall and in the online modality. In other words, female students had a higher average GPA than male students.

In summary, tables 8a and 8b demonstrate that while female students had a higher GPA overall, it did not translate into a significant performance difference. However, when it came to F2F sections, females were not significantly different from males in GPA, but performed better. Conversely, in the online sections, females had a higher GPA than males, but did not perform significantly better. This seems to indicate that F2F learning is more conducive to better performance outcomes for female students in the elective course, at least within our sample.

Table 9 looks at the results of student performance in teams. In the core course, students worked on a group project, while the elective students analyzed a business case study.

Table 9
Group Project / Case Study Performances

Panel 1: FI 4000 (Core)

Modality	**Mean**	**Stdev**	**Number of Groups**	**p-value**
Face-to-Face	91.96	5.24	23	
Online	88.55	5.31	22	**0.036****

Panel 2: FI 4040 (Elective)

Modality	**Mean**	**Stdev**	**Number of Groups**	**p-value**
Face-to-Face	87.22	5.06	18	
Online	85.99	6.31	38	**0.473**

Table 9 shows that in the core course, students did better teamwork when F2F rather than in the online synchronous mode. In the elective course, there was no significant difference in the team performances between a F2F and the online asynchronous mode.

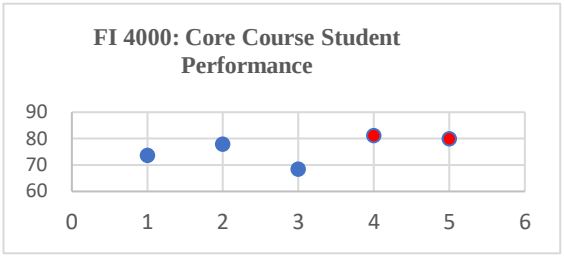
For the core course, with lower initial motivation, interaction in F2F classes seems to be more beneficial to team performance than in the online synchronous setting. However, for the elective course, the greater initial motivation seems to mitigate the lower degree of interaction in the online asynchronous sections, resulting in similar team performance as in the F2F sections.

Given the onset of the pandemic towards the end of our sample period, it is possible that it had some effect on our results. However, given that we are still amid the pandemic, we will need longer term data that spans the entire period from before the pandemic to after it ends to study such an

effect. Another aspect to consider is the anecdotal observation by faculty colleagues and business academics, that the quality of students has declined over time. We therefore examined the data to see if there is any trend in student performance over time. Figure 2 exhibits student performance in the core course, across the semesters included in this study. F2F sections are shown in Blue, while Online sections are shown in Red.

Figure 2
Performance over time for FI 4000 – Core Course

Obs	Semester	Modality	Performance	ANOVA Grouping
1	Fall 2017	F2F	73.69	B, C
2	Sum 2018	F2F	77.87	A, B
3	Fall 2019	F2F	68.39	C
4	Sum 2020	Sync	81.10	A
5	Fall 2020	Sync	79.91	A

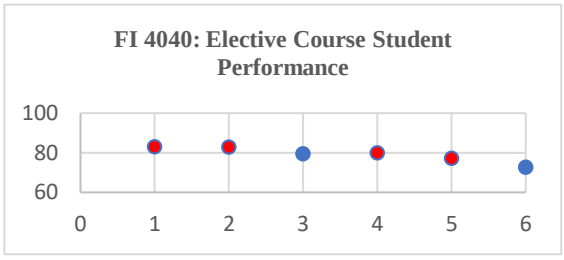


As seen above, contrary to anecdotal observations from faculty across educational institutions of higher learning, there is no downward trend in student performance over time. In fact, the performance in the last two semesters is the highest. It is important to note that those two semesters were also the ones taught online. One-way ANOVA was performed with two-way comparisons using Tukey's method, and the table shows the groupings of student performance based on this analysis. Common grouping letters indicate no significant difference, while different letters indicate that the average performance was different in those groups. For instance, the average for Summer 2020 and Fall 2020 was significantly higher than each of Fall 2017 and Fall 2019, but not significantly different from Summer 2018.

As in Figure 2 with the core, student performance over time for the elective course is shown in Figure 3. Once again, F2F sections are shown in Blue, while Online sections are shown in Red.

Figure 3
Performance over time for FI 4040 – Elective Course

Obs	Semester	Modality	Performance	ANOVA Grouping
1	FA 2017	ASY	82.96	A
2	SP 2018	ASY	82.84	A
3	SP 2018	F2F	79.42	A, B
4	FA 2019	ASY	79.91	A, B
5	SP 2020	ASY	77.06	B, C
6	SP 2020	F2F	72.66	C



The data for the elective course show a decline in student performance over time, consistent with anecdotal observations. For instance, the ANOVA with two-way comparisons shows that the most recent semester (grouping C) had a significantly lower performance than the first four semesters (grouping A and B) in this dataset.

Faculty Survey Results

Since our quantitative analysis did not permit a direct comparison between asynchronous and synchronous modalities, we sought qualitative feedback from faculty to understand the pros and cons of the two online modalities based on their recent experiences. Table 10 shows a summary of the faculty feedback received, organized into three parts, by themes. Broadly, these are instructor related, student related, and technology & administration related dimensions. For each dimension, the pros and cons of the synchronous and asynchronous modalities are compared with the f2f modality as a reference point.

Table 10
Faculty Survey Feedback

Panel 1: Instructor Related

Dimension	Face to Face	Online Synchronous	Online Asynchronous
Instructor Preparation	• Easiest, as most instructors have experience in this mode. Easy to clarify misconceptions.	• Needs more preparation. Must pay attention to technology as well as course content.	• Hardest to set up. Greater planning needed; pedagogy must be adapted for the online world. Set up time is much longer. Need to learn the nuances of the Learning Management System.
Content Type	• Best suited for learning which needs immediate clarification, plenty of give and take. • Quantitative courses likely to benefit from this mode, as well as case discussions.	• Like f2f in many ways, quantitative courses likely to benefit, as well as case-based courses.	• Best for absorption of basic content in small chunks at one's own pace. • Narratives, visualization/imagery based content is better suited to this modality.
Content Presentation/ Student Engagement	• Ability to read body language, eye contact, reading a room. • Immediate questioning and response possible. • Content scope can be adapted according to student understanding and response from one class period to the next. • Can do role-plays, physical activities in groups in class.	• Much weaker sense of body language (Dual monitors, high-tech rooms can enhance this aspect). • Questioning possible as in f2f. • Scope of lecture can be adjusted. • Can discuss in groups, but cannot participate together physically in any role-plays, simulations, etc.	• No direct contact, body language absent. • No back-and-forth dialogue in real time. Questioning possible asynchronously via discussion boards or other tools. Needs constant monitoring. • Posted materials are essentially pre-planned, fixed. • Interaction with other students is limited to what students create among themselves.

Exams/Grading	• Much easier to monitor. Cheating is always possible, but perhaps easier to control.	Easier to cheat on exams since monitoring activities remotely is very difficult.	• Much easier to cheat assuming exams are also asynchronous.

Panel 2: Student Related

Class time	• Fixed class time	• Fixed class time	• Flexible, can study any time.
Student Age/Maturity	• Suitable for all kinds of students	• OK for juniors/seniors, not so good for freshmen/sophomores. Younger students need the in-person college experience for learning and development of social skills.	• Unsuitable for younger students that need the in-person college experience. Best for mature students - graduate students, those with families, full-time jobs.
Student Attendance	• Students generally attend. • Easier to monitor if students distracted, on a phone, etc. • Better sense of control overall for the instructor.	• Good for students that cannot be on campus. • Can log-in and disappear. • Videos may be off • Participation drops off as semester progresses. • Easily distracted. Distractions at home (crying children, other family issues).	• Not an issue. No attendance is required. • Perfect for students with full time jobs, families, those who need to travel for work, or simply those who live too far from campus.
Student Motivation	• Instructors can motivate students in a class. • Students can be a bit passive in a classroom, expecting instructor to tell them exactly what to expect. • F2F can disable student autonomy	• Instructors can motivate, but more discipline needed from students to overcome distractions • Students see synch sessions as a substitute for f2f, and may not see the added difficulties. • Greater autonomy for students in learning.	• Most discipline demanded of students. Must motivate themselves. May need instructors to prod them regularly. • Students expect this mode to be different from f2f, so are better prepared to take charge of their learning. They may work harder and reap the rewards. • Provides greatest autonomy in learning.
Commute	• Wastes a lot of time in traffic. • Frustration/tiredness/hunger due to commute. • Cost of driving, parking can be significant.	• No commute	• No commute

Panel 3: Technology & Administration Related

Technology	• Classrooms, instructor workstation (internet enabled), projection equipment.	• Connecting software like Zoom, WebEx, Teams, etc. • Document camera is useful. • Independent microphone to enhance audio. • Good broadband connection. • Ideally more than one monitor to see all or most students.	• A good learning management system. • Basic computer with ability to communicate with students.
Scalability/Cost	• Most classes limited in size to between 20 and 60, though in some cases class size can be quite large. • Most expensive, with classroom space needed in addition to technology and instructor presence.	• Scalable to any size in theory, though still limited if interaction is important for pedagogy. • Less expensive for all – no classrooms or commute needed.	• Scalable to any size in theory. Limited by ability to grade, conduct online discussions, etc. • Higher setup cost for instructor, but cheapest way to deliver content in the long run.

In response to the question about their preference of modality, faculty by and large indicated that a hybrid approach combining the best elements of the synchronous and asynchronous modalities may be the most effective.

Discussion

Course Design and Modality Choice

The choice of modality for a course is often determined not by the instructor, but by the department or college concerned, based on the nature of the program and the course concerned. This decision is generally limited to whether the course will be offered F2F or online. However, the instructor may have some leeway in deciding whether the online course will be synchronous or asynchronous in nature. Whoever decides on the type of modality should consider some of the factors outlined in this paper, and summarized in Table 11.

As indicated in the literature, social interaction (student-student and student-instructor) is a key factor in student learning. This interaction has traditionally been easily facilitated in the F2F environment. The online synchronous environment permits similar interactions among students through breakout sessions, but student-instructor interactions are a bit more difficult in this setting. Asynchronous settings provide the least amount of interaction opportunities. In theory, students could choose to interact online even in an asynchronous setting, but this requires initiative on their part, and is thus an added cost to the creation of interactions. Such interactions are therefore less likely to occur in asynchronous settings.

Table 11
Factors affecting the modality decisions

Modality	Social Interaction	Flexibility	Available Tools
Face-to-Face	High	Low	Standard classroom with instructor workstation with internet connection
Online Synchronous	Medium/High	Medium	Video conferencing ability in classroom or home (Zoom, WebEx, MSTeams, etc.). Ability to create online interaction with breakout rooms, polling, etc.
Online Asynchronous	Low	High	Secure site for storage of course material accessible to students and instructors for uploading material (readings, ppts, videos, assignments, exams).

Flexibility works in reverse compared to social interaction, in the sense that the asynchronous format offers students and faculty the greatest amount of flexibility. There is no set time required for attending class, and no commute to class. Aside from the basic structure required due to exam dates or assignment/project due dates, students are free to decide when to work on the course. In a synchronous setting, while there is still no commute, there is a fixed time for attending class. In a F2F setting, both the commute as well as the fixed time for attending class, take away the flexibility.

For the courses discussed in this paper, the F2F modality has been traditionally used for decades. Starting in 2017, the elective course was also offered in an online format, while the core course started being offered online only in 2020. In making the choice between asynchronous and synchronous formats for these two courses, the factors discussed above were considered, as was the fact that one of them was a core course for finance majors while the other one was an elective course. This is because the literature indicates that the initial motivation of a student in a core course is generally lower than in an elective course since the former is mandatory. Given the lower motivation of the students in the core course, it was thought that greater interaction would serve them better than greater flexibility. Further, the subject matter of this course was primarily quantitative in nature, and therefore more challenging for many students. Finally, this is a foundational, six-credit course where immediate response to student questions was seen as more important, thus deserving the synchronous modality. Likewise, given the higher motivation of the students in the elective course, the need for social interaction as a motivator would be lower, and hence they would benefit more from the greater flexibility afforded by the asynchronous format. Also, the elective course was less quantitative in nature, and was likely to benefit from the greater emphasis on narratives and imagery in the eBook and in the videos (that simulated the lecture format by recording the videos in executive education classrooms, and that simulated the tutorial format with problem solving sessions in state-of-the -art video recording-rooms) which were provided in the asynchronous content.

Interpretation of Results

The results clearly show better student performance in the online sections when compared to the F2F ones. There are, however, some nuances to consider.

First, in the core course, the exam scores improved about 8% for all the students, from about 72% in the F2F sections to about 80% (statistically significant) in the online sections. This improvement was about the same for both male students as well as female students. When student performance was compared between genders, overall (F2F and online modalities combined) or within each modality separately, there was no significant difference. In terms of group work, however, performance was better in the F2F environment. This is perhaps because the creation of a team report is facilitated more effectively when students are F2F. The students' initial ability as captured by their GPA at the point of entry was not significantly different for the segments compared in any of the cases above.

For the elective course too, the results show a significant improvement in student performance in the online sections when compared to the F2F ones. The scores improved about 5%, going from about 76% in the F2F sections to 81% in the online sections. This improvement was significant when broken down by gender as well. When the genders were compared with each other overall (F2F and online modalities combined), there was no significant difference in performance between male and female students. While this was also true for the online sections, it was not the case for the F2F sections. Female students outperformed the males in the F2F sections even though their initial GPAs were not significantly different. The difference was small, and likely specific to our sample. In the case analyses presented by teams, no significant difference in performance was found between the F2F and the online modalities. There was no significant difference in the GPAs of the students in the segments compared above.

Why was student performance better online?

The study finding that student learning outcomes and performance in the online modalities was better than in the F2F classrooms for both the core and the elective course leads us to propose some plausible reasons that may explain these results.[1]

1. The instructor's choice of the appropriate modality for each course may be a reason for improved student performance. Several of the components identified by respondents in the faculty survey are consistent with reasons for our course design discussed earlier (and summarized in Table 11) – synchronous for core course, and asynchronous for elective course.
2. Choosing between F2F and online sections was left up to the students. This self-selection could have led to better outcomes for the students in the online sections, since they were perhaps the ones who found that modality more suitable to their learning preferences.
3. Stanford-Bowers (2008) argue that "students do not realize that online learning is very challenging and will most likely require more time and discipline than a comparable F2F class." One logical conclusion from this statement is that when you are required to give more time and effort, the outcome is bound to be better. Student feedback received

[1] We thank the anonymous referee who thoughtfully suggested some of the plausible reasons for these findings.

by one of our faculty colleagues over several years of online teaching corroborates it, and can be paraphrased as: "we worked harder and learnt better; so, we would recommend online learning to students who want to work hard and also do well."

4. The prevalence of more sophisticated and user-friendly technology allows for high interactivity and amazing visual presentation. So, the necessary and sufficient condition for better student learning outcomes in online modalities seems to be sophisticated, user-friendly technology used to advantage by resourceful instructors. The greater familiarity and ease of dealing with technology among both instructors and students in recent years may have also played a part in the improved outcomes in online modalities compared to the F2F classes.
5. Better focus on self-study that is made possible with online education due to cutting back on commuting and wasteful expenditure of time and energy could be another strong reason for online modalities leading to better learning outcomes.

Possible Confounding Factors

There are some confounding factors that may explain some of the variation in student performance in the online and F2F modalities. These factors and our efforts to control their effects are discussed below.

1. Instructor effects: Different instructors for different sections can lead to variations in student performance. To control for this effect, the sections chosen in this study were all taught by the same instructor. As discussed earlier in the course descriptions, the assessment of student performance was done consistently by the instructor, both in terms of exam design and exam grading.
2. Cheating online: To address the possibility of increased cheating online, due precautions were taken, that included requiring students to have their cameras on during exams while the instructor proctored the exam and using turn-it-in software to check for obvious cases of plagiarism. Also, the exams were designed to be open book and notes requiring students to think beyond what they read in the book, and simply looking up material online would not provide them with the answers. While this does not guarantee absence of cheating, it reduces the likelihood that cheating contributed to student performance.
3. Leniency in grading due to the pandemic: There was no conscious choice made by the instructor to grade more easily after the onset of the pandemic (applies only to the core course since the data do not include the Summer 2020 and Fall 2020 semesters for the elective course).
4. Decline in student quality over time: Anecdotally, faculty speak of a decline in student quality in recent years. Figure 2, however, shows that student performance in the core course not only did not decline, but seems to show a slight improvement over time. It should be noted that the last two observations in this timeline are the online sections with better student performance. In other words, the online modality seems to have trumped a possible decline in student quality. Interestingly, in the elective course (shown in Figure 3), there is indeed a steady decline in student performance over time. The online sections still exhibit better student performance than the F2F sections, but the declining trend is evident within the online modality and within the F2F sections.

5. For both the core and elective sections, we again analyzed the GPAs by section (over time) using ANOVA and pairwise comparisons (see Appendices B1 & B2). We found no significant difference in initial ability of the students. Inconsistency in the downward trend between the core and elective courses leads us to speculate that the downward trend observed in the elective course may simply be an aberration.

Suggestions For Instructors

Within the broader decision of online synchronous vs online asynchronous modalities, there are nuances to consider in the delivery of a course. The improvement in student performance online compared to the F2F classes seen in this study can be attributed broadly to the course design using the online synchronous modality for the core course and the online asynchronous modality for the elective. However, some points of detail in each case may be worth considering.

For the core course, interaction among students was ensured through breakout sessions in zoom. Zoom permitted the instructor to move around among the breakout rooms and observe the interactions and help them as needed. In fact, it was observed that students felt less restricted in their interactions with each other in the breakout rooms than even in a F2F setting, perhaps because the instructor was not always monitoring their discussion. Also, in a F2F classroom, group interactions require physical movement that is awkward and tedious. In some F2F classrooms with chairs rigidly fixed, it becomes even more difficult. The instructor-student interaction was facilitated with the polling feature, which also permitted the instructor to share the findings with the students immediately, replicating the process followed in a F2F classroom by asking for a show of hands for responding to questions. The polling feature also permitted the instructor to get feedback from the students by asking questions about features of the class, about difficulties they were having, etc., just as one might be able to do in a F2F classroom. However, the online poll allows the student to be anonymous in responding and is more likely to elicit honest responses. Also, the synchronous sessions were all recorded, and the recordings made available to students, so they had the ability to rewatch the session in portions or in its entirety, something traditional classes generally do not provide.

For the elective course, delivered asynchronously, both readings and videos of lectures were posted online to the Learning Management System (LMS). An eBook was created especially for the course to enable systematic tracking of the asynchronous material as an alternative to watching videos. To ensure that they kept up with the work each week, some form of assessment was included in the course every week. This was in the form of either quizzes at the end of a video lecture, or a case study report and discussion, as well as modular exams.

In both courses, office hour equivalents were offered through drop-in sessions via zoom. These were optional, and recorded. This offered students a chance to ask questions as they might in an office hour. However, it was more beneficial than traditional office hours, since there was no commuting involved for students. Thus, it was noticed that more students took advantage of this offer throughout the semester. Also, students that could not make it to the drop-in session due to a time conflict could simply watch the recording of that session later. Also, students spoke of the benefit of being able to watch and review videos as often as needed.

An interesting note about the improved performance in the online classes when compared to F2F, is that in both classes, the average exam score increased to about 80%. However, the average score in the F2F setting was about 72% in the core course and about 76% in the elective course. This is consistent with the idea that students have greater initial motivation in elective courses, and

therefore likely to perform better than in a core course. However, by appropriately choosing the right online modality (synchronous or asynchronous) based on the type of course (core or elective), the performance in both classes was improved and equalized.

Conclusion

This study focuses only on undergraduate finance courses at a large public university. The study could be extended to other disciplines to determine if there is a clear benefit to online classes compared to traditional F2F ones. Also, a direct comparison of synchronous and asynchronous modalities for the same course would help understand the pros and cons of choosing these modalities for core and elective courses. The courses and sections used in this study were all taught by the same instructor, to control for instructor effects. This precluded the use of all different modalities in the same semester since that would have introduced the confounding effect of having different instructors. A key conclusion from this study is that courses can be designed effectively in the online modalities to ensure better student learning and performance. It is important for instructors to think about the suitability of the online asynchronous and online synchronous modalities based on the subject matter and other factors discussed in this paper.

As a further note, hybrid offerings that combine synchronous and asynchronous modalities may be the future of online education. Given the pros and cons of each online modality, no single modality may be the best. Instructors may find that mixing modalities according to the learning needs of the students and the nature of the subject matter may be the way forward.

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Appendix A1
FI4000 Exam Questions: F2F and Online Synchronous sections

Summer 2018 F2F

Let an investor be considering two risky portfolios: X and Y to construct a complete portfolio C with a riskfree asset. The reward-to-variability ratio of portfolio X is 0.18 and reward to variability ratio of portfolio Y is 0.14. Choose TRUE/FALSE for the following statements.

A. Lower reward-to-variability ratio of portfolio Y implies that its capital allocation line is steeper than that of X.

   (TRUE/FALSE)

Fall 2019 F2F

Let an investor be considering two risky portfolios: X and Y to construct a complete portfolio C with a risk-free asset. The reward-to-variability ratio of portfolio X is 0.18 and reward to variability ratio of portfolio Y is 0.14. Choose TRUE/FALSE for the following statements.

A. Higher reward-to-variability ratio of portfolio Y implies that its capital allocation line is not steeper than that of X.

   (TRUE/FALSE)

Summer 2020 Synchronous

A pension fund manager is considering three mutual funds. The first is a stock fund, the second is a long-term government and corporate bond fund, and the third is a T-bill money market fund that yields a sure rate of 5.5%. The probability distributions of the risky funds are:

	Expected Return	Standard Deviation
Stock fund (S)	15%	32%
Bond fund (B)	9	23

The correlation between the fund returns is 0.15.

What is the Sharpe ratio for the minimum variance portfolio (MVP)?

[Hint: The minimum-variance CAL is the line joining the risk-free asset to the minimum-variance portfolio (MVP). Now calculate slope of line after characterizing the minimum-variance portfolio.]

Fall 2020 Synchronous

You are considering investing in three different assets. The first is a stock, the second is a long-term government bond and the third is a T-bill money market fund that yields a sure rate of 5%. The probability distributions of both the risky assets:

	Expected Return	Standard Deviation
Stock (S)	15%	32%
Bond (B)	9	23

The correlation between the stock and bond returns is 0.10.
Compute the expected return and standard deviation of the optimal risky portfolio (aka optimal tangency portfolio).

Appendix A2
FI4040 Exam Questions: F2F and Online Asynchronous sections

Spring 2017 F2F

The Chinese yuan was reset from 8.28 Yuan / $ to 8.11 Yuan / $ in July 2005. If Cnooc (Chinese corporation) had agreed to acquire Unocal (US corporation) before July for a pre-set price in dollars,

a) Cnooc would pay more in Yuan for Unocal after July
b) Unocal would receive less in dollars from Cnooc after July
c) Cnooc would get to save Yuan on the acquisition after July
d) Unocal would receive more in dollars from Cnooc after July

Spring 2018 F2F

The Chinese yuan was reset from 8.28 Yuan / $ to 8.11 Yuan / $ in July 2005. If Cnooc (Chinese corporation) had agreed to sell its US subsidiary before July for a pre-set price in dollars,

a) Cnooc would receive less in dollars for it after July
b) Cnooc would get less in Yuan from it after July
c) Cnooc would receive more in Yuan on the sale after July

Spring 2019 F2F

Link Technologies' (LT) hedging strategies
LT used currency futures and currency options to hedge against exchange risk. Suggest at least one statistical technique for ascertaining whether LT was correctly hedging against exchange risk while using these derivative contracts. Explain how the statistical technique you suggest helps in determining that the hedging is being correctly implemented.

[Hint: Use the learning from your first case-study in answering this question]

Fall 2019 Asynchronous

LT used currency futures and currency options to hedge against exchange risk. Choose one of two techniques: correlation test and variance test. Explain how the statistical technique you choose helps in determining that the hedging is being correctly implemented.

[Hint: Use the learning from your LT case-study in answering this question]

Appendix B1

FI 4000
One-way ANOVA: PRIOR_GPA versus YearSem

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	α = 0.05

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
YearSem	5	2017Fall, 2018Summer, 2019Fall, 2020Fall, 2020Summer

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
YearSem	4	2.244	0.5611	1.99	0.098
Error	177	49.940	0.2821		
Total	181	52.185			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.531178	4.30%	2.14%	0.00%

Means

YearSem	N	Mean	StDev	95% CI
2017Fall	38	3.2897	0.5693	(3.1197, 3.4598)
2018Summer	24	3.1150	0.4448	(2.9010, 3.3290)
2019Fall	28	3.1389	0.5191	(2.9408, 3.3370)
2020Fall	38	3.3568	0.5844	(3.1868, 3.5269)
2020Summer	54	3.0839	0.5044	(2.9412, 3.2265)

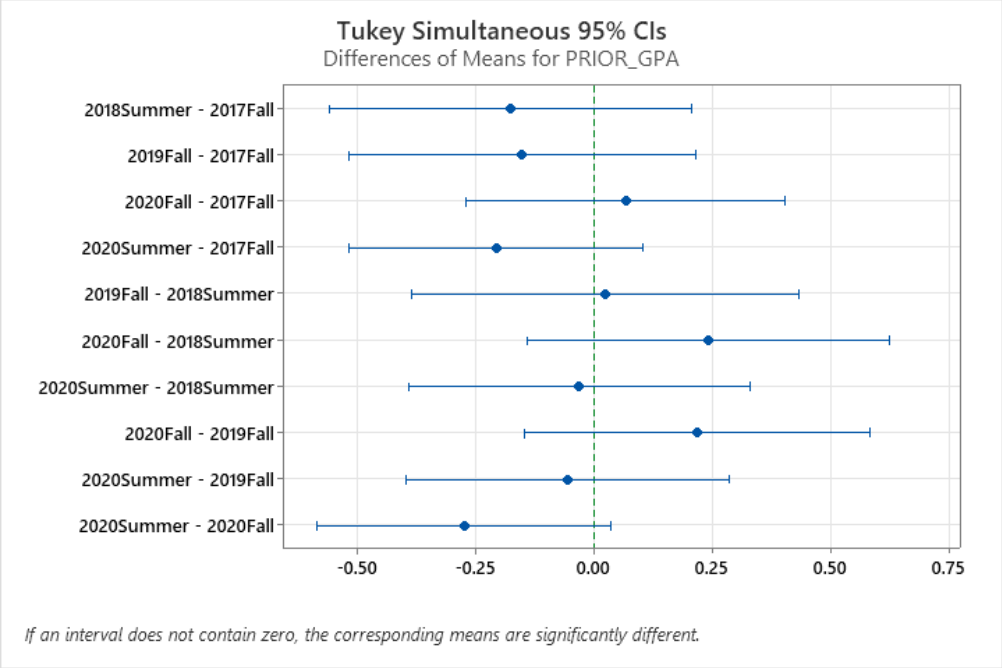
Pooled StDev = 0.531178

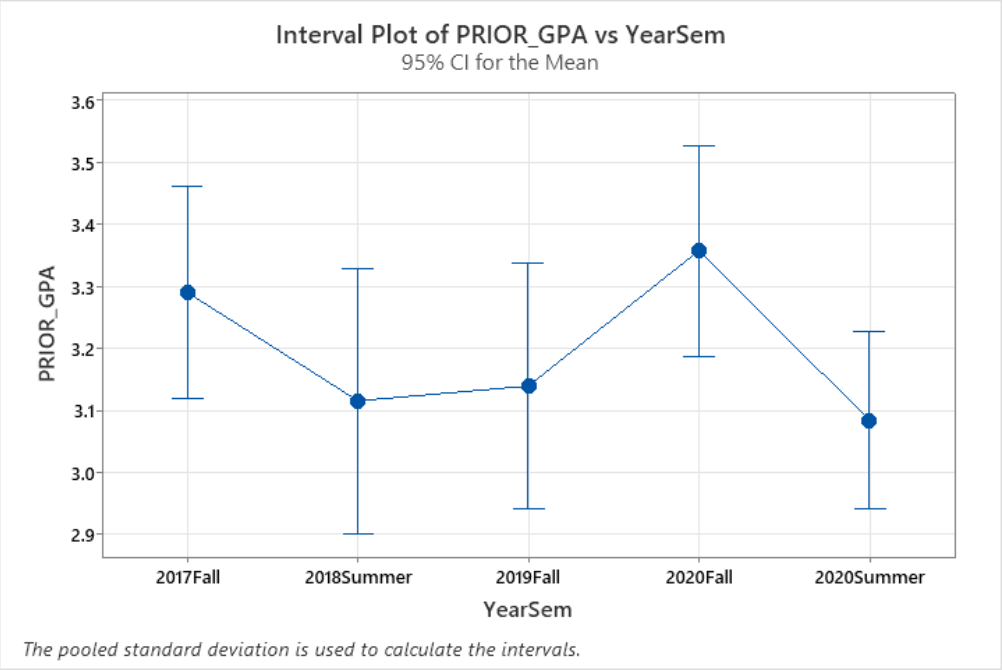
Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

YearSem	N	Mean	Grouping
2020Fall	38	3.3568	A
2017Fall	38	3.2897	A
2019Fall	28	3.1389	A
2018Summer	24	3.1150	A
2020Summer	54	3.0839	A

Means that do not share a letter are significantly different.


Tukey Simultaneous 95% CIs
Differences of Means for PRIOR_GPA
2018Summer - 2017Fall
2019Fall - 2017Fall
2020Fall - 2017Fall
2020Summer - 2017Fall
2019Fall - 2018Summer
2020Fall - 2018Summer
2020Summer - 2018Summer
2020Fall - 2019Fall
2020Summer - 2019Fall
2020Summer - 2020Fall
-0.50
-0.25
0.00
0.25
0.50
0.75
If an interval does not contain zero, the corresponding means are significantly different.


Interval Plot of PRIOR_GPA vs YearSem
95% CI for the Mean
PRIOR_GPA
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2017Fall
2018Summer
2019Fall
2020Fall
2020Summer
YearSem
The pooled standard deviation is used to calculate the intervals.

Appendix B2

FI 4040
One-way ANOVA: PRIOR_GPA versus YrSemMode

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	α = 0.05

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
YrSemMode	6	2017FallOnline, 2018SpringF2F, 2018SpringOnline, 2019FallOnline, 2020SpringF2F, 2020SpringOnline

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
YrSemMode	5	0.4144	0.08288	0.42	0.835
Error	219	43.2495	0.19749		
Total	224	43.6639			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.444394	0.95%	0.00%	0.00%

Means

YrSemMode	N	Mean	StDev	95% CI
2017FallOnline	55	3.1332	0.4416	(3.0151, 3.2513)
2018SpringF2F	36	3.2269	0.4513	(3.0810, 3.3729)
2018SpringOnline	37	3.1905	0.5056	(3.0466, 3.3345)
2019FallOnline	37	3.1932	0.4547	(3.0493, 3.3372)
2020SpringF2F	29	3.2638	0.3365	(3.1012, 3.4264)
2020SpringOnline	31	3.2265	0.4387	(3.0691, 3.3838)

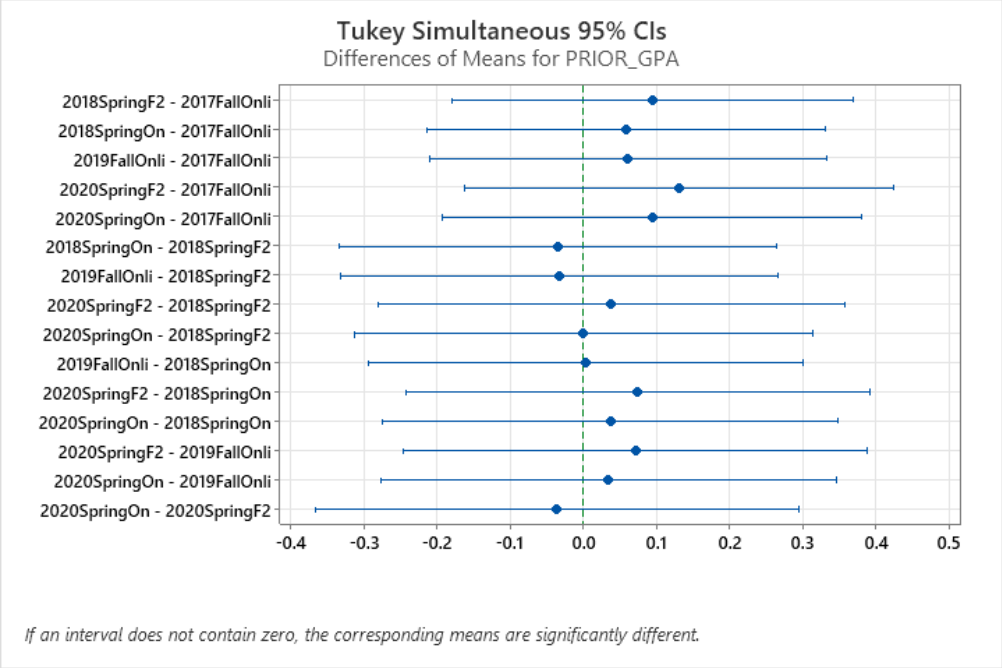
Pooled StDev = 0.444394

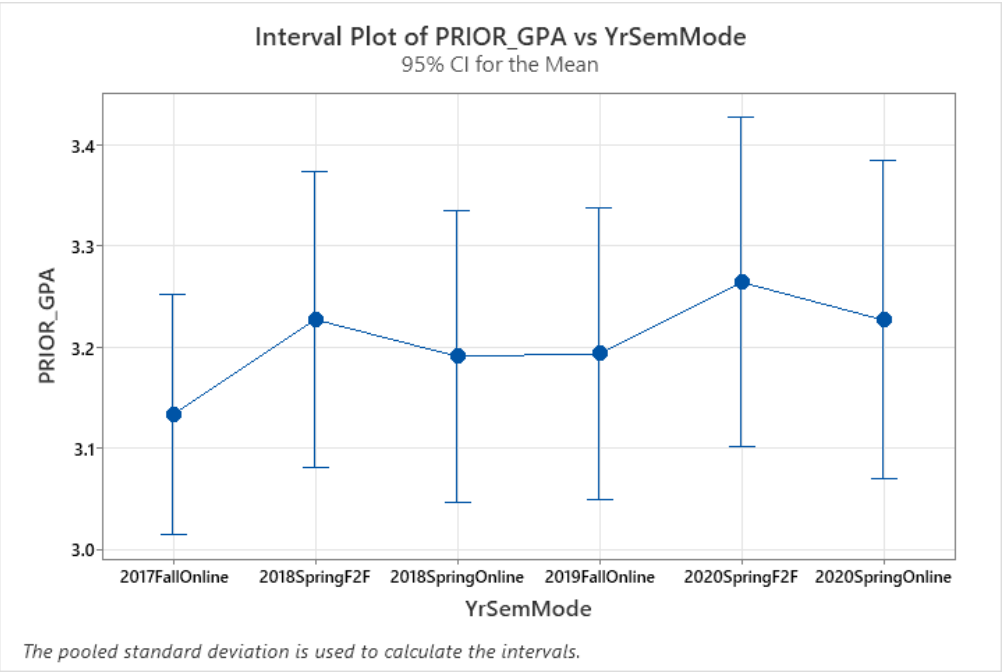
Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

YrSemMode	N	Mean	Grouping
2020SpringF2F	29	3.2638	A
2018SpringF2F	36	3.2269	A
2020SpringOnline	31	3.2265	A
2019FallOnline	37	3.1932	A
2018SpringOnline	37	3.1905	A
2017FallOnline	55	3.1332	A

Means that do not share a letter are significantly different.


Tukey Simultaneous 95% CIs
Differences of Means for PRIOR_GPA
2018SpringF2 - 2017FallOnli
2018SpringOn - 2017FallOnli
2019FallOnli - 2017FallOnli
2020SpringF2 - 2017FallOnli
2020SpringOn - 2017FallOnli
2018SpringOn - 2018SpringF2
2019FallOnli - 2018SpringF2
2020SpringF2 - 2018SpringF2
2020SpringOn - 2018SpringF2
2019FallOnli - 2018SpringOn
2020SpringF2 - 2018SpringOn
2020SpringOn - 2018SpringOn
2020SpringF2 - 2019FallOnli
2020SpringOn - 2019FallOnli
2020SpringOn - 2020SpringF2
-0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5
If an interval does not contain zero, the corresponding means are significantly different.


Interval Plot of PRIOR_GPA vs YrSemMode
95% CI for the Mean
PRIOR_GPA
3.4
3.3
3.2
3.1
3.0
2017FallOnline
2018SpringF2F
2018SpringOnline
2019FallOnline
2020SpringF2F
2020SpringOnline
YrSemMode
The pooled standard deviation is used to calculate the intervals.

The Impact of Instructional Delivery Misalignment on Student Performance of Finance Courses

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This paper investigates the impacts of instructional delivery alignment/misalignment on student performance in finance courses. We define instructional delivery modality as aligned if the actual delivery format of a course is the same as a student's preferred format and misaligned if different. Controlling for factors that could impact student performance, we find that instructional delivery alignment improves student performance whereas misalignment impairs it. Further analysis shows that these findings are especially pronounced for in-person undergraduate and asynchronous online graduate finance courses. Our paper adds to the existing literature by discovering the significance of instructional delivery alignment/misalignment on student learning outcomes and highlighting the importance of universities providing students with a variety of instructional delivery modalities of finance courses.

Keywords: Instructional delivery alignment/misalignment, student performance, finance courses, instructional delivery modality/format, online learning

Introduction

The landscape of higher education has experienced significant transformation in the recent decade as online education shakes up every corner of the playing field. According to the report by U.S. Department of Education (2019), over one third of the students in U.S. post-secondary institutions had taken some distance education courses in fall 2018. More recently, Covid-19 pandemic drastically accelerated online course adoption by colleges and universities. Many institutions cut the number of in-person courses and provided more online options during the pandemic. The sudden and massive shift from in-person to online instruction raises interesting questions: Does online learning fit everyone? Does instructional delivery misalignment impact student performance?

To better understand the rationale behind student preference for one instructional modality over another, we often ask students the following survey question in a course: Would you prefer to take this course online or in a traditional classroom and why? The following are two typical feedback from students:

> "*I easily get distracted when I am on the computer or any other electronic devices. I prefer a face-to-face class because I get a chance to ask questions during or after class and it is easy for me to understand the course. I have tried some online classes, but I*

do not like them. I take courses online sometimes because I don't have a choice." – Spring 2019

"*I prefer online courses because I can work around my volunteer and other schedules with more flexibility. I can manage my time effectively and multi-task to complete all my obligations. Also, I live an hour away from the campus, so logistically, it's more convenient.*" – Spring 2019

It is evident, from these responses, that students have different preferences for course delivery modality, and they are not always offered the option of their preferred formats. Hence, there exists a misalignment between the actual and preferred instructional delivery formats among students. This misalignment could be further exacerbated during the pandemic when students who prefer in-person instruction have no choice but to take classes online. Similarly, students who prefer online courses may have to take in-person classes if their institutions offer no online options. In this study, we investigate whether instructional delivery alignment/misalignment impacts student performance in finance courses. More specifically, we examine whether misalignment impairs student performance while alignment encourages better performance.

Extant literature has examined different factors that could impact student performance. For instance, a large body of research (e.g., Bredthauer & Fendler, 2016; Didia & Hasnat, 1998; Sen, et al., 1997; Terry, 2002) finds strong evidence that student cumulative GPA is a key determinant of student success in finance courses. Other studies (e.g., Borde, 2017; Didia & Hasnat, 1998; Mahbobi, 2012; Pilloff & Kling, 2017; Rich, 2006; Sen et al.,1997; Terry, 2002) indicate that factors such as student gender, age, major, effort, outside distractions, performance in prerequisite classes, and predictability of schedule are related to performance in finance courses. Moreover, Fendler et al. (2011) document that course delivery modality impacts student performance in finance courses of different learning levels. Still, as online learning becomes increasingly prevalent and institutions offer multiple course delivery modalities to students, little is known about the effects of instructional delivery alignment/misalignment on students. Our research aims to fill this gap.

The sample in this study consists of 269 students of three finance courses from two large regional public universities during spring, summer, fall 2019, and summer 2020. Students develop preference for course delivery modality per their prior experience in taking in-person and online courses. We define course delivery modality as (mis)aligned if a student's actual instructional delivery is (different from) the same as her preferred format. Controlling for possible factors that could impact student performance (e.g., Bredthauer & Fendler, 2016; Terry, 2002), we find that instructional delivery misalignment negatively affects student performance, whereas alignment positively contributes to student performance in the overall sample.

We next partition the overall sample into subgroups and test the robustness of the results across the subsamples. We find that the negative relation between instructional delivery misalignment and student performance is especially pronounced for in-person undergraduate and online graduate subsamples. More specifically, for undergraduate in-person courses, our results suggest students with misaligned course delivery format (those who prefer online instruction) tend to perform worse than students with aligned instructional delivery (those who prefer in-person instruction). For undergraduate online courses, students with misaligned course delivery format (those who prefer in-person instruction) do not significantly underperform students with aligned instructional delivery (those who prefer online instruction). These different results between undergraduate in-person and online subsamples could arise from factors that influence student preference for a specific course delivery format. Prior studies (e.g., Jose et al., 2019; Oh & Lim, 2005; Zacharis,

2011) document that student preference for online instruction is mainly driven by lifestyle factors such as work schedule, flexibility, convenience, and family commitments. Student preference for in-person instruction could be more of a result of her learning style. For instance, some students learn more effectively interacting with instructors and peers in a classroom. As such, our findings further suggest lifestyle factors that influence student preference for online instruction have negative effects on performance if these students cannot take courses online, while learning style that contributes to student preference for in-person instruction has insignificant impact on student performance in undergraduate courses. Different from undergraduate online courses, we find a significant and negative relation between misalignment and student performance for graduate online sample. Specifically, students with preference for in-person instruction do perform worse than those with preference for online instruction in graduate online courses. This result implies that the impact of learning style on student performance is more pronounced for graduate courses that assess higher learning levels.

Moreover, we find evidence consistent with prior studies that student GPA is a vital factor in determining student performance in finance courses. Lastly, we report that student gender, major, age, cumulative credit hours taken, outside distractions, transfer status, and other factors play somewhat less significant roles in affecting student performance.

Our paper contributes to the existing literature in several aspects. We are the first study to examine the effects of instructional delivery alignment/misalignment on student performance in finance courses. Our findings provide practical implications to university administrators on course offering planning and to students on selecting courses of different delivery modalities. Secondly, our sample is drawn from students enrolled in two large regional public universities – one from the Upper Midwest of the U.S. and the other a historically black university in the Southwest of the U.S., and thus represents a diverse body of students. Thirdly, our study consists of two undergraduate finance courses and one graduate finance course and is broader than many other studies that usually examine courses either at an undergraduate or a graduate level. Although our study focuses on finance courses, we believe the implication of our findings could be extended to other disciplines.

The rest of the paper is organized as follows. Section 2 reviews existing literature. Section 3 describes the data and methodology used in the study. Section 4 discusses our findings, and Section 5 concludes the paper.

Literature Review

Student Preference for Instructional Delivery Modality

Extant literature has documented that lifestyle and learning style could impact student preference for instructional delivery modality. Using a sample of 104 students enrolled in various online courses, Oh and Lim (2005) find that students' previous online learning experiences and computer competency, but not learning styles, are strongly related to student preference for online instruction. Thompson et al. (2008) examine students in two graduate courses delivered via an asynchronous online format and a blended format with a significant in-person component and find that students choose the online asynchronous format because of the greater flexibility and independence it offered. Zacharis (2011) investigates the role of learning style and finds it has no impact in student instruction delivery method selection. He instead finds that lifestyle is an important factor influencing student selection of course delivery format – students perceive online

courses to provide greater flexibility and convenience. More recently, Jose et al. (2019) investigate the learning styles among 167 students enrolled in two courses with both in-person and online versions. Consistent with Zacharis (2011), Jose et al. (2019) find that student lifestyles, such as work schedule, family obligations, and personal commitments, drive course modality selection. In sum, the extant literature has suggested that lifestyles, but not learning styles, significantly influence student preference for a specific instructional modality.

Determinants of Student Performance

Abundant research has examined the determining factors of student success in finance, economics, and accounting courses. Sen et al. (1997) investigate the impact of major on student performance in an introductory finance course using data from two large public universities. They find that GPA and prerequisites significantly impact student performance in the course. Sen et al. also report that finance and non-business majors perform better than average business students in the course. Didia and Hasnat (1998) study the determinants of student performance in an introductory finance course and report that student GPA is a key predictor of student performance. Didia and Hasnat also find that students with better performance in accounting, math, and economics tend to perform better in the introductory finance course, and student gender is unrelated to student performance. Terry (2002) uses a large sample of students to explore determining factors of student performance in an introductory corporate finance course. He finds that student GPA, student past performance in prerequisite classes, major, and gender are all determining factors of student performance. Rich (2006) investigates the effect of student effort on student learning outcome. He finds that student effort, measured as number of days used for homework preparation and participation in class discussion, significantly influences student exam score. Mahbobi (2012) examines the relationship between students' past academic performance in high school and student likelihood of success in first-year economics courses. He finds that student age and previous academic performance are significant predictors of student performance in first-year economics courses. Additionally, Mahbobi (2012) reports that male students tend to have a higher chance of success in completing macroeconomics course than female students.

Bredthauer and Fendler (2016) examine the key factors of success in an online core finance course and find that student college GPA, major, and student satisfaction are positively related to student success of the course, whereas outside distraction, total semester hours taken, and gender (i.e., female) are negatively associated with student performance. Pilloff and Kling (2017) study the impacts of student employment status, course retake, and transfer status on student performance in an introductory finance course. They find that higher employment is related to poor performance in the course, whereas repeating a course is related to improved performance. They further report that student transfer status is unrelated to student performance. Examining the factors that could affect student performance in intermediate corporate finance courses, Borde (2017) finds that student high school GPA is positively associated with student performance, and male students and students who had high-school education in the U.S. tend to perform better than female students and students who earned high-school education outside the U.S.

To sum up, extant literature has consistently demonstrated the significance of GPA in determining student success in finance courses. Almost all the studies that examined the determinants of student performance have shown that GPA, whether it is high school or college GPA, is a strong predictor for student success in finance courses. Besides GPA, other student

characteristics such as previous academic experience, major, gender, and efforts also impact student performance.

Another strand of research that examines the determinants of student performance focuses on the relation between learning style and student performance. These studies produce mixed results. Some studies (e.g., Aragon et al., 2002; Ashraf et al., 2013; Terrell & Dringus, 2000) find no significant relation between student learning style and course performance. It is interesting to note that, although Ashraf et. al (2013) find learning style does not influence student overall performance, they demonstrate that student learning style does affect student performance at higher learning levels, such as comprehension, application, and analysis, in finance courses. Other studies (e.g., Battalio, 2009; James & Gardner, 1995; Manochehr, 2006) suggest that certain learning style impacts student performance. For instance, independent-learning students perform better in an online environment than their in-class counterpart of the same subject.

Methodology and Data Analysis

Our sample consists of students in three finance courses at two large regional public universities during the semesters of spring, summer, fall 2019 and summer 2020. We exclude spring 2020 in this study because many in-person courses were transitioned to online instruction in the middle of the semester in response to Covid-19 pandemic. The three finance courses employed in our study are Managerial Finance, Investment Principles, and Financial Management. Managerial Finance is an undergraduate introductory finance course and a core for business students. Investment Principles is an undergraduate intermediate finance course and a core for finance majors and an elective for other business majors. Financial Management is a core course for all MBA students and covers similar topics as Managerial Finance, but at higher learning levels. The three courses were delivered to students either in a face-to-face or an asynchronous online format.

All students of the three finance courses were approached to participate in our study in spring, summer, fall 2019 and summer 2020. In the end, 305 students agreed to participate. We further exclude students who had no online learning experience and end up with a final sample of 269 students. Table 1 presents the distribution of the overall sample. Of the 269 students, 71 (26%) students claim misalignment between actual and preferred instructional delivery format, while 198 (74%) students claim instructional delivery alignment. Instructional delivery misalignment could arise due to factors such as limited choice of course delivery modalities, schedule conflict, family, and work commitments, etc. We report that the number of students who had previously taken between one and three online courses and more than three online courses is 100 (37%) and 169 (63%), respectively. Of all the students, 130 (48%) students took asynchronous online courses and 139 (52%) in-person courses. The proportion for male and female students are comparable with 48% and 52%, respectively. Moreover, we have 57% of the observations drawn from undergraduate introductory course, 21% from undergraduate intermediate course, and 23% from graduate course. Lastly, our sample represents a diverse body of students. Students with Asian, African American, Hispanic, White, and other origins account for 18%, 30%, 3%, 46%, and 3%, respectively, of the overall sample. Domestic and international students represent 85% and 15% of the sample.

Table 1
Summary Statistics

	Number of Observations	Percent
Instructional Alignment/Misalignment		
Misalignment	71	26%
Alignment	198	74%
Online Courses Taken		
Between 1 and 3	100	37%
More than 3	169	63%
Instructional Delivery Modality		
Asynchronous online	130	48%
In-person	139	52%
Gender		
Female	141	52%
Male	128	48%
Courses		
Managerial Finance	152	57%
Investment Principles	56	21%
Financial Management	61	23%
Student Status		
Domestic students	229	85%
International students	40	15%
Ethnic Origin		
Asian	49	18%
African American	81	30%
Hispanic	7	3%
White	124	46%
Other origins	8	3%
Total	269	100%

Note: This table reports summary statistics of the overall sample of 269 students in three finance courses during spring, summer, fall 2019 and summer 2020.

We conduct univariate and multinominal logistic regression analysis to examine the relation between instructional delivery alignment/misalignment and student performance. The following is the regression model utilized in the study:

$$\begin{aligned} Course\_Grade_{i,t} &= \alpha + \beta_1 Misalignment + \beta_2 GPA_{i,t-1} + \beta_3 Major_{i,t} + \beta_4 Pre\_Schedule_{i,t} \\ &+ \beta_5 Credit\_Hours_{i,t-1} + \beta_6 Gender_i + \beta_7 Work\_Hours_{i,t} + \beta_8 Age_{i,t} \\ &+ \beta_9 Credit\_Hours\_Taking_{i,t} + \beta_{10} Study\_Hours_{i,t} + \beta_{11} Transfer_i + \varepsilon_i \end{aligned}$$

Course grade (*Course_Grade*) is the dependent variable and measures student performance. Student course final/semester grade is an ordinal rank from high (A+ or A) to low (F). Specifically, *Course_Grade* equals 0 if a student earned a letter grade of F, 1 for D-, 2 for D, 3 for D+, 4 for C-, 5 for C, 6 for C+, 7 for B-, 8 for B, 9 for B+, 10 for A-, and 11 for A or A+. *Misalignment,* a binary variable, is our variable of interest. It equals 1 if the instructional delivery modality of a

student's registered class differs from her preferred format, and 0 if aligned. For example, if a student registers for an online class (in-person class) but the student's preferred delivery modality is in-person (online), *Misalignment* is set to 1. On the other hand, if a student registers for an online class (in-person class) and the student's preferred delivery modality is also online (in-person), *Misalignment* is set to 0. We propose that *Misalignment* could negatively impact student course grade in finance courses. Finance courses, to some extent, are quantitative in nature. Some students learn quantitative materials better when attending in-person and interacting with instructors and peers. If the student must register for an asynchronous online course due to conflict of schedule and/or unavailability of in-person class offering, such misalignment could pose a challenge to student learning and lead to poor performance in finance courses. Similarly, if a student prefers online courses because of her inflexible schedule but must register for an in-person class, she could miss classes from time to time and finally perform worse than she could otherwise.

Following prior studies (e.g. Borde, 2017; Didia & Hasnat, 1998; Mahbobi, 2012; Pilloff & Kling, 2017; Sen et al., 1997; Terry, 2002), we also control for other student characteristics that have shown to impact student performance in the regression analysis. *GPA* is defined as a student's self-reported GPA up to the semester of data collection for either an undergraduate or a graduate program. Numerous studies have shown that student GPA is a key factor in influencing student performance of finance courses, and we expect a strong and positive relation between *GPA* and *Course_Grade*. *Major*, a binary variable, equals 1 for student with accounting or finance major, and 0 otherwise. Following prior studies (e.g., Bredthauer & Fendler, 2016; Sen et al., 1997; Terry, 2002), we expect a positive relation between *Major* and *Course_Grade*. *Pre_Schedule* is student predictability of schedule. A value of 1 is assigned if a student's schedule is highly unpredictable, 2 for somewhat unpredictable schedule, and 3 for predictable schedule. *Work_Hours* is the number of hours a student works at a job or participates in school-related programs per week. Both *Pre_Schedule* and *Work_Hours* are proxies for student outside distraction. Bredthauer and Fendler (2016) argue that more outside distraction could lead to poor performance in class and we therefore expect *Pre_Schedule* to positively and *Work_Hours* to negatively impact course grade. *Credit_Hours* is defined as the cumulative credit hours earned by a student up to the semester of data collection. Anderson et al. (1994) argue that more years of schooling could lead to better student performance. Following this reasoning, we expect a positive relation between *Credit_Hours* and *Course_Grade*. *Gender*, a binary variable, equals 1 for male students, and 0 for female students. The relation between *Gender* and *Course_Grade* is inconclusive with some studies (e.g., Didia & Hasnat, 1998) reporting insignificant relation between the two and other studies (e.g., Borde, 2017; Bredthauer & Fendler, 2016; Mahbobi, 2012) finding male students outperforming female students in quantitative courses. *Age* equals 1 for students with age between 18-20, 2 for between 21-23, 3 for between 24-30, 4 for between 31-40, and 5 for 41 and above. Mahbobi (2012) reports that student age is an important factor in determining student performance of first-year economics courses. Older students may have better soft skills such as time management to be successful in both in-person and online courses. *Credit_Hours_Taking* is defined as the number of credit hours a student registers for in the semester of data collection. Bredthauer and Fendler (2016) find a negative relation between semester hours taken and student performance in online core finance course. We expect a negative association between *Credit_Hours_Taking* and *Course_Grade*. *Study_Hours* is defined as the average hours a student spends on a course per week. Intuitively, more time spent in studying course materials should lead to better student performance. *Transfer*, a binary variable, equals 1 for transferred students, and 0 otherwise.

Table 2 presents the descriptive statistics of the variables used in the study. The mean (median) value for *Course_grade* is 7.41 (8), representing a letter grade of B- (B). The mean (median) value for *Misalignment* is 0.26 (0). As noted in Table 1, 26% of students had misaligned instructional delivery of courses. The mean and median *GPA* are both 3.24, equivalent to a letter grade of B. The mean (median) value for *Major* is 0.38 (0), indicating that 38% of the undergraduate students have majors in finance or accounting. *Pre_Schedule* has an average (median) of 2.17 (2), which implies that the schedule of an average student in the sample is somewhat unpredictable. The mean (median) value for *Credit_Hours* is 77.13 (81.5), showing that an average undergraduate student in our sample had completed 65% of the credits needed for her degree. The mean (median) value for *Gender* is 0.48 (0), which suggests 48% of the students are male and 52% female. The mean (median) value for *Work_Hours* is 25.83 (25), which indicates that students in the sample work an average of 25 hours per week. Based on the mean value of 2.49 for *Age*, student average age is between 21 and 23. Additionally, students take an average of 12 credit hours in a semester and spend 7 hours per week studying course materials. Finally, students with transferred status account for 38% of the undergraduate sample.

Table 2
Descriptive Statistics of Variables

Variables	N	Mean	Median	Std	Min	25%	75%	Max
Course_Grade	269	7.41	8	3.01	0	5	10	11
Misalignment	269	0.26	0	0.44	0	0	1	1
GPA	258	3.24	3.25	0.45	2	2.9	3.58	4
Major	208	0.38	0	0.49	0	0	1	1
Pre_Schedule	269	2.17	2	0.66	1	2	3	3
Credit_Hours	250	77.13	81.5	54.36	0	36	102	600
Gender	269	0.48	0	0.50	0	0	1	1
Work_Hours	267	25.83	25	16.41	0	15	40	65
Age	268	2.49	2	0.99	1	2	3	5
Credit_Hours_Taking	267	12.52	13	4.30	3	9	15	21
Study_Hours	268	6.96	5	6.70	0	3	9.5	42
Transfer	208	0.38	0	0.49	0	0	1	1

Note: This table reports the descriptive statistics for key variables used in the study.

Table 3 compares the differences in the variables used in our study between students who prefer in-person instruction and those who prefer online instruction. Overall, students who prefer online instruction work more hours per week, tend to be older, take fewer credit hours in a semester, and study more hours on a weekly basis than students who prefer in-person instruction. The comparisons of student characteristics between the two groups suggest that student preference for online instruction could be mainly driven by lifestyle factors such as work schedule, family, and other commitments.

Table 3
Variable Mean Test for Students with In-person vs. Online Instruction Preference

Variables	Students with Preference for In-person Instruction	Students with Preference for Online Instruction	Difference	*p*-value
Course_Grade	7.2597	7.6	-0.3403	0.3593
Misalignment	0.2792	0.2435	0.0357	0.5124
GPA	3.2278	3.2452	-0.0174	0.7572
Major	0.3561	0.4079	-0.0518	0.4596
Pre_Schedule	2.2078	2.1130	0.0947	0.2463
Credit_Hours	81.1573	71.6640	9.4933	0.1729
Gender	0.4610	0.4957	-0.0346	0.5755
Work_Hours	23.7763	28.5522	-4.7759**	0.0182
Age	2.2549	2.8087	-0.5538***	<.0001
Credit_Hours_Taking	13.3312	11.4159	1.9152***	0.0003
Study_Hours	6.2792	7.8816	-1.6024*	0.0528
Transfer	0.3561	0.4342	-0.0781	0.2668

Note: This table reports variable mean test for students with preference for in-person instruction vs. students with preference for online instruction. The symbols ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

Table 4 displays the comparisons of student characteristics for misalignment and alignment groups for the overall sample (Panel A), the undergraduate (Panel B) and graduate (Panel C) subsamples. We notice that misalignment group significantly differs from alignment group in variables such as *Course_Grade*, *GPA*, *Pre_Schedule*, and *Age* for the overall sample. Specifically, students in misalignment group have significantly lower course grade, lower GPA, less predictable schedules, and are older than those in the alignment group. Panel B shows that in the undergraduate sample students in the misalignment group are significantly older and study more hours than students in the alignment group. The two groups are statistically similar in course grade and GPA. Panel C shows that for the graduate sample students in the misalignment group earned significantly lower course grade and GPA than students in the alignment group.

Table 4
Misalignment vs. Alignment Group Univariate Test

Panel A: Overall Sample

Variables	Misalignment Group	Alignment Group	Difference	*p*-value
Course_Grade	6.6056	7.6919	-1.0863***	0.0087
GPA	3.1355	3.2705	-0.135**	0.0336
Pre_Schedule	2.0563	2.2071	-0.1508*	0.0999
Credit_Hours	83.0869	75.0399	8.047	0.3056
Gender	0.3944	0.5051	-0.1107	0.1099
Work_Hours	27.0352	25.398	1.6372	0.4723
Age	2.6761	2.4264	0.2497*	0.068
Credit_Hours_Taking	12.2714	12.6091	-0.3377	0.5736
Study_Hours	7.7214	6.6919	1.0295	0.27

Panel B: Undergraduate Sample

Variables	Misalignment Group	Alignment Group	Difference	*p*-value
Course_Grade	6.6071	7.3224	-0.7153	0.1458
GPA	3.1138	3.2049	-0.0911	0.19
Major	0.4464	0.3487	0.0977	0.1983
Pre_Schedule	2.1071	2.2434	-0.1363	0.1919
Credit_Hours	103.8	92.667	11.133	0.1669
Gender	0.4464	0.5461	-0.0997	0.204
Work_Hours	22.8125	21.5833	1.2292	0.6084
Age	2.4464	2.1325	0.3139**	0.018
Credit_Hours_Taking	13.8727	14.2649	-0.3922	0.4407
Study_Hours	6.9909	5.3158	1.6751*	0.0565
Transfer	0.5	0.3421	0.1579**	0.038

Panel C: Graduate Sample

Variables	Misalignment Group	Alignment Group	Difference	*p*-value
Course_Grade	6.6	8.913	-2.313***	0.0003
GPA	3.2464	3.496	-0.2496*	0.0691
Pre_Schedule	1.8667	2.087	-0.2203	0.244
Credit_Hours	13.8933	20.2	-6.3067	0.1324
Gender	0.2	0.3696	-0.1696	0.2313
Work_Hours	42.8	37.837	4.963	0.1983
Age	3.5333	3.3913	0.142	0.5765
Credit_Hours_Taking	6.4	7.1739	-0.7739	0.3004
Study_Hours	10.4	11.2391	-0.8391	0.7405

Note: This table reports variable mean test for misalignment vs. alignment group. Panel A presents the results for the overall sample. Panels B and C present the results for the undergraduate and graduate subsamples, respectively. The symbols ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

Empirical Results

Table 5 presents the results of multinomial logistic regressions for the overall sample, the in-class, and the online subsamples. Controlling for explanatory variables that could impact student success in finance courses, we find that our variable of interest, *Misalignment*, is negatively and significantly related to *Course_Grade* in Models (1) and (2). This result suggests that, everything else equal, students with misaligned instructional delivery modality tend to perform worse than students with aligned instructional delivery in the overall sample. The finding supports our hypothesis that misalignment could adversely impact student performance while alignment could favorably affect student performance of finance courses. Additionally, *GPA*, *Gender*, and *Work_Hours* are significantly and positively related to student performance of the three finance courses. In other words, students with higher GPAs, male students, and students who work more hours are more likely to perform better than students with lower GPAs, female students, and students who work fewer hours.

Next, we partition the overall sample into in-class and online subsamples and test the impact of *Misalignment* on student performance of the three finance courses. Models (3) and (4) present the results of the in-class subsample. *Misalignment*, *GPA*, *Pre_Schedule*, *Gender,* and *Age* are all significant determinants of student success in face-to-face finance courses. Specifically, consistent with Models (1) and (2), students with misaligned delivery modality are more likely to perform worse than students with aligned delivery format. Students with higher GPAs and more predictable schedules tend to do better than students with lower GPAs and less predictable schedules. Additionally, male students tend to outperform female students, and older students are more likely to do better than younger students in face-to-face finance courses. Lastly, we notice in Models (3) and (4) that *Work_Hours* no longer significantly impacts student performance.

Models (5) and (6) present the results for the online subsample. Consistent with the overall sample and in-class subsample, *Misalignment* continues to be negative and significant at least at the 10% level. Meanwhile, *GPA* and *Gender* remain positive and significant in the online subsample. Lastly, *Credit_Hours_Taking* is negatively and significantly related to student performance in the online sample. This result indicates that students who register for more credits in a semester may have to spread their time, energy, and efforts across more courses, thereby leading to poor performance in finance courses for the online sample.

Overall, Table 5 shows that *Misalignment* is negatively and significantly associated with student performance in almost all the Models. Meanwhile, *GPA* is positively and significantly related to student performance, and male students tend to perform better than female students in finance courses.

Table 5
Multinominal Logistic Regression Results for Overall Sample and Subsamples

Independent Variables	Dependent Variable: *Course Grade*					
	Overall Sample		In-Class Sample		Online Sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Misalignment	-0.6305**	-0.7665***	-0.5267	-1.076**	-0.7349**	-0.6527*
	(0.0161)	(0.0068)	(0.181)	(0.0171)	(0.0405)	(0.0901)
GPA	3.3578***	3.447***	3.7596***	4.3012***	3.0575***	3.0873***
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
Pre_Schedule		0.2305		0.6503**		-0.133
		(0.2312)		(0.0179)		(0.6354)
Credit_Hours		-0.0006		-0.0029		0.00271
		(0.8186)		(0.3577)		(0.5743)
Gender		0.7487***		0.8493**		0.8017**
		(0.003)		(0.0161)		(0.0351)
Work_Hours		0.0168*		0.0144		0.0205
		(0.0614)		(0.2581)		(0.1221)
Age		-0.0045		0.5635**		-0.2769
		(0.9767)		(0.0407)		(0.1802)
Credit_Hours _Taking		-0.0167		0.074		-0.1022*
		(0.6837)		(0.3348)		(0.0709)
Study_Hours		0.0117		0.0339		0.0179
		(0.5666)		(0.4713)		(0.4676)
N	258	237	134	121	124	116
Chi-square statistic (H_0: Beta = 0)	139.71	144.89	80.36	98.18	60.27	64.02
p-value for Chi-square statistic	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Pseudo-R2	42.74%	46.80%	45.99%	56.75%	39.53%	43.57%

Note: This table presents the multinominal logistic regression results for the overall sample and subsamples. The symbols ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

Table 6 presents the results of multinomial logistic regressions for undergraduate and graduate subsamples. Models (1) and (2) show the results for the overall undergraduate and graduate subsamples. *Misalignment* continues to be negative and significant in both models. In Model (1), for the overall undergraduate subsample, we also find that *GPA*, *Pre_Schedule*, *Gender*, *Work_Hours*, and *Transfer* are positively related to course grade. These results indicate that students with higher GPAs, more predictable schedule, more working hours, male students, and transferred students tend to perform better. Surprisingly, *major* is negatively associated with course grade in the undergraduate sample. In Model (2), for the graduate subsample, we continue to find that *Misalignment* and *GPA* are significantly related to student performance.

Table 6
Multinominal Logistic Regression Results for Undergraduate and Graduate Subsamples

Independent Variables	Dependent Variable: *Course_Grade*				
	Undergraduate Sample	Graduate Sample	Undergraduate In-person Sample	Undergraduate Online Sample	Graduate Online Sample
	(1)	(2)	(3)	(4)	(5)
Misalignment	-0.607*	-2.3654***	-1.0118**	-0.3488	-2.509***
	(0.0534)	(0.006)	(0.0261)	(0.4591)	(0.0049)
GPA	3.8859***	3.5481***	4.3988***	3.5616***	3.2085***
	(<.0001)	(0.0008)	(<.0001)	(<.0001)	(0.0032)
Major	-0.794***		-0.9247**	-0.6612	
	(0.0078)		(0.0222)	(0.175)	
Pre_Schedule	0.405*	-0.4434	0.5744**	0.2218	-0.7555
	(0.0579)	(0.3968)	(0.0369)	(0.5303)	(0.183)
Credit_Hours	-0.00018	0.0152	-0.00154	-0.00494	0.0146
	(0.9492)	(0.5512)	(0.6269)	(0.5758)	(0.6677)
Gender	0.8118***	0.6469	0.9963***	0.6284	1.0764
	(0.0047)	(0.3967)	(0.0071)	(0.2185)	(0.1855)
Work_Hours	0.0167*	0.0398	0.0176	0.0142	0.0457
	(0.086)	(0.1562)	(0.1789)	(0.3802)	(0.1408)
Age	-0.00247	-0.1373	0.4394	-0.4128	0.0351
	(0.9896)	(0.7201)	(0.1244)	(0.1419)	(0.9303)
Credit_Hours_Taking	-0.0338	-0.0337	0.1314	-0.1736**	-0.1205
	(0.487)	(0.8364)	(0.1146)	(0.0153)	(0.4929)
Study_Hours	0.0248	0.0163	-0.00551	0.0346	0.00856
	(0.3462)	(0.6642)	(0.9181)	(0.3251)	(0.8337)
Transfer	0.5341*		0.4181	0.735	
	(0.0868)		(0.3116)	(0.1638)	
N	184	53	116	68	48
Chi-square statistic (H_0: Beta = 0)	120.78	35.89	95.13	41.78	34.48
p-value for Chi-square statistic	<.0001	<.0001	<.0001	<.0001	<.0001
Pseudo-R2	48.98%	55.30%	57.09%	46.62%	57.49%

Note: This table presents the multinominal logistic regression results for undergraduate and graduate subsamples. The symbols ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

We next partition the undergraduate sample into in-class and online subsamples and present the results in Models (3) and (4). Interestingly, we find that the coefficient on *Misalignment* is negative and significant in the undergraduate in-class sample, but insignificant in the undergraduate online sample. In other words, instructional delivery misalignment could adversely and significantly impact student performance in in-person undergraduate finance courses but play no significant role in online courses. More specifically, for undergraduate in-person courses, students with misaligned course delivery modality (those with online instruction preference) perform worse than students with aligned delivery format (those with in-person instruction preference). However, for undergraduate online courses, students with misaligned delivery format (those with in-person instruction preference) do not significantly underperform students with aligned instructional delivery (those with online instruction preference). These different results could be due to different factors that influence student preference for in-person or online instruction. Following prior studies and our analysis in Table 3, we argue that lifestyle factors, such as work schedule and family commitment, coupled with the convenience and flexibility provided by online courses, drive student preference for online instruction. Learning style, the way that learners take in and process information, determines students' preference for in-person mode. As such, the result in Model (3) suggests lifestyle factors that contribute to student preference for online instruction have significant and negative effects on student performance if they cannot take those classes online. The result in Model (4) implies that student learning style has insignificant impact on student performance in undergraduate courses as students who prefer in-person instruction do not significantly underperform in online courses. This inference is consistent with extant studies which find insignificant relation between student learning style and performance (e.g., Ashraf et al., 2013). Lastly, students with higher GPAs (*GPA*), more predictable schedules (*Pre_Schedule*), and male students (*Gender*) tend to perform better in undergraduate in-person finance courses, whereas students with higher GPAs (*GPA*) and taking fewer credit hours in a semester (*Credit_Hours_Taking*) tend to do better in undergraduate online finance courses.

In Model (5) of Table 6, we report the regression analysis for the graduate online subsample. We did not report the results for the graduate in-person subsample as it only includes 5 students and is too small to warrant a reliable regression analysis. Different from the insignificant coefficient on *Misalignment* (β = -.3488, p .4591) for undergraduate online sample in Model (4), *Misalignment* (β = -2.509, p .0049) for graduate online sample is negative and significant at the 1% level. This result indicates that graduate students with preference for in-person instruction (but register for online course) significantly underperform students with preference for online instruction in graduate online finance courses. Preference for in-person instruction could be mainly driven by student learning style. Our result suggests that learning style that contributes to student preference for in-person instruction has significant and negative effect on student performance if those students cannot take courses in-person for graduate-level class. This implication is consistent with Ashraf at el. (2013) who find that learning style plays a significant role in courses of higher learning levels. Lastly, we continue to find that *GPA* plays a critical role in determining student performance of graduate online finance courses.

In conclusion, we find consistent and negative relation between *Misalignment* and *Course_Grade* in the overall sample and the undergraduate in-person and graduate online subsamples. It is worth noting that *Misalignment*, our variable of interest, remains statistically significant in almost all the models after we control for key explanatory variables, such as GPA, in our regression analysis. This consistent result implies that *Misalignment* contributes to student performance above and beyond GPA influence.

Conclusion

In this study, we examine the impacts of instructional delivery alignment/misalignment on student performance of three finance courses. We provide evidence that instructional delivery misalignment adversely affects student performance whereas alignment encourages better performance. These results are especially strong for undergraduate in-person and graduate online subsamples. Our empirical evidence provides support for institutions offering a variety of instructional modalities to students. Students could benefit from choosing an instructional modality that matches their preferred format. These efforts could potentially help students improve academic performance in finance courses. Additionally, we confirm prior studies of GPA as a significant determinant of student success in finance courses. More specifically, students with higher GPAs tend to perform better in finance courses. Finally, we document that student attributes such as gender, age, major, outside distractions, predictability of schedule, effort, and other factors play less significant roles in determining student performance.

A limitation of our study is that we only focus on courses delivered through in-person and online asynchronous modalities. A possible future research direction is to include online synchronous modality and examine how misalignment between in-person and online synchronous, and misalignment between online synchronous and online asynchronous format affect student success in courses. Adding online synchronous modality to the current study could provide us with a more comprehensive understanding of the effects of alignment/misalignment between actual and preferred format on student performance in courses.

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The Paradox of Gender and Performance in the Introductory Business Finance Course

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Studies of the effect of gender on student performance in the introductory finance course have produced puzzling results. Some find that females are less successful than males while others conclude that gender is inconsequential as a determinant of student performance. Interestingly, no study finds that females outperform males in introductory finance. We hypothesize that these ambiguities occur because previous studies have not considered the distribution of brain-types by gender. Using a dichotomous gender variable in performance models confounds the interpretation of gender by commingling different brain-types in the same gender category. While there are strong reasons to believe that males and females have different brain-types, considerable overlap exists in the statistical distributions. This paper asks which brain-types are more successful in the introductory business finance course and whether these brain-types can be associated with a particular gender.

Introduction

Studies of the impact of gender on student performance in the introductory finance course can be summarized in one word, *puzzlin*g. Some studies find that gender has no effect on class performance (Didia and Hasnat, 1998; Filbeck and Smith, 1996; Henebry and Diamond, 1998), while others conclude that males consistently outperform females even though females tend to have higher GPAs (Al-Tamimi, 2002; Borde, et al., 1998; Flanegin, 2010; Benrud, 2003; Terry, 2002).[2] No scientific study has concluded that females, as a group, outperform males in introductory business finance. The purpose of this study is to show that these ambiguous findings could be due to a failure to consider brain type as a factor determining student interest and success in the introductory finance course.

We use a standard brain type test coupled with the results of a standardized introductory finance examination as the basis for our investigation. Our hypothesis is that gender cannot be viewed separately from brain type with respect to performance on the standardized finance exam. We

[2] Ambiguous findings on the role of gender in student performance have been evidenced in studies of principles of economics courses as well. See, for example, Graddy and Yang (2010).

assert that the observations of past studies are not based on gender, *per se*, but on variations in brain-types across different groups of students. While brain-types tend to cluster by gender, there is, nevertheless, considerable overlap in the statistical distributions of brain type – enough, in fact, to account for the ambiguities in past works.

Literature Review

In the extant studies relating gender to performance in introductory finance, there exists no unanimity regarding the effect of gender on student success. In the section that follows, we review a significant portion of the pertinent literature and introduce our hypothesis as a viable alternative to existing studies. We begin with a discussion of studies that find gender to be an important factor in course success.

Borde, et al. (1998) analyzes the problem using a model of final course grades that includes a binary gender variable among other covariates. Borde, et al. (1998) examined a sample comprised of 766 introductory business finance students (56% males; 44% females) during the 1994-1995 academic years. Their results indicate that, on average, males tend to outperform females in a statistically significant manner. Finding this result vexing, they proceeded to test the differences between the means of all the covariates grouped by gender and found that the only statistically significant difference between the genders was with the overall grade point average (GPA). Females, as a group, had a significantly higher GPA than males. Therefore, while females as a group had higher GPAs, they underperformed their male counterparts in introductory business finance. Borde, et al. relates this anomalous result to unexplained cognitive factors.

Obtaining similar findings to Borde, Terry (2002) analyzed the gender question by studying a sample of 956 introductory corporate finance students (51% male; 49% female) from the fall 1995 to spring 2000 period. Including gender as one of the covariates in his model of student performance, Terry found that females, while having higher GPAs, tended to underperform their male counterparts. While this finding is reconcilable with prior literature, other aspects of the study are perplexing. For example, Terry found that females, as a group, not only had higher GPAs but also made higher average grades in prerequisite courses. Further, in classes that used only multiple-choice questions, females performed no differently than males; however, males outperformed females in classes using only short problems and essays. Terry speculated that these disparate findings were due to personality differences rather than gender.

Al-Tamimi and Al-Shayeb (2002) examined the effect of gender on 256 fundamentals of finance students (43% male; 57% female) at the United Arab Emirates University during the 1999-2000 academic year. Because the university enforces strict rules requiring females to remain on the campus grounds on weekdays and limits their travel on weekends, they hypothesized that female student productivity should be greater than their male counterparts. Among the explanatory variables in their model of course grades, they found GPA, attendance, semester load, and gender to be statistically significant. Contrary to the authors' expectations, females underperformed the males in the sample.

Examining the question from a different direction, Flanegin, et al. (2010) draw their conclusions about the determinants of performance in introductory finance from pre- and post-tests administered to 111 students in the spring semester 2006. While the pre-test scores of males and females were identical, females showed statistically less post-test gains. In summarizing their results, Flanegin, et al. (2010) concluded that females learned significantly less in the introductory

finance course and required additional help and/or special teaching methods to achieve the course learning goals.

Benrud (2003) expands the extant literature by analyzing the performance of students in an entirely web-based introductory finance course and by using different types of student assessments. His sample included 76 students (54% male; 46% female) enrolled in introductory finance during the spring and fall semesters of 2001. Gender, age, entrance exam scores, and enrollment in a web-based degree program were significant in explaining student performance on exams. Males had significantly higher scores than females on final exams, course grades (excluding discussion grades), and overall course grades. Online discussion grades were not influenced by gender.

All of these studies find gender to be an important factor in determining success in an introductory finance course. However, there are several hypotheses for the observed differences, including cognitive differences, instructional shortcomings, examination construction, and personality differences. Nevertheless, none of the studies discussed provide significant scientific support for the conjectures they present. The remainder of this section summarizes a group of studies that provide alternative views on gender and performance in introductory finance.

One of the earliest studies to examine gender's effect on performance in introductory finance was Simpson and Sumrall (1979). Examining a sample of 101 students in two sections of business finance during the same semester with the same instructor, they use stepwise regression to investigate the relationship between 15 performance factors and a student's final grade. Although gender was one of the covariates considered in the study, it did not reach the five percent significance threshold and was eliminated from the final estimating equation.

Henebry and Diamond (1998) studied the final course grades, pass rates, and withdrawal rates for a sample of 5,239 students (55% male; 45% female) for the period 1986-1995. Their methods entailed grouping the students by gender and testing the null hypotheses of no differences between the group means. Differences between the means of final course grades were statistically insignificant. However, the mean withdrawal rate for females was significantly higher (one percentage point) than that of males. Pass rates varied depending on whether the course was taught by a male or female professor but were insignificant for the overall gender groupings. The ambiguity in these findings is perplexing and suggests that the effect of gender on performance may be the incorrect question to examine.

Examining the performance of 210 introductory finance students (55% male; 45% female) during the 1994-1995 academic years, Didia and Hasnat (1998) include a binary gender variable among the covariates in their model of final course grades. Other covariates included cumulative GPA, study time, credit hours, grades in basic accounting, math and economics, age, transfer status, and instructor. The model was estimated using both OLS and ordered probit. In both estimations, gender was insignificant casting further doubt on the question of gender's effect.

In a somewhat different approach, Filbeck and Smith (1996) used the Myers-Briggs Type Indicators to test whether different personality types performed differently on various kinds of exam questions. Their sample was comprised of 94 students enrolled in the second quarter of introductory corporate finance. Gender was included as a covariate in their models; however, it was insignificant in all of the test results. Females, as a group, performed no differently than males on the four exam formats included in the tests.

While the second set of studies generally provides no substantive explanation for the lack of gender differences in performance, the results nonetheless provide sound statistical support for an alternative view of the role of gender in determining success in an introductory finance course. We

posit that it is brain type – and not gender per se – that is the determining factor for success in introductory finance. In the section that follows, we discuss a theory of brain type that serves as the basis for our independent variable of interest.

Theory Of Brain Dimorphism

The behavioral, neurological, and endocrinological studies summarized in Baron-Cohen (2003), Baron-Cohen and Wheelwright (2004a), Baron-Cohen, Lutchmaya, and Knickmeyer (2004), Brizendine (2006), Browne (2002), Kimura (1987, 1999, 2005), and Pinker (2008) establish a biological basis for gender differences in the brain.[3] Based on this research, Baron-Cohen and his colleagues at the ARC Research Centre at Cambridge University have identified two specific brain-types related to gender, classifying them as Type E (empathizing) and Type S (systemizing).

Empathy consists of two cognitive components. The first component encompasses the understanding of one's feelings towards others and the ability to take another person's position. Baron-Cohen (2003) related this component to Piaget's idea of decentering or reflecting on another person's emotional state non-egocentrically. This process involves using one's experience to place him or herself into the emotional state of someone else (i.e., to infer the likely content of the emotional state of another). The second aspect of empathy entails one's response to the emotional state of another person. Sympathy is an element of this affective component, but so are the emotions of anger, fear, guilt, and pity. As long as the feelings of the observer match the emotions of the person being observed, then the observer's reaction fits within the definition of empathy.

In contrast to empathizing, systemizing is a nomologically-based process, i.e., a process that takes the form of input-operation-output relationships. As an innate cognitive process, systemizing is the drive to understand and control systems of all types. Systemizing is the brain's attempt to comprehend finite, deterministic, and lawful systems, whether that system is mathematics, music, biology, astronomy, or finance. Understanding the laws and regularities that underlie a system allows an individual to predict the outcome of changes in underlying parameters. The ultimate payoff of systemizing (understanding the true laws and regularities of a system) is control of the system itself.

[3] From a biological perspective, differences in hormonal secretions in the early stages of child development seem to be important in explaining the lasting patterns of interests and inherent traits among different brain-types. For example, experiments by Baron-Cohen, et al. (2004a, 2004b, 2004c) found that the level of pre-natal testosterone was one factor determining brain type and gender-typical behavior. Geschwind and Galaburda (1987) relate fetal testosterone to the growth of the hemispheric regions of the brain. Greater testosterone was associated with increased growth of the right hemisphere and slower growth of the left. In general, males (Type-S) have greater right hemisphere skills, while left hemisphere skills appear to be a female (Type-E) trait. Congenital adrenal hyperplasia (CAH) cases are another example of pre-natal androgenic influences. Girls with unusually high levels of androgens usually fall into the Type-S brain classification. Structural differences in the limbic system play a role in brain classification also. For instance, a larger amygdala tends to be a trait of young males in contrast to young females. As an area abundant in testosterone receptors, the larger amygdala is viewed as source of typical male traits. Brain dimorphic factors have been associated with differences in the hippocampus and hypothalamus as well. Recent work by Sapienza, et al. (2009) found that elevated levels of prenatal and circulating testosterone were associated with lower risk aversion. Furthermore, among the MBA students in their sample both testosterone and risk aversion predicted career choices. Thirty-four percent of females chose risky careers in finance (e.g., trading) compared to 57% of males. Sapienza, et al. concluded that students high in testosterone and low in risk aversion were more like to seek risky careers in finance.

Individuals with Type-E brains are better at empathizing (E) than systemizing (S). In contrast, Type-S brains systemize better than empathize. To distinguish between these brain-types, Baron-Cohen and his research team developed two indices. Each index is a summary score from an individually administered questionnaire. The empathy quotient (EQ) measures how easily a person recognizes other people's feelings and how strongly other people's emotions affect the person. The degree to which a person is drawn to machines, mathematics, maps, statistics, and syllogistic thinking is measured by the systemizing quotient (SQ). Application of these tests to large groups of individuals indicate that, on average, females score significantly higher than males on the EQ tests, while males score significantly higher than females on the SQ test. These test results provide the basis for Baron-Cohen's theory of brain type dimorphism. As a group, females tend to be empathizers or Type-E brains. Males, as a group, are systemizers or Type-S brains. While there is considerable overlap in the statistical distributions of EQ and SQ scores between females and males, we can say, based on past research that higher EQ scores are a female trait and higher SQ scores are a male trait.

The distribution of brain-types between the genders may help to explain the disparate findings of past studies of student performance in introductory finance. We would expect females (EQ's), as a group, to be less interested in and have more apprehensive attitudes toward studying the intricacies of financial analysis than males (SQ's). Studies of gender differences in personal financial literacy support this assertion. For example, Chen and Volpe (2002) surveyed students from 14 colleges in six states about their knowledge of personal finance. The sample included 924 students (males 44%; females 56%) distributed among various age groups, class ranks, income categories, and work experience. They found that females (EQ's) had less enthusiasm for, lower confidence in, and less willingness to learn about personal finance subjects than males (SQ's). Further, when asked to rank academic subjects in terms of importance, males (SQ's) ranked mathematics and other quantitative sciences as most important, while females (EQ's) ranked English and other literary subjects as most important. Chen and Volpe conclude that compared to males, females have less interest in finance and have less knowledge of personal finance.[4]

Students' prior expectations can be very important to future performance in introductory courses as evidenced in a study of economics students by Ballard and Johnson (2005). In their study, females expected to do less well than males, holding other performance factors constant. Ballard and Johnson contend that this predisposition had a powerful influence on student performance but were unable to isolate its source. They speculated that the expectations variable was merely a proxy for some aspect of student ability unobservable to the researcher. However, it is not differences in ability that are being observed, but an innate disinterest or predisposition on the part of EQ brain-types to the subject matter of finance and economics. Finance may be more attractive to Type-S students leading to higher expectations of success than Type-E students. The lack of enthusiasm, confidence, and willingness to learn on the part of females observed by Chen and Volpe (2002), Goldsmith and Goldsmith (1997a), and Goldsmith, et al. (1997b) is not due to gender, per se, but to brain type. Financial topics may be more attractive to Type-S individuals (female or male) and those individuals may have higher expectations for success.[5]

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[4] Attitudes towards economics have produced similar results. For example, Siegfried (1979) found that among individuals who had not had any college economics, males were more interested in the subject than females. Likewise, Bollinger, et al. (2006) determined that females had significantly more negative attitudes toward economics prior to taking principles of economics than did males. Moreover, while male attitudes were positive after taking the principles course, the negative attitudes among females persisted.

[5] Goldsmith, et al. (1997b) captured the essential point when they stated that " ... females have lower scores than males on these measures (real and perceived financial knowledge indicators) derives from the fact that in general they are

The theory of brain dimorphism developed by Baron-Cohen and others presents a highly plausible explanation for and interpretation of the varied results of the studies discussed previously. Because brain type is not easily observable for inclusion in a statistical model and because gender is a traditional demographic factor, we suggest that gender may be acting (whether intended or not) as an instrumental variable for brain type and that statistical significance varies based on the brain-types of the student populations sampled. As the populations of student subjects vary across research studies with respect to Type-E and Type-S brain-types, we would expect gender to wax and wane in statistical significance. In order to provide evidence in support of our conjecture, we develop and implement the methods discussed in the subsequent sections of this paper.

Sample

The sample for this study included 194 students enrolled in 4 sections of introductory business finance at a large state university in the Southeast United States. The sections were taught by three instructors who used the same testing procedures and administered the same 50 question comprehensive final exam.[6] The sections were taught during the academic year 2009-2010. The comprehensive exam, which is the focus of this study, had two parts. The recall section had 25 questions based on the first three cognitive levels (remembering, understanding, and applying) of the Bloom-Anderson–Krathwohl learning taxonomy. Questions evaluated as Bloom-Anderson–Krathwohl levels four through six (analyzing, synthesizing, and evaluating) are included in the analytical portion of the exam. The student's score on the comprehensive exam counted a minimum of 25% of his or her final grade. Moreover, students failing to make an absolute minimum score on the exam are required to repeat the course regardless of their other performance in the course. The important aspect of the comprehensive exam for this study is that, unlike course grades, it provides a homogenous instrument for evaluating student performance.

The general characteristics of the sample are presented in Table 1. The gender composition of the sample was 47% females and 53% males. This distribution is similar to the prior studies in this area. On average, females had marginally higher GPAs than males, however, the difference between the means was not statistically significant ($t = 1.380$). Males performed somewhat better ($t = 1.763$) than females in terms of their overall comprehensive exam scores.[7] On a univariate basis there was little difference in male and female performance on the individual sections of the exam. Hours worked did not differ significantly between the genders ($t = 1.006$). The students ranged in age from 20 to 55. The median ages for females and males were each 22 years, respectively. Participation in outside activities (athletics and university organizations) was low for both groups. Although students are encouraged to take the course during their junior year, just fifty-four percent of the females were classified as juniors and only 47% of the males. Of the 194 students, 27 were finance majors. Sixty-seven percent of the finance majors were male and 33%

less interested in the topics of investments and personal finance. Females would score higher than males (based on higher GPAs) on knowledge where they have greater interest than males."

[6] All of the instructors were male.

[7] We opted to use the comprehensive final exam grade as our performance measure instead of the course grade for several reasons. First, the exam is comprehensive; it covers all of the core subject areas. Second, the exam questions are separable into two sections (analytical and recall) based on Bloom's taxonomy. Each part can be analyzed separately. Third, all of the business finance students take the exam at the same time under the same conditions. Fourth, all instructors must participate in the comprehensive exam process and follow the rules for including the exam scores in their student assessments. Fifth, instructors cannot curve the exam results as they can final course grades.

Table 1
Description of Sample

This table reports the academic and demographic characteristics of the students in our sample. The gender composition was 47 percent female and 53 percent male. GPA is the cumulative grade point average measured on a scale of A = 4 to F = 0. The Comprehensive Exam Grade is the average numerical score received on the departmentally administered final exam. Hours worked is the time measured in hours that students spend in full- or part-time work. Age is the student's age in years. SQ is the numerical score from the systemizing questionnaire. EQ is the numerical score from the empathizing questionnaire. Class Rank is the students' class standing by credit hours. Major is the students major as listed on the latest student transcript. Athletes indicate that the student is on an athletic scholarship. Organizations include number of students participating in University sanctioned groups. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Student	Female	Male	Diff	t-statistics	Prob.
Sample	92	102			
Student Characteristics					
GPA	2.976	2.871	0.105	1.380	0.169
Comp Exam Grade	59	63	-3.158*	1.763	0.0790
Range: Comp Exam Grade	26-84	34-98			
Analytical Questions	62	66	-3.724	1.604	0.1100
Range: Analytical	20-92	36-100			
Recall Questions	56	59	-2.600	1.362	0.1750
Range: Recall	24-84	28-96			
Hours Worked	20	22	-1.92	1.006	0.316
Age	23	24	-1.000	1.428	0.155
Athletes	1	0			
Organizations	9	12			
Brain-Type Measures					
SQ	24	34	-10.000***	5.957	0.0001
EQ	48	42	6.000***	4.916	0.0001
Class Rank:					
Junior	50	48			
Senior	42	54			
Major					
Finance	9	20			
Accounting	16	9			
Information Systems	3	10			
Management	10	10			
Marketing	26	21			
Other	28	32			

were female. Females represented 64% of accounting majors[8] but only 23% of information systems majors. Management and marketing attracted roughly equal portions of male and female students. The *other* category included mainly general business and entrepreneurship majors and was composed of 47% females and 53% males.

EQ and SQ are summary measures obtained from two questionnaires. The questionnaires were developed by Simon Baron-Cohen (2003) and are available to the public for noncommercial use. Each questionnaire contains 60 questions, where 40 of the questions are scored, while the remaining 20 questions are not relevant to the calculation of the EQ and SQ indices. For the legitimate questions, participants were scored two points if they strongly displayed the characteristics being measured (either EQ or SQ) and one point if they slightly displayed the trait. Students completed the questionnaires online. Before completing the questionnaires, students were advised that their participation was strictly voluntary, and that the anonymity of their responses was maintained at all times. Of the questionnaires submitted, only 4.43% were deemed unusable because of omissions or failure to complete both questionnaires. The response rate was 75.46% (203/269).

Baron-Cohen (see Baron-Cohen, 2003), pp. 207 and p.216) provides benchmark SQ and EQ scores for the general population. For the SQ score, females and males average around 24 and 30, respectively. Females typically score around 47 on the EQ scale, while males average 42. The results in Table 1 follow the predictions of Baron-Cohen's brain-type measures. Female students have significantly higher average EQ scores and males have higher SQ scores. A detailed analysis of these scores is provided in a later section. However, it is important to point out that enough overlap exists between brain type and gender to conduct the remainder of the study.

Methods

We conducted the study in three stages. Stage one involved the analysis of the SQ and EQ scores by gender. Essentially, we sought to establish that the distribution of scores supports Baron-Cohen's theory of brain dimorphism. In stage two, we estimated an ordered probit model to determine a student's probability of receiving a specific grade on the comprehensive exam. Particular attention was focused on the contribution of differences between EQ and SQ, as a brain-type measure, to the probability of receiving a designated grade on the exam, and to the interrelationships among gender classification and the SQ and EQ scores. The ordered probit model allows us to predict the probability that a given student can be identified with a given discrete grade category based on the covariates listed in Table 2.

[8] However, it should be noted that the average SQ score (27) for female accounting majors is above the female sample average. SQ scores for female accounting majors are in the upper tail of the SQ distribution. The 95% CI for female accounting majors was 21.7 – 31.4 in contrast to 21.9 – 26.0 for female students.

Table 2
Covariates Included in the Regression Models

This table defines each of the covariates used in the probit regression equations. GPA is the student's cumulative grade point average on a 4-point scale. Hours worked is the number of hours worked per week. Instructor denotes the teacher in the student's section of the course. AGE is the student's age in years. The natural log of age was also used in separate estimations of the regression models. The results were virtually the same as those reported in Tables 5 and 7. These estimations are available from the authors on request. SQ is the numerical score from the systemizing questionnaire. EQ is the numerical score from the empathizing questionnaire. Junior and senior represents the student's class standing at the time of the course. Finance through Other indicates the student's major as listed on her/his official transcript. Organization denotes a student's participation in a university organization. Athletes indicate that the student is on an athletic scholarship. Extra indicates a student's participation in athletics, an organization, or both.

Covariate	Description	Notation
GPA	student's cumulative average	x_1
Hours worked	hours worked per week	x_2
Instructor 1	1; if Instructor 1, 0; otherwise	x_3
Instructor 2	1; if Instructor 2, 0; otherwise	x_4
Instructor 3	1; if Instructor 3, 0; otherwise	x_5
AGE	student's age in years	x_6
SQ	systemizing coefficient	x_7
EQ	empathizing coefficient	x_8
EQ-SQ	difference between EQ and SQ	x_9
Gender	1; if female, 0; otherwise	x_{10}
Junior	1; if junior, 0; otherwise	x_{11}
Senior	1; if senior, 0; otherwise	x_{12}
Finance	1; if finance major, 0; otherwise	x_{13}
Accounting	1; if accounting major, 0; otherwise	x_{14}
Info Systems	1; if info systems major, 0; otherwise	x_{15}
Management	1; if management major, 0; otherwise	x_{16}
Marketing	1; if marketing major, 0; otherwise	x_{17}
Extra	1; if organization or athlete, 0; otherwise	x_{18}

The model is expressed in equation (1).

$$y_i^* = x_i^{'}\beta + u_i \quad \text{where } u_i \sim n(0,1),\ \forall_i = 1..., n \tag{1}$$

y_i is the observed ordinal grade (A = 4 through F = 0) of the ith student. y_i^* is the student's predicted grade as a function of the covariates listed in Table 2. $x_i^{'}$ and β are the matrices of

covariates and regression coefficients, respectively. The probability of a student receiving a given letter grade is based on the slope and threshold estimates from equation (1).

$$\begin{aligned}
\Pr[y_i = 0] &= \phi\left(-\hat{\beta}x\right) \\
\Pr[y_i = 1] &= \phi[\lambda_1 - \hat{\beta}x] - \phi\left(-\hat{\beta}x\right) \\
\Pr[y_i = 2] &= \phi[\lambda_2 - \hat{\beta}x] - \phi(\lambda_1 - \hat{\beta}x) \\
\Pr[y_i = 3] &= \phi[\lambda_3 - \hat{\beta}x] - \phi\left(\lambda_2 - \hat{\beta}x\right) \\
\Pr[y_i = 4] &= 1 - \phi\left(\lambda_3 - \hat{\beta}x\right)
\end{aligned} \tag{2}$$

where ϕ denotes the standard normal cumulative distribution (cdf) and λ_j signifies the grade threshold values. In the third stage of the study, we conducted robustness tests using an alternative definition of the dependent variable and an alternative estimating procedure.

The covariates and binary variables included in the models are listed in Table 2. Among the covariates are the students' cumulative grade point averages (GPA), hours spent in outside employment per week, student's age, and the brain-type measures SQ and EQ. GPA is an indicator of a student's cognitive ability and aptitude. Students with higher GPAs are expected to perform better in the basic finance course than students with lower GPAs. Hours worked is a surrogate for hours unavailable for studying. The anticipated sign of the coefficient for hours worked is negative Stinebricker and Stinebricker (2003); the more hours worked, the less time available for studying. Age is the student's age in years. More mature students are expected to perform better than less experienced students. We expect the sign of Age to be positive. SQ and EQ are the brain-type measures and are discussed in the next section. The fixed effects factors include instructor, gender, academic rank, major, and extracurricular activities. The dependent variables include the overall score on the comprehensive final exam and the scores on the analytical and recall question clusters. All of the grades were scaled as A = 4 through F = 0.

Results

Gender Differences In EQ And SQ Scores

A comparison of the SQ and EQ scores for our sample are included in Table 3. The purpose of this analysis is to establish the gender dichotomy between SQ and EQ scores suggested by Baron-Cohen (2003). As expected, males had a significantly higher mean SQ score than females. The 95% confidence interval for the male SQ scores was 31.45 – 36.55. Male SQ scores ranged from 5 to 80. For females the 95% confidence interval was 21.93 – 26.07 with a range of 5 to 61. The difference between the means of the SQ scores $\left(\bar{X}_{female} - \bar{X}_{male} = -10\right)$ was negative and significant at the 0.0001 level. In contrast to the SQ scores, female EQ scores were significantly higher than male scores. The difference between the means $\left(\bar{X}_{female} - \bar{X}_{male} = 6\right)$ was significant at the 0.0001 level. EQ scores ranged from a minimum of 26 to a maximum of 60 for males and from 26 to 69 for females.

Shown in the bottom portion of Table 3 are the correlation coefficients for gender and the brain type measures and for SQ and EQ separately. Per our hypothesis, there is a strong correlation between gender (female = 1) and both SQ and EQ. Moreover, both correlation coefficients carry the hypothesized signs. SQ and EQ were positively correlated. However, while significant at the 0.0758 level, the magnitude of the correlation coefficient was relatively low ($\rho = 0.1278$). This issue is addressed further in the next session.

Table 3
Gender Differences in SQ and EQ Scores

This table presents a test of the difference between the mean SQ and EQ scores for the student in our sample. Also shown are the correlation coefficients for gender (female = 1) and the brain type measures (SQ and EQ) and for the brain type measures themselves. The confidence intervals are for the 95% level. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Students' Gender	SQ	EQ	
Female			
Mean ($\overline{X}_{female}$)	24	48	
Confidence Interval of $\overline{X}_{female}$	(21.93 , 26.07)	(46.43 , 49.66)	
Range	5.00 – 61.00	26.00 – 69.00	
Male			
Mean ($\overline{X}_{male}$)	34	42	
Confidence Interval of $\overline{X}_{male}$	(31.45 , 36.55)	(40.23 , 43.77)	
Range	5.00 – 80.00	26.00 – 60.00	
Difference between Means			
$\bar{X}_{female} - \bar{X}_{male}$	-10***	6***	
Confidence Interval of $\bar{X}_{female} - \bar{X}_{male}$	(-11.653 , -8.347)	(4.791 , 7.209)	
t-statistic	5.957	4.916	
Correlation Coefficients			
	SQ	**EQ**	**EQ-SQ**
Correlation Coefficient for Gender (Female = 1; t-statistic in parenthesis)	- 0.3727*** (5.5644)	0.3400*** (5.010)	0.5356*** (8.788)
Correlation coefficient for SQ vs. EQ (t-statistic in parenthesis)	0.1278* (1.7851)		

We extend the analysis in Table 4 by estimating the probability of being classified as female based on the two brain type measures. The coefficients of both brain measures are significant at the 0.0001 level. Higher SQ scores decrease the probability of being classified as female, while higher EQ scores increase the probability. While the results presented in Table 4 support the Baron-Cohen's brain dichotomy model, the real issue is whether they have any predictive relevance to the performance of students in the basic business finance course.

Table 4
Probit Model Estimations for Being Classified as Female Based on Brain-Type

This table presents the estimated coefficient from a regression of gender on SQ and EQ. The SQ and EQ scores are the systemizing and empathizing coefficients calculated from the student questionnaires. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Covariates	Estimated Coefficients	z-statistics	Prob.
Intercept	-1.4745***	2.87	0.0040
EQ	0.0677***	5.87	0.0001
SQ	-0.0574***	6.22	0.0001
N	194		
LL Ratio $\left(\chi^2\right)$	66.3684		0.0001
McFadden R^2	0.2472		

Brain-Type and Performance

The second stage of the analysis estimates the probability of making a particular grade on the comprehensive final exam and its two question groupings (analytical and recall) treated individually. The covariates and categorical variables used in these estimations are listed in Table 2. The brain-type measure used in our estimating equations is the difference between EQ and SQ (EQ-SQ). That is, it is the differential between EQ and SQ that allows us to predict student performance in the basic finance course. Wider positive differences predict poorer performance in basic finance. The grading scale employed to evaluate the overall exam and its components was the standard A through F with numerical scores ranging from 90 percent and above for an A to below 60 percent for an F. The ordinal rankings for the dependent variables were y = 4 for an A to y = 0 for an F. The ordered probit estimations are presented in Tables 5, 6 and 7.

Model 1 in the first column of Table 5 replicates the model estimated in past studies. That is, the model estimates the probability of earning one of the five letter grades as a function of a dichotomous gender variable, GPA, instructor, work habits, age, major, class standing, and extra curricular activities. This model expresses an unconditional relationship between gender and performance. The model is unconditional in the sense of estimating the effect of gender on the probability of making a particular grade when brain-types are not considered. In Model 1, the probability of making a higher grade on the comprehensive final exam is improved by having a higher GPA and being an accounting, finance, management or marketing major.[9] Being female, attending instructor 2's class, and having a full- or part- time job reduces a student's probability of earning a higher grade on the exam. Specifically, the coefficient of the gender variable is negative and significant at the 0.01 level. The model predicts a lower probability of success for females in basic finance. In relation to the question of gender's effect on performance, this finding is similar

[9] Note that the impact of major on the probability being in a higher grade category is measured relative to the omitted major, business administration. Two economics majors were included in the finance category. Separate estimates with and without this aggregation did not change any of the regression results.

Table 5
Ordered Probit Estimations for the Comprehensive Final Examination

This table presents the results of the ordered probit specified model. The dependent variable is the student's numerical score on the final examination (90-100% = 4, 80-89% = 3, 70-79% = 2, 60-69% = 1, and 0-59% = 0). Model 1 includes gender as a dichotomous variable along with the other covariates listed in Table 2. Model 2 excludes the categorical gender variable, replacing it with the difference between EQ and SQ. N = 189 due to missing values for one or more variables for five students. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

	(1) Gender Model			(3) Brain-Type Model		
Covariates	Coeff	z-value	Prob	Coeff	z-value	Prob
GPA	1.231***	6.105	0.0000	1.186***	5.967	0.0000
INSTR 1	-0.288	1.406	0.1604	-0.159	0.759	0.4257
INSTR 2	-0.423*	1.682	0.0926	-0.394	1.567	0.1170
AGE	0.021	0.740	0067	0.011	0.551	0.5819
GEND	-0.487***	2.660	0.0078			
WORK	-0.010*	1.549	0.1215	-0.012*	1.737	0.0823
ACC	0.607**	2.098	0.0359	0.613**	2.123	0.0337
FIN	0.628**	2.313	0.0207	0.666**	2.456	0.0141
CIS	0.270	0.759	0.4477	0.304	0.857	0.3912
MGT	0.565*	1.806	0.0709	0.658**	2.074	0.0381
MKT	0.463*	1.893	0.0583	0.508**	2.062	0.0392
SEN	0.020	0.107	0.9144	0.113	0.595	0.5520
EXTRA	0.236	0.871	0.3835	0.290	1.066	0.2864
EQ-SQ				-0.017***	2.807	0.0050
λ_1	3.788***	4.616	0.0000	3.463***	4.175	0.0000
λ_2	4.660***	5.610	0.0000	4.346***	5.183	0.0000
λ_3	5.646***	6.515	0.0000	5.325***	6.093	0.0000
λ_4	6.931***	7.192	0.0000	6.578***	6.819	0.0000
N	189			189		
LL Ratio test (χ^2)	72.508***		0.0000	73.631***		0.0000
McFadden R^2	0.1555			0.1591		

to those in Borde, et al (1998), Terry (2002), Al-Tamimi and Al-Shayeb (2002), Benrud (2003), and Flanegin (2010).

However, the results of past works are misleading in the sense of commingling different brain-types under the gender classification. Our hypothesis is that the traditional approach inherently uses gender as an instrumental variable for brain-type. In doing so, past studies raise the issues of measurement error and bias estimates of the gender coefficient. That is, while gender is contemporaneously correlated with brain-type (see Table 3), it is also contemporaneously correlated with the error term due to the distribution of brain-types among females and males.

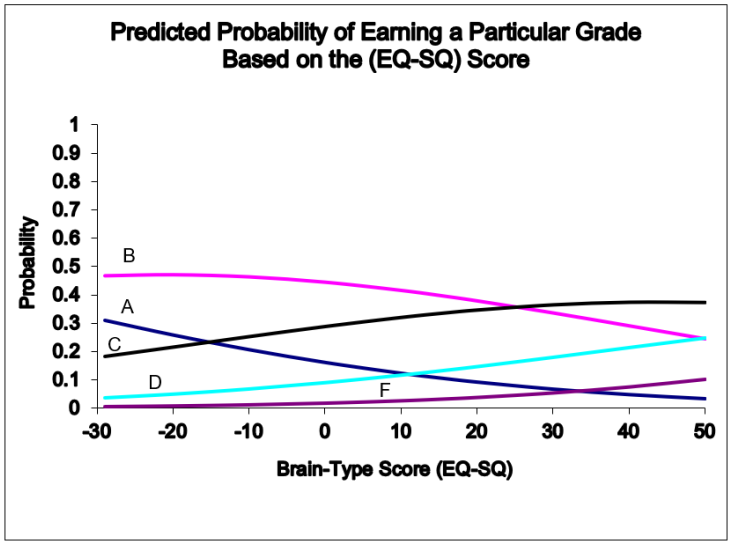
Model 2 substitutes the brain-type measure, EQ-SQ, for GEND in Model 1. Examining the EQ-SQ coefficient in Model 2 provides key evidence in support of our hypothesis. The EQ-SQ coefficient is negative and significant indicating that students (males or females) with higher EQ scores relative to their SQ scores have a reduced probability of earning a higher grade on the comprehensive exam. It is true that females, as a group, tend to have higher EQ scores than males; however, as noted in Table 3, there is substantial overlap in the male-female EQ distributions. Thus, the dichotomous female classification reflects the predominance of the EQ scores just as the male classification mirrors the predominance of SQ scores. Our focus is the contribution of brain-type – irrespective of gender – to the probability of making a particular grade on the comprehensive exam.

Figure 1 illustrates the predicted probabilities of earning a particular grade when the (EQ-SQ) scores are varied with all other covariates held constant at their means. The range of (EQ-SQ) scores was from the actual minimum score (-29) to the maximum score (50). For example, as the as the (EQ-SQ) score increases from its minimum to its maximum the predicted probability of earning an A in the basic finance course declines from 31% to 3.2% while the probability of earning a D rises from 3.6% to 24.7%. Moving from the minimum to the maximum (EQ-SQ) score increases the predicted failure rate from less than 1% to 10%.

Figure 1

Predicted Probability of Earning a Particular Grade Based on Variations in the (EQ-SQ) Score

Figure 1 was constructed by changing the EQ-SQ measure on a scale from the minimum value (-29) to the maximum value (50) while holding all other variables in model (2) at their mean values.



The marginal probabilities for five significant covariates from Model 2 are presented in Table 6. The marginal probabilities for (EQ-SQ) are linear estimates of the slopes of the grade functions shown in Figure 1. The signs of the marginal probabilities in column 3 imply that increases in the (EQ-SQ) score reduce the probability of earning a passing grade (A-D) and increase the probability of failure. What the results for the marginal probabilities suggest is that Type-S students have a higher probability of success in the first business finance course than Type-E students. Since males are, on average, in the upper-tail of the SQ distribution we would expect their performance to be somewhat better, on average, than the performance of females. Furthermore, differences in the sampling distributions of brain types may account for the ambiguous findings of previous studies of the gender effect in basic finance courses.

Table 6
Marginal Probabilities for Selected Covariates of the Probit Estimations

This table presents the marginal probabilities of selected significance coefficients from Model (2) in Table 5. The marginal probabilities are estimates of the slopes of the grade functions plotted in Figure 1. The probabilities were calculated at the means of the covariates included in Model (2).

Comprehensive Exam Grade	GPA	EQ-SQ	Work	FIN	ACC
A	0.0045	-0.0001	-0.0000	0.0025	0.0023
B	0.0891	-0.0013	-0.0009	0.0500	0.0460
C	0.2455	-0.0036	-0.0024	0.1378	0.1269
D	0.1331	-0.0019	-0.0013	0.0747	0.0688
F	-0.4721	0.0068	0.0047	-0.2649	-0.2440

The probability of success in the basic finance course was also impacted by GPA, hours worked, and major. Students with higher GPAs had higher probabilities of success than students with lower GPAs. For instance, an increase in a student's GPA from a 2.5 to a 3.0, increased the probability of earning an A on the comprehensive final exam from 2.2% to 13.1% and reduced the probability of earning an F from 13.4% to 2.3%. An increase in hours worked from 20 to 40 hours per week reduced the probability of earning an A from 10.6% to 6.8% and increased the probability of earning an F from 3% to 5.1%. Finally, being a finance or accounting major improved a student's chances of earning a higher grade on the comprehensive exam relative to business administration majors. Finance and accounting majors were significantly less likely to fail the comprehensive exam than business administration majors.

Analytical and Recall Questions

According to Baron-Cohen (2003), the systemizing brain comprehends subjects and events in terms of deterministic, numerical, and law-like patterns. The systemizing quotient (SQ) measures the degree to which an individual is drawn to mathematics, statistics, and syllogistic reasoning. In contrast, the empathizing brain is better at verbal memory, recall, and language skills. Higher EQ scores are indicative of these traits. The results in Table 7 focus on EQ and SQ as determinants of student grades on the two question components of the comprehensive final exam. The analytical portion included 25 numerical questions and decision problems (e.g., calculating NPVs and distinguishing between profitable and unprofitable capital budgeting projects). These questions

were classified by a three instructor panel to be in the top-three tiers (analyzing, synthesizing and evaluating) of the Bloom-Anderson-Krathwohl learning objective taxonomy.[10] The recall section was composed of 25 questions requiring the recollection of specific concepts, definitions, meanings of ratios, and identification of different financial instruments. The panel judged these questions as being in the three lowest tiers (remembering, understanding, and applying) of the learning objective taxonomy.

Table 7 presents the ordered probit estimations for the analytical and recall portions of the final exam. The brain type measure was statistically significant in the analytical questions estimations but not for the recall model. As expected, the coefficient of (EQ-SQ) in Model 1 of Panel A carried a negative sign indicating that students with higher SQ scores had a better chance of earning a high grade on the analytical portion of the exam than students with a lower score. These results suggest that Type-S students, whether female or male, had a higher probability of success on the analytical questions than did Type-E students. Higher GPAs and being either a finance or accounting major also enhanced the probability of higher scores on analytical questions. Attending instructor 1 or instructor 2's classes reduced a student's probability of success on the analytical questions.

Models 2 and 3 of Panel A contrast the brain-type model to the more traditional gender approach. Model 2 replicates a gender-type model typical of past studies. The results for this model show that being female reduces a student's probability of earning a higher grade on the analytical portion of the exam. Analytical questions model 3 retains the gender variable but accounts for brain-type by including (EQ-SQ) in the estimating equation. With the exception of gender, the estimated coefficients are quite stable between models 2 and 3. When (EQ–SQ) is added to model 3 gender becomes insignificant as a determinant of the probability of earning a particular grade on the analytical questions. However, (EQ-SQ) is statistically significant at the 0.08 level and carries the predicted negative sign indicating that students (male or female) with higher SQ scores had an increased probability of success on the analytical portion of the comprehensive exam. As noted in model 1, the significance of brain-type becomes clearer once the confounding effects of the categorical gender variable are removed from the estimating equation.

For the recall section of the exam, the coefficient of (EQ-SQ) in Model 1 of Panel B carried a negative sign but was significant at only the .16 level; indicating that brain-type is not a dominant influence on the probability of success on finance exams composed of definitional and identification-type questions. The probability of being in the upper-range of the grade distribution on the recall section was enhanced by higher GPAs, age (perhaps, an indicator of experience with recall-type tests) and being an accounting, finance, or management major.[11] Students gained no advantage on the recall portion of the exam by attending any particular instructor's class. Recall Questions Models 2 and 3 show that while the inclusion of the brain-type measure in the estimating equation reduces the significance of the gender variable neither are statistically significant.

[10] In order to test the robustness of the recall estimations, the three instructor panel classified each of the 25 questions in the recall cluster as belonging to one of the first three tiers in the Bloom-Anderson-Krathwohl taxonomy. The questions were distinguished by the verbs used in the interrogative expressions. For example, questions using such verbs as define, identify, and label were included in the first tier (remembering). Second tier (understanding) questions included verbs such as predict, conclude, and compare. Questions with verbs like list, classify and complete were classed as third tier (applying). Separate probit and OLS estimations were run for each tier. None of the brain type coefficients proved statistically significant.

[11] This result also held for the overall comprehensive final exam score as well.

Table 7
Ordered Probit Estimations for the Analytical and Recall Question Clusters

This table presents the ordered probit estimations for the numerical score on the analytical and recall question clusters in Panels A and B, respectively. N = 189 due to missing values for one or more variables for five students. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Panel A: Analytical Question Cluster

	Model 1 – Brain-type			Model 2 – Gender			Model 3 - Combined		
Covariates	Coeff	z-value	Prob	Coeff	z-value	Prob	Coeff	z-value	Prob
GPA	1.209***	6.340	0.0000	1.261***	6.510	0.0000	1.257***	6.486	0.0000
INSTR 1	-0.520***	2.701	0.0069	-0.649***	3.291	0.0010	-0.599***	3.012	0.0026
INSTR 2	-0.580**	2.362	0.0182	-0.605**	2.466	0.0137	-0.614**	2.496	0.0125
AGE	0.014	0.500	0.7303	0.025	1.295	0.1952	0.018	0.917	0.3591
GENDER				-0.530***	3.038	0.0024	-0.338	1.637	0.1016
WORK	-0.009	1.405	0.1599	-0.007	1.152	0.2495	-0.009	1.364	0.1726
ACC	0.638**	2.333	0.0197	0.645**	2.355	0.0185	0.659**	2.400	0.0164
FIN	0.565**	2.152	0.0314	0.520**	1.975	0.0483	0.523**	1.983	0.0473
CIS	0.352	1.022	0.3070	0.337	0.980	0.3272	0.312	0.905	0.3653
MGT	0.308	1.011	0.3119	0.220	0.732	0.4642	0.293	0.965	0.3345
MKT	0.364	1.566	0.1174	0.315	1.360	0.1737	0.358	1.536	0.1246
SEN	-0.106	0.583	0.5602	-0.200	1.104	0.2697	-0.148	0.803	0.4217
EXTRA	0.233	0.896	0.3704	0.172	0.663	0.5070	0.203	0.779	0.4358
EQ-SQ	-0.018***	3.101	0.0019				-0.012*	1.747	0.0807
λ_1	2.883***	3.642	0.000	3.250***	4.152	0.000	2.994***	3.756	0.000
λ_2	3.891***	4.865	0.000	4.244***	5.352	0.000	4.005***	4.971	0.000
λ_3	4.380***	5.431	0.000	4.727***	5.905	0.000	4.496***	5.534	0.000
λ_4	5.678***	6.560	0.000	6.062***	7.014	0.000	5.822***	6.655	0.000
N	189			189			189		
LL Ratio test	88.707***		0.000	88.340***		0.000	91.395***		0.000
McFadden R^2	0.1657			0.1657			0.1706		

Panel B: Recall Question Cluster

	Model 1 – Brain-type			Model 2 – Gender			Model 3 - Combined		
Covariates	Coeff	z-value	Prob	Coeff	z-value	Prob	Coeff	z-value	Prob
GPA	0.849***	4.413	0.0000	0.854***	4.410	0.0000	0.846***	4.367	0.0000
INSTR 1	0.271	1.368	0.1714	0.236	1.174	0.2404	0.278	1.360	0.1738
INSTR 2	-0.295	1.135	0.2564	-0.290	1.113	0.2656	-0.292	1.119	0.2633
AGE	0.043**	2.217	0.0266	0.047**	2.442	0.0146	0.043**	2.188	0.0286
GENDER				-0.117	0.643	0.5199	0.031	0.143	0.8863
WORK	-0.011	1.591	0.1117	-0.010	1.459	0.1445	-0.011	1.592	0.1113
ACC	0.668**	2.266	0.0235	0.657**	2.233	0.0255	0.667**	2.262	0.0237
FIN	0.907***	3.342	0.0008	0.906***	3.321	0.0009	0.911***	3.335	0.0009
CIS	0.254	0.675	0.4998	0.266	0.702	0.4829	0.260	0.687	0.4922
MGT	0.952***	3.003	0.0097	0.888***	2.836	0.0046	0.955***	3.006	0.0026
MKT	0.399	1.564	0.1177	0.367	1.449	0.1474	0.400	1.566	0.1173
SEN	0.022	0.115	0.9086	-0.011	0.061	0.9515	0.025	0.131	0.8959
EXTRA	0.199	0.712	0.4763	0.174	0.625	0.5316	0.201	0.720	0.4713
EQ-SQ	-0.009	1.403	0.1605				-0.009	1.257	0.2088
λ_1	3.634***	4.491	0.0000	3.800***	4.763	0.0000	3.628***	4.479	0.0000
λ_2	4.814***	5.740	0.0000	4.974***	6.007	0.0000	4.809***	5.729	0.0000
λ_3	5.658***	6.552	0.0000	5.818***	6.815	0.0000	5.653***	6.540	0.0000
λ_4	6.426***	7.023	0.0000	6.574***	7.260	0.0000	6.420***	7.009	0.0000
N	189			189			189		
LL Ratio test	56.849***		0.0000	55.288***		0.0000	56.870***		0.0000
McFadden R^2	0.1419			0.1383			0.1420		

Robustness Checks

The final stage of our analysis provides a robustness check of the previous conclusions. In this stage we re-specified our models in terms of the number of questions answered correctly on the exam rather than using discrete grade intervals. Using the number of questions answered correctly as the dependent variable provides another test of our hypothesis and addresses some potential biases that could arise in the interval estimates. For example, while the students' grades are the same in a given grade interval, the number of questions they answered correctly varies. Also, a one or two question difference in the number of questions answered correctly around a cut point could move a student from one grade interval to another. The OLS specifications in Tables 8 and 9 replicate our original probit estimations using the number of questions answered correctly as the dependent variables.

The results reported in Table 8 show that the coefficient of the binary gender variable in Model 1 is statistically significant and carries a negative sign; implying that being females reduced the number of questions answered correctly on the comprehensive final exam. This result is the same as that found in Model 1 of Table 5 for the interval estimates (i.e., being female reduced the probability of a higher grade on the exam). The other significant coefficients in our robustness model generally mirrored those found in Model 1 of Table 5 as well. Students who work more hours and attended instructor 2's class answered fewer questions correctly. GPA, age and whether the student was a finance or accounting major positively impacted the number of questions answered correctly. In the second robustness model the brain type measure (EQ-SQ) was substituted for the binary gender variable. As in Model 2 of Table 5, the coefficient of (EQ-SQ) was negative and statistically significant. The implication of this finding is that the higher the EQ score relative to the SQ score (male or female) the lower the number of questions answer correctly on the comprehensive exam. Again, GPA and being a finance or accounting major contributed positively to the number of questions answered correctly on the exam. Increases in hours worked and attending instructor 2's class reduced the number of questions answered correctly.

The robustness tests for the analytical and recall question clusters produced results similar to the original models. These results are reported in Table 9. The brain-type measure was highly significant in the Analytical Question Model. Students with higher EQ scores relative to their SQ scores answered fewer questions correctly on the analytical portion of the exam. The number of analytical questions answered correctly was positively related to GPA and whether a student majored in finance, accounting, or marketing. Hours worked and attending the classes of instructors 1 and 2 reduced the number of analytical questions answered correctly.

The results for the brain-type measure in the Recall Question Model were somewhat stronger than the probit specifications presented in Model 2 of Table 7. The coefficient of the (EQ-SQ) carried a negative sign in Model 2 and reached a level of significance of .07. Students with higher EQ scores relative to SQ scores did marginally worse on the recall portion of the exam. Again, hours worked reduced the number of questions answered correctly while GPA and majoring in finance, accounting, management or marketing improved a student's exam results.

Table 8
Robustness Checks for the Comprehensive Final Examination Estimates

This table presents an OLS specification as a robustness check for the probit model specifications in Table 5. The dependent variable is the number of questions answered correctly on the comprehensive final exam. Model 1 includes gender as a dichotomous variable along with other covariates listed in Table 2. The second specification excludes the categorical gender variable, replacing it with the difference between EQ and SQ. N = 189 due to missing values for one or more variables for five students. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

	(1) Gender Model			(2) Brain-Type Model		
Covariates	Coeff	t-value	Prob	Coeff	t-value	Prob
GPA	6.173***	7.472	0.0000	5.960***	3.062	0.0000
INSTR 1	-0.944	1.058	0.2913	-0.397	0.447	0.6553
INSTR 2	-2.309**	2.065	0.0404	-2.072*	1.842	0.0671
AGE	0.186**	2.075	0.0394	0.148	1.610	0.1092
GEND	-2.512***	3.164	0.0018			
WORK	-0.057*	1.927	0.0556	-0.0613**	2.026	0.0443
ACC	2.707**	2.090	0.0381	2.6079**	1.994	0.0477
FIN	3.092**	2.535	0.0121	3.357***	2.740	0.0068
CIS	1.375	0.845	0.3993	1.6623	1.015	0.3113
MGT	2.012	1.466	0.1444	2.3599*	1.689	0.0930
MKT	1.529	1.442	0.1512	1.6225	1.509	0.1330
SEN	-0.671	0.806	0.4213	-0.3101	0.366	0.7143
EXTRA	1.410	1.135	0.2577	1.6967	1.353	0.1780
EQ-SQ				-0.0686**	2.514	0.0128
λ_1	9.883***	2.865	0.0047	10.888***	3.062	0.0025
N	189			189		
Adjusted R^2	0.356			0.342		
F-statistic	8.981***		0.0000	8.533***		0.0000

Table 9
Robustness Checks for the Analytical and Recall Estimates

This table presents an OLS specification as a robustness check for the probit model specifications in Table 7. The dependent variable is the number of questions answered correctly on the analytical and recall clusters of the comprehensive final exam. The covariates of these estimations are listed in Table 2. N = 189 due to missing values for one or more variables for five students. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

	(1) Analytical Question Model			(2) Recall Question Model		
Covariates	Coeff	t-value	Prob	Coeff	t-value	Prob
GPA	3.339***	6.140	0.0000	2.092***	4.185	0.0000
INSTR 1	-1.207**	2.020	0.0449	0.550	1.016	0.3111
INSTR 2	-1.339*	1.808	0.0723	0.088	0.131	0.8952
AGE	0.055	0.883	0.3783	0.079	1.416	0.1584
WORK	-0.042**	2.113	0.0360	-0.059***	3.311	0.0011
ACC	1.595*	1.813	0.0715	1.452*	1.825	0.0697
FIN	1.745**	2.115	0.0358	1.706**	2.285	0.0235
CIS	1.311	1.189	0.2361	0.112	0.113	0.9103
MGT	0.907	0.965	0.3361	1.544*	1.814	0.0714
MKT	1.450**	2.044	0.0424	1.527**	2.379	0.0184
SEN	0.121	0.2152	0.8299	0.354	0.695	0.4879
EXTRA	0.827	0.981	0.3280	0.473	0.620	0.5361
EQ-SQ	-0.056***	3.099	0.0023	-0.031*	1.859	0.0647
λ_1	6.279***	2.654	0.0087	7.010***	3.275	0.0013
N	189			189		
Adjusted R^2	0.2851			0.1893		
F-statistic	6.858***		0.0000	4.431***		0.0000

Conclusions

We find that success in the basic business finance course is related to brain type, not gender, *per se*. Type-S students had a higher probability of being in the upper ranges of the grade distribution than did Type-E students, irrespective of gender. This conclusion became particularly apparent when the comprehensive final exam was separated into its analytical and recall components based on Bloom's taxonomy. When a categorical gender variable was included in the analytical questions estimating equation, being female decreased the probability of success

significantly. Estimating the same equation with brain-types held constant eliminated the categorical gender variable as a significant determinant of the probability of success on the exam. While there is some overlap in the probability distributions of SQ (Type-S) and EQ (Type-E) scores, high SQ scores are a male trait and high EQ scores are a female trait. Studies that show an advantage for males over females in the basic business finance course are really observing an advantage for Type-S students over Type-E students. Thus, the tendency for fewer females to major in finance or select careers in finance may be attributable to the generally lower percentage of Type-S females.

Our results indicate that properly identifying brain-type might be included as an initial step in the educational counseling process so that students can receive superior advising with regard to future educational pursuits. It follows that, given a superior matching of student and curriculum, resources (human capital and monetary) would be better employed in the educational process, that educational attainment and satisfaction would improve, and that society would be the beneficiary as educators began to consider diversity of brain-type rather than focusing solely on gender differences.

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Using Knowledge Maps to Support Deeper Learning in Introductory Finance

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The challenges students face when trying to understand the links and relations between introductory accounting content and introductory finance content demand further analysis. Accounting is consistently a prerequisite to finance; however, when we reviewed the terminology used in accounting textbooks, we identified potential sources of confusion. We focus on two specific aspects of course content: terminology and reading versus building financial statements. We examine the hypothesis that if students better understand the links between accounting and finance, their understanding of finance will improve. We applied the knowledge map as a tool, and the measured outcomes suggest that this approach does indeed help students gain a better understanding of finance by relating it to concepts learned in accounting. Furthermore, student feedback suggests that students found the time dedicated to explaining the relationship between accounting and finance to be a beneficial and valuable addition to the corporate finance course.

Keywords: Introductory Finance, Accounting terminology, Knowledge maps

Introduction

Introductory corporate finance courses challenge both students and instructors. Anecdotal evidence abounds and suggests that some students dread the class and may even postpone the introductory finance course as long as possible, taking the course during their last semester. The quantitative content may intimidate some students, and the unique terminology and use of jargon contributes to the confusion. There is a rich body of work that examines factors related to success in introductory finance courses; the factors include GPA, demographic factors and success in prerequisite courses. It is common to see introductory accounting as a prerequisite to introductory finance. However, students struggle to link the content from these two courses. After reviewing the content in introductory accounting textbooks, we understand these difficulties and suggest a process to address these issues.

We focus on content that is first introduced in introductory accounting and then help students to link this content to finance. The goal is to gain a deeper understanding of the concepts. We contend that if students have a better understanding of accounting and finance and how they are related and work together, their understanding of finance will improve. Our primary areas of emphasis are definitions and understanding how to build and read financial statements.

The first step in this project included a review of the terms and definitions used in both courses. We inspected a group of commonly used accounting and finance textbooks and looked up specific definitions, as well as jargon used in both fields. All faculty involved registered surprise at the dense and confusing terminology, especially when considered from the point of view of a

beginning student. We looked at the accounting definitions and then compared how these same terms appeared within the context of finance. It is clear that we needed to help students transfer to finance what they learned in accounting. We used knowledge maps as a framework and tool to help students with this process.

Knowledge maps are well researched tools that enhance student learning at many levels. The work in this area is grounded in the understanding that the multiple acts of picturing something in your mind, drawing it out and looking at it, all work together to activate more areas in the brain (Wammes et al., 2016). The goal is to increase understanding and retention and to make content make sense and stick. This project introduces knowledge maps in introductory finance courses. The maps were designed to help students link the content from accounting to finance and to help them better understand financial statements and financial ratios. The study was run over one academic year and involved using two sections of introductory corporate finance in Fall 2018 as a control group without exposure to knowledge map content, and four sections from Spring 2019 – Fall 2021 that did use knowledge maps. The measured outcomes suggest that this approach does indeed help students gain a better understanding of content. Furthermore, student feedback suggests that students found the time dedicated to explaining the relationship between accounting and finance to be a beneficial and valuable addition to the corporate finance course.

This research offers ideas that can easily be incorporated into introductory finance courses. First, we offer specific tools to help instructors and students enhance their understanding of accounting and transfer that into finance. This work encourages them to build on an accounting foundation as a part of constructing a solid understanding of finance. Second, we highlight an issue that, to our knowledge, business curriculum has not addressed. This issue is the confusion that results from different terminology being used in accounting and finance. In another sense, this work encourages all of us to look beyond our areas of specialization and help students link their knowledge of varied aspects of business education together. This approach also encourages students to move from a rote form of low-level learning to a higher level of learning based on a deep understanding of how topics and content are related. Finally, this work proposes study methods to students that have far reaching benefits. The modules developed here allow students to work with knowledge maps and decide for themselves how best to use these tools and methods to enhance understanding and retention.

This paper is organized as follows. A literature review highlights factors that contribute to student success in introductory finance and the learning theory that forms the foundation for the use of knowledge maps. A review of the project including project design, methodology, results, and conclusion. Sample materials are included in the Appendix.

Literature Review

This literature review provides a brief synopsis of the two streams of research that motivate and inform this work. First, we review literature related to determinants of student success in introductory corporate finance courses. Second, we review literature related to learning theory and knowledge construction. There is a rich body of work that examines the factors that contribute to student success overall, and in finance courses, in particular. Early studies focused on academic factors, demographic factors, instructor traits and course design. We note some highlights here. Studies suggest a number of factors contribute to student success in finance. GPA, age and prior success in economics are positively related to performance in introductory finance courses (Simpson & Sumrall, 1979; Terry, 2002). Transferring from a community college is negatively

related to student performance in finance (Simpson & Sumrall, 1979; Borde et al., 1998). More recent work focuses on determining the factors that contribute to success in all quantitative courses. The literature of interest in this area is related to student performance in previous courses. Grover et al. (2009) find that start-of-the semester tests in accounting are predictive of student grades in introductory corporate finance.

These studies suggest that academic success in accounting may contribute to success in finance. We use this information as a foundation for the design of learning tools to help students successfully move from accounting into finance. These tools focus on clarifying terminology differences in areas that are consistently confusing to students. Additionally, the tools offer students a process for knowledge construction that supports an understanding of the relationships and differences between accounting and finance.

As previously mentioned, the use of knowledge maps is grounded in decades of work in learning theory. Learning theory stresses the importance of constructing knowledge from a foundation of what we already know. To this foundation, we add new information and build an understanding of what the additional information can do for us. Work in this area suggests that learning occurs along a continuum with rote learning being the lowest level and meaningful learning being the highest level (Novak, 1998). This approach coordinates well with Bloom's (1956) models of learning. Both suggest two related ideas. The first is that within rote learning processes, there is no commitment to relate new knowledge to prior learning. The second is that within a meaningful learning process, there is a deliberate effort to link new knowledge with higher-order concepts.

Research supports a strong connection between a meaningful learning process and knowledge retention (Lindsey et al., 2014; Rondon et al., 2013; Beers & Bowden, 2005). A primary tool for developing meaningful learning is the knowledge map (Novak, 1998: Wandersee et al., 1994). These maps help to organize content and serve as a tool for students to find and link key concepts. For many students, this is a natural process, with research indicating that younger students find it easier than university students (Wandersee et al., 1994).

Project Design

Sections of introductory corporate finance taught between 2018 through 2021 are involved in this study. Two sections taught in Fall 2018 did not include knowledge maps and are used as control groups. Two sections taught in spring 2019, one section in Fall 2020 and one section in Fall 2021 did include knowledge maps. All sections were taught by the same instructor utilizing identical course materials, except for knowledge map material. The content covered early in the course includes financial statements, working with financial statements and ratios. Knowledge maps were introduced at the beginning the classes that were not control groups. The impact of this intervention was measured throughout the first half of the semester using targeted exam questions.

Knowledge maps can be utilized in several different ways in the classroom. The approach used here was one in which students were assigned to draw two different maps. The first map was assigned before the relevant chapters were covered in class. The focus was simply to capture what students knew about the income statement and balance sheet. The second map was assigned and required after covering income statement and balance sheet content in class. They were asked to draw what they know about income statements and balance sheets and include any notes that help them to remember terminology and how the financial statements are related. All maps were combined into one assignment that counted for approximately 5% of the total grade.

Project Review and Teaching Modules

We designed simple modules to outline this process and content, and these are included in the Appendix. Module 1 introduces students to knowledge maps and explains why this content is being added to this course. Module 2 focuses on the terminology in accounting and finance and focuses on learning definitions and being able to translate definitions into simple and easy to understand explanations. Module 2 contains an initial list of 63 terms taken from introductory accounting textbooks. We focus on the 25 terms included in the table in Exhibit 3a and build a discussion around both the accounting definition and the finance definition or explanation. We discuss the different perspectives and how we can build on the original accounting definitions to expand our understanding. Module 3 focuses on financial statements and includes a discussion about what information we get from financial statements and how they are related to one another. The emphasis is on reading the statements, as opposed to building them. Handouts for Modules 1, 2 and 3 are included in Appendix 4 that follows the references.

Course Details

The course being analyzed is undergraduate Corporate Finance. The course is a required course for all business majors and is taught at a liberal arts college in the western region of the country. Class sizes are small and average 25 students. The topics included are financial statements and ratios, time value of money, stock and bond valuation, capital budgeting and weighted average cost of capital. The focus of this study is on the content at the beginning of the course related to financial statements. To evaluate student outcomes, we first analyze the similarities between the class sections and then we examine student performance on targeted questions.

Data, Methodology and Statistical Results

All sections involved in this study were taught by the same professor. The content was the same except for knowledge maps. All sections were administered utilizing the Canvas learning management software and all received the same lecture, class exercises, class notes and homework problems. Correct answers to homework are posted in Canvas. All quizzes and exams were administered in class with none administered online. Students were not allowed to use a book or notes on the exams. The control group was based on Fall 2018 data. The group that was introduced to knowledge maps and form the basis of this study included two sections from Spring 2019, one section from Fall 2020 and one section from Fall 2021. There was a total of 155 students involved with 54 in the control group.

Data on all course sections was reviewed for other significant differences using a standard t test to determine significance. The two samples showed nearly identical mean performance across factors that included average GPA and average grade in the prerequisite accounting course. The average GPA for the Fall 2018 sections was 3.34 and for the other sections it was 3.36. This difference was not significant. The average grade in introductory accounting was also not significantly different. The Fall 2018 sections had an average of 87.5% and the other sections had an average of 87.37%.

The major difference between these course sections was the addition of the knowledge map modules and the focus on helping students transition their knowledge and understanding from

introductory accounting to finance. In addition to including the modules presented here, students turned in knowledge maps for points that counted for approximately 5% of their overall grade. Otherwise, the grading calculation was the same as that for Fall 2018.

The following steps were followed to gather student feedback and analyze student performance. The first step was to gather student feedback through a survey at the end of the Fall 2018 semester. We used the same student survey at the end of all other semesters. The results are summarized in the following paragraph. The second step was to analyze specific student performance measures.

A student feedback survey was given to all students at the end of each semester. It is included in Appendix 5. One hundred fifty-five students completed the survey. Fifty-four students were in a control group during fall 2018. These students did not receive any knowledge map content. At the end of the semester, 52 students out of 54 participated in an in-class survey related to understanding the relation between accounting and finance. The results indicated that most students did not see the relations between the two classes and felt like they were beginning a new topic, not building on anything they had already learned. The results showed that 91% of students strongly disagree that the content in corporate finance builds on content in introductory accounting. The overwhelming majority (93%) felt that the content in corporate finance was entirely new and in no way related to previous accounting courses. The final question on the survey asked whether students felt it would be valuable for them to understand the links between these two courses to improve their understanding of finance. It was not surprising to find that 94% of respondents strongly agreed that understanding the links between accounting and finance will improve their understanding of both areas in meaningful ways.

Between Spring 2019 and Fall 2021, 101students were given the same survey questions as the control group. These sections were exposed to the knowledge map content as outlined previously. Student feedback was very positive and 96% of students felt that the content in corporate finance related to introductory accounting. It was not surprising to find that 94% of respondents strongly agreed that understanding the links between accounting and finance will improve their understanding of finance. In addition, 56% of students surveyed noted in a comments section that the additional time spent on terms and definitions from an accounting and finance perspective was a valuable addition to this course.

Three specific performance outcomes were analyzed. A standard t test is used to determine if there is a significant difference in the two samples and unequal variance is assumed. The first performance outcome is an accuracy score on 8 specific questions that were included on exam one. These questions relate directly to financial statements and financial ratios and are the focus of the knowledge map projects. The second measure is the overall grade in the class. The final performance outcome is the grade on Test I. We controlled for the following variables that may influence student performance. These are gender, GPA, transfer status, and grade in introductory accounting.

We report summary statistics and significant outcomes in Table 1. As previously noted, the results in this table indicate that the group differences are not significant when considering GPA, average grade in introductory accounting and average grade in corporate finance. There is a significant difference in the student performance on eight accounting related questions that were a part of Test I and performance on Test I.

Table 1
Summary Statistics and Significant Outcomes
All Students Enrolled in Introductory Finance (Fall 2019 – Spring 2020)

	Fall 2018: No knowledge maps	Spring 2019: Knowledge maps included	t statistic
# of students	54	101	
Female (%)	26%	38%	
Average GPA	3.34	3.36	.9209
Transfer %	14.8%	53%	
Prerequisite Introductory accounting course grade	87.5%	87.37%	-.6379
Mean score Test I	77.56%	83.21%	-2.0815*
Mean score course grade	81.5386	83.2679	-.7110
Mean score on identified test I questions	75.8113	82.2538	-2.2448*

Significance levels: *, **, *** denote 5%, 1% and .01%, respectively.

These results, combined with student feedback, indicate that using knowledge maps in introductory finance courses can help students successfully transition from building financial statements to understanding and reading financial statements. These results suggest that knowledge maps make a significant contribution to improving student understanding of basic accounting and financial concepts.

Conclusion

Learning theory stresses the importance of constructing knowledge by building on a foundation of what we know. To this foundation, we add new information, expand our understanding and explore what the additional information can do for us. Our goal with this project was to directly address the confusing terms from introductory accounting and finance textbooks in an effort to provide a more meaningful learning process and support finance students in creating a strong foundation in accounting.

This paper contributes to the literature on student outcomes in introductory finance courses by encouraging accounting faculty and finance faculty to work together to develop tools that help students link the content from these courses and build a strong foundation for understanding. In environments filled with new technology and new learning tools, we return to old methods that continue to prove effective at helping students engage with deeper learning. Our results indicate that incorporating knowledge maps into finance courses with a focus on specific content areas improves student performance in these areas.

We brought a rich background and decades of teaching experience to this work; however, we knew little of the classes taught outside our areas. Like many in academic environments, we work within our divisions. This project provided an opportunity to cross disciplinary lines and develop an approach that benefits students.

Based on student feedback, this project demonstrated a positive impact on student learning. We will continue to work together to find ways to improve and expand this work. There is value in understanding the prerequisites for the courses we teach. There is also value in providing students with tools to link the knowledge from different courses together so that they gain a deeper understanding of business concepts.

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Appendix 1

Module 1 -- What is knowledge mapping and why are we using it?

What are knowledge maps?

- Tool that helps people create a picture that shows the relationships between concepts
- Structured diagram
- Map of relationships and ideas

Why are we using them?

- Proven results related to improved learning (understand relationships between content)
- Promotes deep learning as opposed to surface learning (rote, memorization)
- Promotes active engagement in the classroom
- Memory/retention – Students are more likely to retain this information and be able to build on what they know in future classes.

Why/how are we using knowledge maps in Finc 300?

- To link information from Acct 213 to Finc 300
- To decrease confusion
- To encourage student success

Appendix 2

Module 2 -- Getting clear on terminology.

- Getting the terms straight
- Language in accounting and finance is different
- Confusing
- Looking for easy to understand explanations and definitions

Appendix 3A
Accounting Terms A-H

Term	Accounting Definition
Accounts Receivable	Expected future cash receipts arising from permitting customers to buy now and pay later.
Accounts Receivable Turnover	Measure of how hast AR is converted to cash.
Allocation	Recognition of expense by systematics assignment of the cost of an asset to periods of use.
Allowance for Doubtful Accounts	Contra asset account that contains an amount of Accounts Receivable likely not to be collected.
Amortization	It's really just depreciation, just for intangible assets
Asset	Probable future economic benefits obtained or controlled by an entity
Average Days in Inventory	Number of days inventory held before sell.
Average No. of Days to Collect AR	Length of average AR collection period.
Book Value	Historical/original cost of an asset minus related accumulated depreciation
Book Value Per Share	Measure of stock value.
Capital Expenditures	Large amounts spent to improve an asset's quality or extend its life.
Capitalized	Amounts spent and recorded as an asset initially.
Classified Balance Sheet	Balance sheet that distinguishes between current and noncurrent items (assets and liabilities).
Common Size Financial Statements	F/S in which amounts are converted to percentages.
Comprehensive Income	Net income plus or minus unrealized gains.
Contributed Capital	Portion of assets contributed by owners.
Cost of Goods Sold	Total cost incurred for the hoods sold during a period.
Current Asset	Asset that will be converted to cash or consumed within one year or an operating cycle.
Current Liability	Liability that will be converted to cash or consumed within one year or an operating cycle.
Current Ratio	Relationship between current assets and current liabilities.
Debt to Assets Ratio	Measure of a company's risk
Deferral	Recognition of revenue or expense in a period after the cash is exchanged.
Depletion	It's really just depreciation, just for natural resources.
Depreciation	Allocation of the costs of long-term assets to expense over their useful lives
Equity	Portion of the assets remaining after the creditors' claims have been satisfied.
Expense	Using up an asset.
Fair Value	The price at which assets or liabilities sell in a free market.
Financial Leverage	Increasing earnings through debt financing.
Financing Activities	Cash transactions associated with owners and creditors.
Future Value	The value of an item at some point in the future.
Gains	Similar to revenue, but from peripheral activities.
Gross Margin	Amount a company makes before subtracting operating expenses.
Gross Margin Percentage	Measure of company's pricing strategy
Historical Cost	Original cost of an asset vs the fair value of an asset

Appendix 3B
Accounting Terms I-Z

Term	Accounting Definition
Inventory	Assets purchase for the purpose of re-selling
Inventory Turnover	Measures how many times inventory is sold in a year
Investing Activities	Cash transactions associated with buying/selling long-term assets
Liquidity	Ability to convert assets to cash quickly and meet short-term obligations.
Losses	Decreases in assets or increases in liabilities that are from peripheral activities.
Market Value	Value of an item on the secondary market.
Net Assets	Portion of assets remaining after the creditors' claims have been satisfied.
Net Income	Bottom line on the income statement resulting from operating the business. Revenues greater than expenses.
Net Loss	Bottom line on the income statement resulting from operating the business. Expenses greater than revenues.
Net Realizable Value	Face amount less any allowance.
Net Sales	Sales minus returns and allowances.
Operating Activities	Cash transactions associated with operating the business.
Operating Income	Includes revenues and expenses related to the principal activities of the company
Price-Earnings Ratio	Comparison of selling price per share to earnings per share
Retained Earnings	Increase in equity that results from operations of the company

Appendix 4A
25 terms: Accounting and finance definitions and explanations A-G

Accounting term	Accounting definition	Finance definition/explanation
Asset	Probable future economic benefits obtained or controlled by an entity	A resource that a company owns or controls / What the company has to use to make money
Book Value	Historical cost of an asset minus accumulated depreciation	Discuss relative to an asset and relative to a firm / what a firm has minus what they owe / equity
Book value per share	A measure of stock value	Equity/shares outstanding
Capital expenditures	Large amounts spent to improve an asset's quality or extend its life	Funds used by a firm to buy, upgrade, or maintain assets such as property and equipment. CapEx is often required when firm undertakes new projects.
Current Asset	Asset that will be converted to cash or consumed within one year or one operating cycle.	Cash or cash equivalents/ money that may be used to pay bills
Current liabilities	Liability that will be paid within one year or one operating cycle	Bills that are due within a short period of time (compare a mortgage loan to a monthly mortgage payment)
Current ratio	Relationship between current assets and current liabilities	Current assets per $1.00 of current liabilities
Debt to assets ratio	Measure of company risk	A measure of leverage or debt / debt per $1.00 of assets / the % of assets funded by debt
Depreciation	Allocation of the costs of long-term assets to expense over their useful lives	An accounting method for allocating the cost of an asset over its useful life / an accounting of the decline in the value of an asset / Depreciation reduces earnings but is not "real money" / Because it is not "real money", depreciation is often added back in finance various formulas.
Earnings per share	Net Income / shares outstanding	Earnings or net income scaled to a per share basis. This form makes it easier to compare earnings information while eliminating the impact of firm size.
Financial leverage	Increasing earnings through debt financing	Borrowing money to finance assets
Gross margin	Amount a firm makes before subtracting operating expenses	Sales – COGS / profit made after only taking out the cost of goods / profit at the top of the income statement
Gross Margin %	Measure of a company's pricing strategy	Gross profit per $1.00 of sales

Appendix 4B
25 terms: Accounting and finance definitions and explanations L-Z

Accounting term	Accounting definition	Finance definition/explanation
Liabilities	A debt or financial obligation	Debt, borrowed money / linked to leverage
Market value	Value of an item on the secondary market	Distinguish between market value of an asset and market value of a firm / share price x shares outstanding / market capitalization is a term commonly used to refer to market value of a firm
Net income	Bottom line on the income statement resulting from operating a business revenues > expenses	Profit, earnings, money you made or lost (if negative)
Operating income	Includes revenues and expenses related to the primary activities of the company	Earnings before interest and taxes (EBIT), earnings before factoring in interest and taxes
Price earnings ratio	Comparison of selling price per share to earnings per share	What investors are willing to pay to buy $1.00 of earnings / a measure of valuation or what a stock is worth / A high PE ratio reflects a more expensive stock because investors are willing to pay more to buy $1.00 of earnings
Return on Assets	Net income / total assets	Profit per $1.00 of assets / links information from your income statement to your balance sheet and provides a measure of how much profit you generate from your assets
Return on Equity	Net income/total equity	Profit per $1.00 of equity / links information from your income statement to your balance sheet and provides a measure of how much profit you generate from your equity

Appendix 5
Student Self-Assessment Survey

Name:

Section:

1. The content in corporate finance builds on content in introductory accounting.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. The content in corporate finance was entirely new and is not related to previous accounting courses.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. Would you find it valuable to understand the links between accounting and finance, in order to improve their understanding of finance.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Corporate Financing Decisions in the Presence of Asymmetric Information – A Classroom Game

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Few experiential learning experiences are available for courses in Corporate Finance. We develop a classroom game that illustrates the concept of asymmetric information – a core concept that underlies the pecking order theory of capital structure. We provide testable implications that explicitly link the game and textbook concepts, questions that can be used by instructors in exams/quizzes, and extensive documents that minimize preparation time for the instructor. Our game is designed to include all four stages of Kolb's (1984) learning cycle, to develop higher-order skills based on Bloom's (1956) taxonomy, and to help courses meet business school accreditation standards. Feedback from implementing this game in a required course of our undergraduate curriculum indicates that it was well received by students.

Keywords: Classroom game, corporate finance, capital structure, asymmetric information, payoff profiles

Introduction

Experiential learning techniques such as classroom games and simulations are common in the undergraduate Finance curriculum. However, most experiential learning experiences have been developed for courses in *Investments* and *Derivatives*; for other core courses (e.g., *Corporate Finance*, *Financial Institutions and Markets*, etc.) documented experiential techniques are limited. We fill this gap by developing a classroom game for a *Corporate Finance* class. Our game provides students with a better understanding of the abstract and hard-to-understand concept of *asymmetric information* – a central tenet of the pecking-order theory of capital structure.

The game is designed to simulate the interaction between providers of capital (i.e., institutional investors such as asset management firms) and demanders of capital (i.e., firms in the Energy sector) in the financial market. Each firm wants to develop an oil field, but its internal funds have been exhausted, and therefore external funds (debt or equity) are needed. Each investor is looking to initiate a position in the Energy sector. The game has three periods, and each period consists of multiple rounds. In each round, firms (represented by their CFO), and investors negotiate on the terms of financing. For debt, they negotiate an interest rate, and for equity they negotiate an equity stake (i.e., % of ownership *bought/sold*). For simplicity, a firm accepts only *one* source of external funds from an investor (i.e., either debt or equity), but not both. The information structure – probability of successful development of an oil field and the knowledge of that probability – changes across the three periods of the game. Periods I and II represent scenarios of symmetric information with equal and unequal probabilities of success respectively, and Period III represents

the scenario of asymmetric information, i.e., a real-world situation where a firm's CFO is better informed about the project's success than is the investor.

The instructor collects the relevant data (e.g., negotiated rates) in each round. At the end of the game, the collected data is used to illustrate whether it conforms with the predictions of the pecking-order theory. This exercise establishes an explicit link between textbook concepts and the game and thus leads to a better understanding of the underlying concepts. For example, since firms are better informed than investors in Period III, we would expect to see higher negotiated rates (i.e., higher interest rates or ownership stakes) in that period compared to Period I and II. Similarly, since the asymmetric information problem is worse for equity than for debt, we would expect the number of deals using debt as a financing source to exceed that using equity in Period III. In addition, the iterative nature of the game (i.e., multiple rounds) allows students to self-correct and learn from their errors thereby developing their decision-making and strategic-thinking skills. This characteristic – iterative nature – of the game is a deliberate choice and is motivated by Kolb's (1984) learning cycle theory. Finally, it is a fun game since students interact with others and negotiate a business deal – a situation which simulates a real-world business scenario.

We implemented this game in two sections of a core finance undergraduate class in Fall 2019 and used the resulting data to illustrate the testable implications of the theory in class. The data indicated some support for the implications of the pecking-order theory. The end-of-semester Course Evaluations indicated that the exercise was well received; many commented that they enjoyed playing the game and now better understood the concept of asymmetric information. The numerical evaluation of the course was slightly higher compared to sections when the game was not played.

Why might instructors consider incorporating this game in their classes? The first reason is that experiential learning activities have been shown to benefit students. We discuss this literature in the next section. The second is that the game helps the course meet business school accreditation requirements. In particular, the 2020 Business Standards require business schools to (i) "…provide a portfolio of experiential learning opportunities that promote learner engagement..."(*AACSB Business Accreditation Standards*, 2020, p. 41, Section 4.3), and (ii) offer curricula to "…include learning experiences that address core competencies…as well as content from business disciplines such as …finance…" (*AACSB Business Accreditation Standards*, 2020, p. 40, Section 4.1). Third, it helps students develop skills that are highly valued by employers. For example, the U.S. Bureau of Labor Statistics (2023) lists analytical skills and decision-making skills as important qualities for a Financial Analyst. Our game involves tasks that help develop these competencies. We discuss this aspect in a subsequent section. Finally, since instructors are always pressed for time, we provide several documents (e.g., excel sheets, student handouts, test questions, etc.) so instructors can implement the game with minimal effort.

The remainder of the paper is organized as follows. In the next section we review the academic literature on capital structure and the pedagogical literature on experiential experiences in Finance courses. We then describe the game. The last section concludes.

Motivation and Literature Review

Motivation

Central to a course in corporate finance is the discussion of a firm's investment and financing decisions. The corporate investment decision typically involves a discussion of various decision criteria for which the computation is relatively straight forward, and the intuition is easily understood by students. For example, the Net Present Value (NPV) rule requires students to first estimate a project's cash flows and discount rate, then discount the future cash flows, and finally net out the initial investment to arrive at the NPV. A positive number implies that a firm "gets more than it puts in" and therefore leads to an "Accept" recommendation.

The corporate financing decision, on the other hand, typically involves a discussion of capital structure which includes abstract concepts – Modigliani and Miller propositions, theories of capital structure such as the trade-off and pecking-order theory – and are therefore hard to understand. Furthermore, capital structure is often discussed in practitioner conferences. For example, in 2017 the *Journal of Applied Corporate Finance* hosted a roundtable discussion of capital structure with the goal of answering the question: "How can corporate executives manage their capital structure and payout policies to increase the value of their companies?" (Smith et al., 2017). Similarly, survey evidence from Graham and Harvey (2002) indicates that the above concepts are routinely discussed by corporate executives.

For this reason, we choose to focus on capital structure. Of all the theories of capital structure, the pecking-order theory receives the most attention in industry and textbooks. We select this theory because it is the dominant theory and because the underlying concept – asymmetric information – is hard to understand.

Literature on Experiential Learning Experiences

Experiential learning switches students' role from passive to active learners by incorporating activities students can participate in the classroom. The benefit of such activities has been well established in the literature. For example, Brozik and Zapalska (1999) find these activities (i) involve problem solving and decision-making which in turn help develop critical thinking skills and reflective thinking, (ii) minimize memorization, and (iii) overcome the gap between textbook concepts and practice. Experiential activities work because they include all steps of a learning cycle (Kolb, 1984) – (i) concrete experience which refers to a new experience/situation, (ii) reflective observation which refers to thinking about the new experience/situation, (iii) abstract conceptualization which refers to learning from or drawing conclusions from the new experience/situation, and (iv) active experimentation which refers to applying the learning from (iii) to a situation/experience – whereas the traditional chalk-and-talk model includes only some stages. We explicitly incorporate this aspect – including all four learning cycle stages – in the design of our game.

The most common experiential learning experience is for courses in *Investments*. The earliest experience is by Eckardt (1975) who develops a computer-based game that lets students manage a single portfolio. More recent papers describe (i) a competition in which student teams first pick portfolios comprising of stock and mutual funds, and then calculate different statistics (Neumann, 2008), and (ii) a simulation with three games which can be incorporated into a range of finance classes for a unified exposure to all aspects of asset management (Mukherji, Etta-Nkwelle, and

Streeter, 2018). The second most common experience is for courses in *Derivatives*. Most papers address the futures markets. For example, Damianova and Damianov (2018) develop a classroom exercise to illustrate the intricacies of the futures market – spot and future price convergence, mechanics of closing positions, operation of margin accounts, etc.

Experiences for the remaining courses – *Corporate Finance*, *Banking*, and *Financial Institutions and Markets* – are few. Experiences in *Corporate Finance* involve forecasting a firm's financial statement using the percent of sales method (Drougas and Johnson, 2004), or advanced topics such as real options (Campbell, 2016). Experiences for a course in *Banking* involve games where students play the role of a bank to understand the creation of money (Laury and Holt, 2000), to make lending decisions (Perry, Jennings, and Zapalska, 2003), or to improve its performance (Tripp and Calvert, 2007). Experiences for a class in *Financial Institutions and Markets* involve arbitrage relations that connect major segments of financial markets (Dubil, 2004; Roden, 2013). Overall, this literature is well established but does not equally cover all areas of the Finance curriculum.

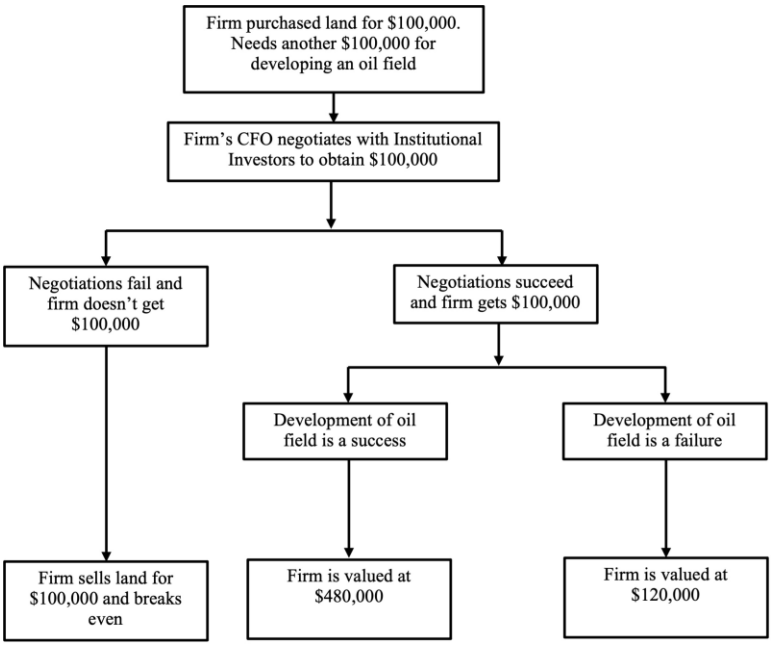
The Game

Description of Economic Transaction

The game is designed to simulate the interaction that occurs between providers of capital and demanders of capital in financial markets. Specifically, institutional investors such as asset management firms represent the providers of capital (i.e., the supply side) and firms in the Energy sector represent the demanders of capital (i.e., demand side). For simplicity, we assume the interaction between them is direct (i.e., intermediaries such as investment banks do not facilitate the transaction), and there are no transaction costs, taxes, and agency costs. A firm's cash flows, and the risk associated with those cash flows vary over its life cycle. This in turn changes its financing needs. For this reason, we assume all firms are in the same phase of their life cycle. Shyam-Sunder & Myers (1999) find the pecking order theory is a better explanation for the capital structure of mature firms. Hence, we assume each firm is in the mature phase of its life cycle.

Each firm faces the following scenario. The company could develop an oil field in a large region where oil has been discovered recently. The company has already purchased the land for $100,000 and requires an additional $100,000 to finance a rig. Internal funds have been exhausted and therefore external funds (debt or equity) are needed. Successful development of the oil field is not guaranteed, with the average chance of success being 50%. If the development of the oil field succeeds, it will be worth $480,000. On the other hand, if it fails, the company will be able to sell the land and all equipment for $120,000. The Chief Financial Officer (CFO) is tasked with procuring the $100,000 and represents the firm in all negotiations. If the negotiation with investors fails, the firm will be able to sell the land at its purchase price of $100,000 and break even. Each institutional investor is looking to initiate a position in the Energy sector. While the sector consists of many companies, the investor is only interested in firms that will develop oil fields in the above-mentioned region. A flowchart showing outcomes of the game appears in Figure 1.

Figure 1
Outcomes in Game



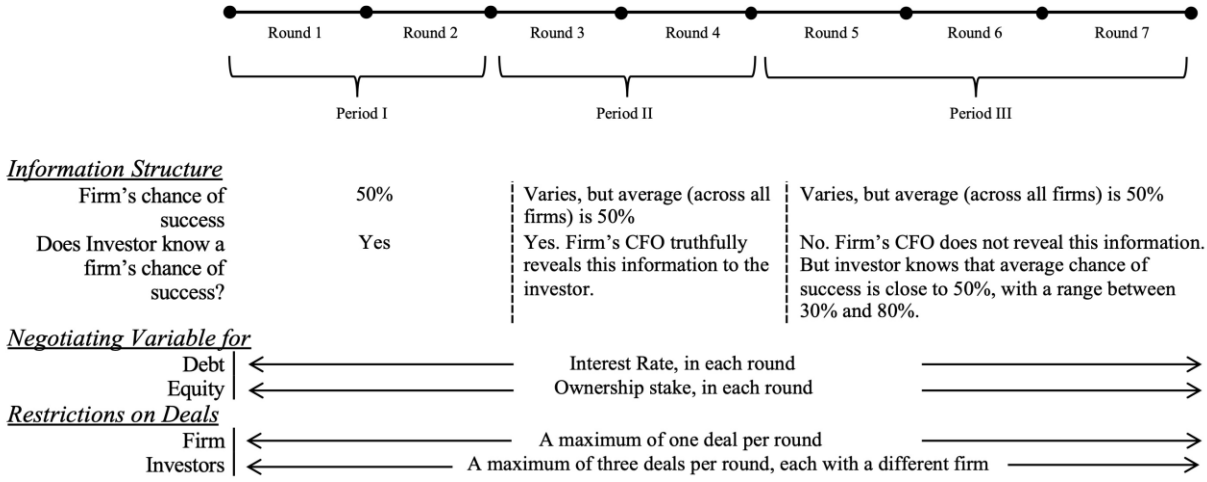
Setup of Game

The game has three periods, and each period consists of multiple rounds. In each round, any CFO can negotiate with any investor in the market. Thus, a round represents one instance of negotiations between CFOs and Investors (hereafter, CFO-Investor pairs). During the negotiation between a CFO-Investor pair, the CFO can offer only one source of external funds, i.e., either debt or equity, but not both. However, the source of financing can differ or remain the same across multiple rounds (with the same investor). For debt, a CFO-Investor pair negotiates an interest rate. For equity, they negotiate an equity stake, i.e., % of ownership *bought/sold*. The investment horizon for each security is one year. To keep the record-keeping tractable, we restrict the number of deals. In particular, the maximum number of deals a CFO may accept in any given round is one. Put differently, a CFO is not obligated to make a deal in each round but if he/she does, it is capped at one. An investor, on the other hand, can make a maximum number of three deals and each deal must be with a different CFO. In addition, an investor is *not* required to make a deal in each round, i.e., zero deal is permitted. The goal of each CFO and Investor is to maximize actual profit across all rounds.

The information structure – probability of a successful development of an oil field and the knowledge of that probability – changes across the three periods of the game. During Period I, each firm has a 50% chance of success, and this is known to each Investor. During Period II, each firm is assigned a probability of success by the instructor, and the firm's CFO needs to truthfully reveal that probability to each investor with whom they're negotiating. The average chance of success for all firms in this period is close to 50%. Thus, Period II differs from Period I in that the probability of success is different across firms. The knowledge of this probability is, however, known to both parties in each CFO-Investor pair. During Period III, each firm is assigned a probability of success by the instructor, but the CFO does *not* reveal that probability to any

investor. But investors know that the average chance of success for all firms is close to 50%, with a possible range between 30% and 80%. Thus, Period III differs from Period II in that the CFO is better informed about the firm's success than is the investor. In other words, it represents a real-world situation where information is asymmetric. These details are illustrated in Figure 2.

Figure 2
Setup of Game



Testable Implications

In Periods I and II of our game all players have the same information. In Period III, each firm's CFO is better informed about the project than are the institutional investor(s) supplying the funds. Hence, we would expect fewer successful deals, higher negotiated rates on successful deals, lower rates of returns to stakeholders, and lower percentage of successful deals using equity as a financing source when asymmetric information is present. These predictions are listed below.

Implication #1:	Fewer successful deals in Period III compared to Period I and II.
Implication #2:	Higher negotiated rates, i.e., higher interest rates (R_D) or ownership stakes (O_E) in Period III compared to Period I and II.
Implication #3:	Lower returns to stakeholders (bondholders and shareholders) in Period III compared to Period I and II.
Implication #4:	The percentage of successful deals using debt as a financing source is higher in Period III than in Period I and II.

Learning Outcomes

The game helps students develop the following competencies:

1. *Distinguish* between a firm's external financing choices (e.g., debt and equity) in terms of the type of claim on its cash flows.
2. *Calculate* the expected payoff to a debt holder and shareholder of a firm, given the probabilities of each scenario and the payoffs to each instrument in each scenario.

3. *Calculate* the actual payoff to a debt holder and shareholder, given the firm's value.
4. *Summarize* the rationale underlying a firm's *pecking-order* when using external financing.
5. Apply #4 above to *choose* a firm's financing choice in different information environments i.e., symmetric, and asymmetric.
6. *Explain* the influence of information asymmetry in the market on a firm's financing choices.

It is worth mentioning that these learning outcomes are in the upper tiers – Analysis, Synthesis, and Evaluation – of Bloom's (1956) taxonomy.

Implementing the Game

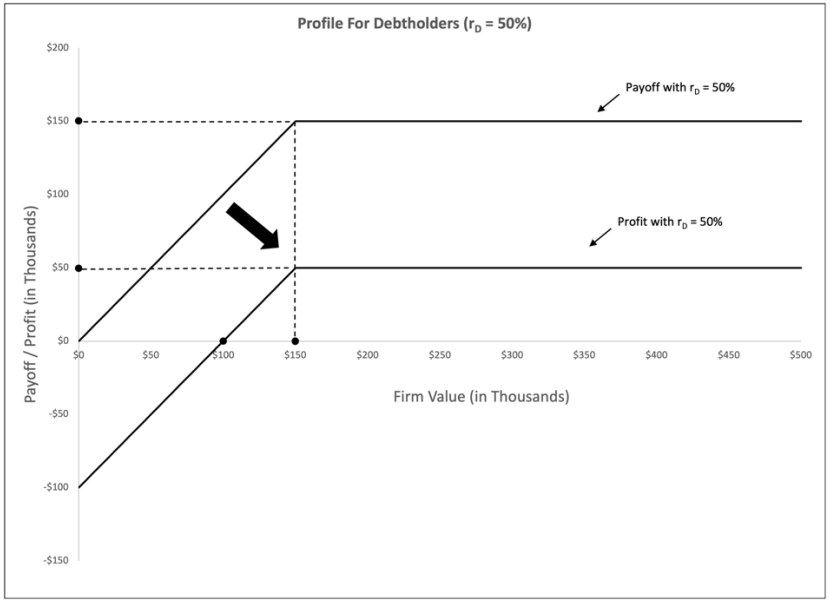
The game was played in two different sections of an upper-level finance class that is required for a bachelor's degree in finance in Fall 2019. Each section had 34 students. Of the 68 students, 60 were finance majors in the third or fourth year of their undergraduate studies; the remaining were pursuing undergraduate degrees in other business majors such as accounting and management. We describe the implementation of the game in the following sub-sections. Our discussion is organized into three parts – pre-game dynamics, running the game, and post-game dynamics.

Pre-Game Dynamics

The length of each class period is 75 minutes; hence, we ran seven rounds – two in Period I, two in Period II, and three in Period III. To ensure students are adequately prepared for playing the game we posted all handouts on the course homepage and assigned these as "Required Readings".

During the class period, we asked students to form a team of two or three students, and then assigned each team a type – CFO or Investor. CFO-teams represent firms seeking capital and Investor-teams represent investors looking to invest capital. The first section had four teams representing investors and six teams representing firms; the second had four and nine teams respectively. Next, we distributed a printed version of the relevant handouts to each team (see Appendix I and II) and explained the information contained in the sub-sections titled *Description of Economic Transaction* and *Setup of Game."* We then illustrated the payoff and profit computations using hypothetical numbers for each stakeholder and plotted these on the corresponding profile diagram. For example, if the investor chooses debt with a negotiated interest rate (R_D) of 50%, he/she will *expect* to receive $150,000 in principal and interest from the firm at maturity. The *actual* payout, however, will depend on whether the development of the oil field is successful. If the development fails, the firm would be valued at $120,000, and the bondholder will only receive $120,000. On the other hand, if the development is successful, the firm would be worth $480,000 and the bondholder will receive $150,000. The *payoff* profile for the bondholder would appear as shown in Figure 3 – they receive all the firm's cash flows until the promised payment but do not receive any additional cash flows beyond that. Their *profit* profile is similar – it is shifted down and indicates a break-even value of $100,000.

Figure 3: Profiles for Different Stakeholders in Game



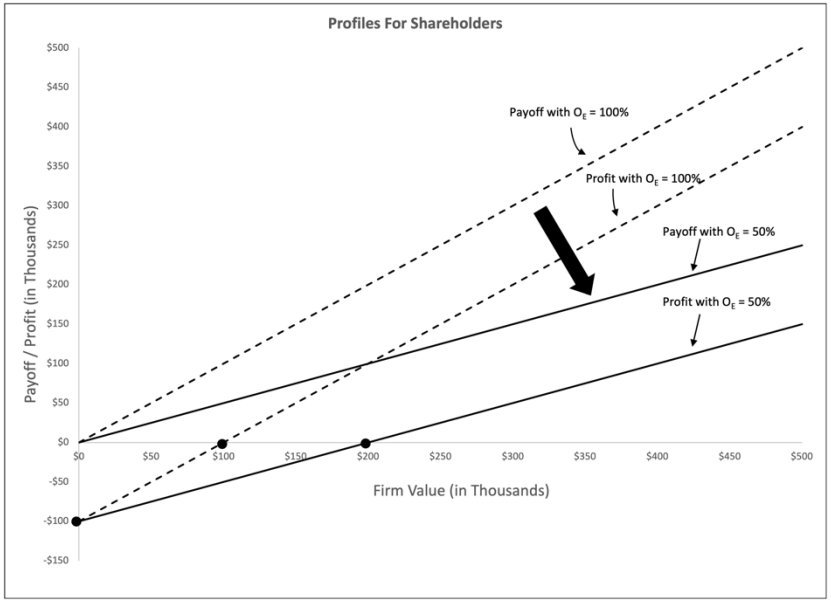


Figure 4: Instructor's Excel Sheet to Record Data from Game

		Investor #1							*Investor #2*							*Investor #3*						
		Financed To Firm #	*Interest Rate For Debt*	*Ownership Stake for Equity*	*Success chance*	*Expected profit*	*Success?*	*Actual profit*	*Financed To Firm #*	*Interest Rate For Debt*	*Ownership Stake for Equity*	*Success chance*	*Expected profit*	*Success?*	*Actual profit*	*Financed To Firm #*	*Interest Rate For Debt*	*Ownership Stake for Equity*	*Success chance*	*Expected profit*	*Success?*	*Actual profit*
PERIOD I		6	31.5%		50%	$ 25,750	0	$ 20,000	5		35%	50%	$ 5,000	1	$ 68,000	2		50%	50%	$ 50,000	0	$ (40,000)
	Round 1	3		42%	50%	$ 26,000	1	$ 101,600				50%	$ -		$ -	1		48%	50%	$ 44,000	1	$ 130,400
		4		38%	50%	$ 14,000	0	$ (54,400)				50%	$ -		$ -				50%	$ -		$ -
		1		40%	50%	$ 20,000	0	$ (52,000)	3		38%	50%	$ 14,000	1	$ 82,400	2	29%		50%	$ 24,500	0	$ 20,000
	Round 2	5		38%	50%	$ 14,000	0	$ (54,400)	6	28%		50%	$ 24,000	1	$ 28,000				50%	$ -		$ -
					50%	$ -		$ -	4		35%	50%	$ 5,000	1	$ 68,000				50%	$ -		$ -
PERIOD II		3		35%	60%	$ 17,600	1	$ 68,000	6		27.5%	80%	$ 12,200	1	$ 32,000	2	48%		30%	$ 28,400	0	$ 20,000
	Round 3	1		40%	40%	$ 5,600	0	$ (52,000)	5	24%		60%	$ 22,400	1	$ 24,000					$ -		$ -
						$ -		$ -					$ -		$ -					$ -		$ -
	Round 4					$ -		$ -					$ -		$ -					$ -		$ -
						$ -		$ -					$ -		$ -					$ -		$ -
						$ -		$ -					$ -		$ -					$ -		$ -
PERIOD III		1		33%	70%	$ 22,760	1	$ 58,400	5	25%		40%	$ 22,000	0	$ 20,000	4		30%	50%	$ (10,000)	0	$ (64,000)
	Round 5	2		37.5%	60%	$ 26,000	1	$ 80,000	6		33.5%	30%	$ (23,620)	0	$ (59,800)	3		34%	80%	$ 38,720	1	$ 63,200
						$ -		$ -					$ -		$ -					$ -		$ -
		1		35%	50%	$ 5,000	0	$ (58,000)	5		34%	40%	$ (10,240)	1	$ 63,200					$ -		$ -
	Round 6	6		33%	60%	$ 10,880	1	$ 58,400	4	25%		70%	$ 23,500	1	$ 25,000					$ -		$ -
						$ -		$ -	2	30%		30%	$ 23,000	1	$ 30,000					$ -		$ -
		2	32%		50%	$ 26,000	1	$ 32,000	4	30%		60%	$ 26,000	1	$ 30,000	1		30%	30%	$ (31,600)	1	$ 44,000
	Round 7	3	36%		30%	$ 24,800	0	$ 20,000					$ -		$ -	5		30%	50%	$ (10,000)	0	$ (64,000)
		6		33%	50%	$ (1,000)	1	$ 58,400					$ -		$ -					$ -		$ -

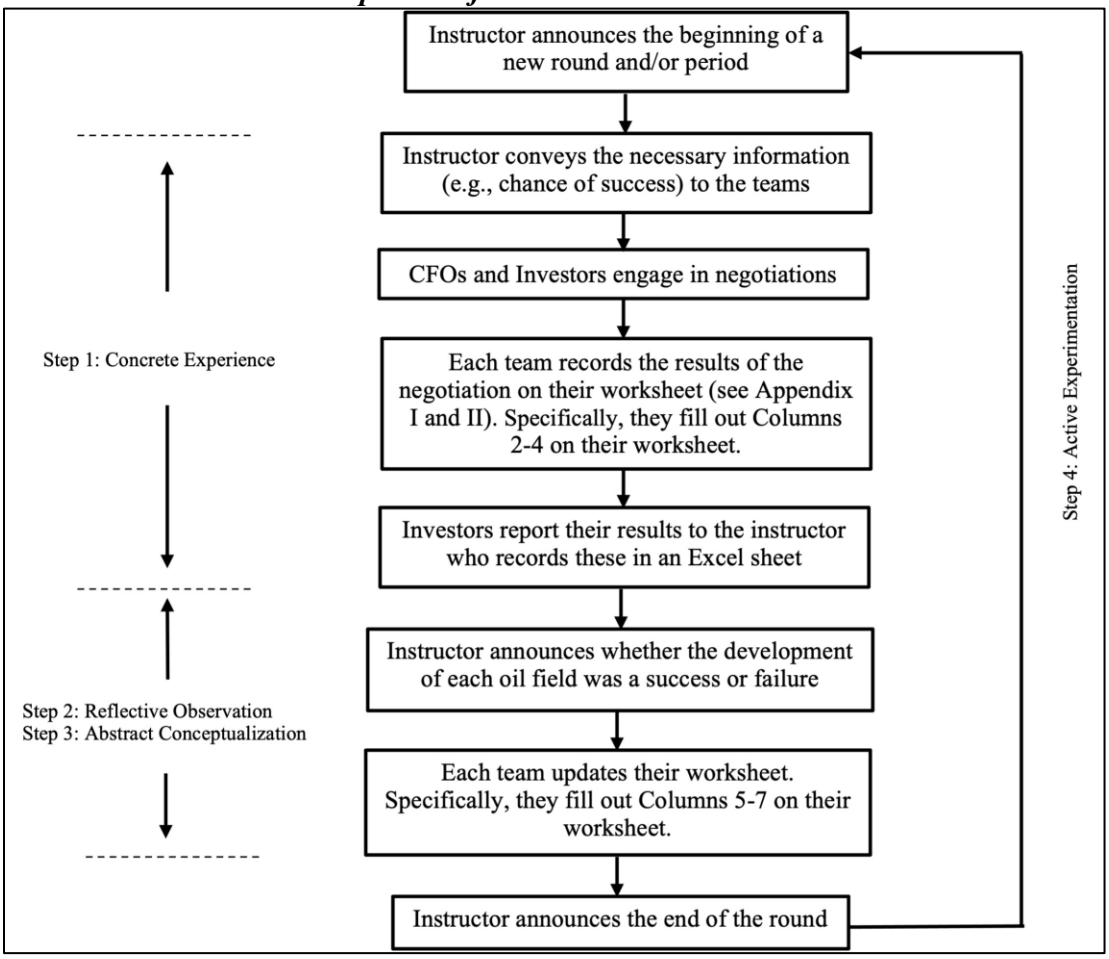
On the other hand, if the investor chooses equity and the negotiated ownership stake (O_E) is 100% (as an extreme example), he/she would receive *all* the firm's cash flows and their payoff would move in perfect lockstep with firm value (see dotted lines in the right panel of Figure 3). The profit profile would be shifted down and the break-even amount would be $100,000. If the negotiated ownership stake is lower, say 50%, the shareholder would receive only one-half of the firm's value. As a result, the break-even amount would double relative to the scenario where ownership was 100%. Quantitatively oriented students might prefer the following formulas: For debt, the Payoff is $\min[V_1; \$100{,}000*(1+r_D)]$, and Profit is Payoff – $100,000. For equity, the Payoff is O_E*V_1, and Profit is Payoff – $100,000. V_1 is the firm value at the end of year 1, r_D is the negotiated interest rate on debt, and O_E is the negotiated ownership stake.

We also contrasted the profiles of our game with those found in a finance textbook. Those profiles assume a firm can raise capital using debt *and* equity. Hence, the sum of the payoff to bondholders and payoff to shareholders equals the value of the firm. Since our game allows for only one source of financing in each round, the additive property of payoff profiles does not hold.

Running the Game

We began by announcing the start of a new round (and period when needed) and provided the necessary information (e.g., chance of success) to the teams. Next, teams of CFOs and Investors engaged in negotiations. Each team recorded the results of the negotiation on their worksheet. Teams classified as Investors also reported details of their negotiations – CFO with whom they struck a deal (if any), negotiated debt interest rate or equity stake, etc. – to the instructor who recorded this information in an Excel sheet (see Figure 4) that could be seen by all students. After this we announced (via random draw) whether the development of each oil field was a success or failure. This allowed each team to calculate the Actual Profit and Cumulative Profits and record it in their worksheets (Columns 5-7 in their respective worksheets). We then announced the completion of the round. Figure 5 contains a flowchart of this workflow and depicts the four stages of Kolb's (1984) learning cycle. At end of the game, we collected the handouts from each team.

Figure 5
Sequence of Events in Each Round



Post-game Analysis

We used data from the Excel sheet to compute metrics (e.g., – number of successful deals, average returns, etc.) required to test the implications listed in the sub-section titled *Testable Implications* and then discussed them in the next class period. Panel A of Table 1 shows results for both class sessions and subsequent panels show results for each session. Each panel shows different details about the negotiations between CFOs and investors. The column "Deals (Number)" shows the number of deals financed by debt and equity, the total number of deals, and the maximum number of deals possible. The column "Deals (%)" shows the percentage of deals financed by debt and equity, "Negotiated Rate" shows the negotiated interest for debt (R_D) and ownership stake (O_E), and "Avg. Return" shows the average return to investors – bondholders and shareholders. Since the number of rounds varies across Periods I, II, and III, we cannot compare the total number of deals (column "Total") in each period. Hence, we scale the total number of deals by the maximum deals possible (column "Max.") to compute the proportion of negotiations that were successful.

Panel A indicates that the proportion of successful deals remains approximately the same regardless of the information structure. For example, in Period I 100% of the negotiations were successful, whereas in Period II 14 out of 15 (93.3%), in Period III 44 out of 45 (97.78%) of the

deals were successful. Panels B and C show similar patterns. These results are not consistent with *Implication #1* which predicts that information asymmetry will deter potential investors thereby lowering the proportion of successful deals in Period III. Another consequence of the information asymmetry is that investors will negotiate a higher rate on debt or equity (*Implication #2*). The columns "Debt" and "Equity" (under "Negotiated Rate") show the rates for each security. We see that the ownership stake in Period III is 36.58% whereas that in Period I and II was 42.71% and 37.13% respectively. For debt, the interest rate of 30.96% in Period III is higher than the rate of 26.50% in Period I but lower than the rate in Period II (34.50%). Taken together, these results are inconsistent with *Implication #2*. Finally, asymmetric information will also lower the return earned by investors (*Implication #3*). The column "*Avg. Returns*" shows returns – computed by dividing Actual Profit by the initial investment of $100,000 – to stakeholders in each period. In Period III, the average return to a stakeholder was 23.71% compared to an average return of 25.33% in Period I and Period II. A similar pattern arises in Panel B. Both results are consistent with *Implication #3*. Panel C shows the reverse pattern – returns are higher in Period III (31.26%) compared to Period I (25.18%) and II (27.28%). The magnitude of the asymmetric information problem depends on the type of security – highest for equity, lower for risky debt and negligible for riskless debt. Stakeholders will therefore demand higher stakes for securities that suffer from this problem. The pecking order theory predicts that firms prefer debt over equity (*Implication #4*). The results support this prediction – for example, in Period III, 50% of the deals are financed through debt, compared to 36.67% in Period I and 42.86% in Period II. Taken together, these results show some support for the pecking order theory; however, the game was played only twice.

The game was well received by the students. At the end of class, several students approached the instructor and stated it was something they liked and learned a lot from the experience. Below are some comments from the end-of semester course evaluations:

- "*We played a game in class, and that was a great exercise. Would recommend another class to try it out.*"
- "*The game feels like real-world exercise that can help me outside of this class.*"
- "*One of the best finance classes – very interactive and the class is super interesting.*"

We also compared the average course evaluation scores for two sections of the course where the game was played, with four sections of the same course taught by the same instructor where the game was not played. The averages were 4.53 and 4.52 respectively on a 5-point scale. Though the average score is slightly higher for the sections where the game was played, the difference is insignificant. This might be attributable to the limited sample size and/or the instructor's teaching method of frequently using real-world examples in all classes.

Although experiential activities are valuable, they require additional effort by instructors who are often pressed for time. For this reason, all materials – excel sheets, handouts to student teams, figures, test questions based on the game, etc. – used in the game are available upon request from the authors.

Table 1
Results from Game

Panel A: Overall

	Deals (Number)				Deals (%)		Negotiated Rate		Avg. Returns
	Debt	**Equity**	**Total**	**Max.**	**Debt**	**Equity**	**Debt**	**Equity**	
PERIOD I	11	19	30	30	36.67%	63.33%	26.50%	42.71%	27.68%
PERIOD II	6	8	14	15	42.86%	57.14%	34.50%	37.13%	22.97%
PERIOD III	22	22	44	45	50.00%	50.00%	30.96%	36.58%	23.71%

Panel B: Session I

	Deals (Number)				Deals (%)		Negotiated Rate		Avg. Returns
	Debt	**Equity**	**Total**	**Max.**	**Debt**	**Equity**	**Debt**	**Equity**	
PERIOD I	3	9	12	12	25.00%	75.00%	29.75%	41.50%	30.19%
PERIOD II	2	3	5	6	40.00%	50.00%	36.00%	32.50%	18.67%
PERIOD III	6	11	17	18	35.29%	61.11%	30.75%	33.02%	16.16%

Panel C: Session II

	Deals (Number)				Deals (%)		Negotiated Rate		Avg. Returns
	Debt	**Equity**	**Total**	**Max.**	**Debt**	**Equity**	**Debt**	**Equity**	
PERIOD I	8	10	18	18	44.44%	55.56%	23.25%	43.92%	25.18%
PERIOD II	4	5	9	9	44.44%	55.56%	33.00%	41.75%	27.28%
PERIOD III	16	11	27	27	59.26%	40.74%	31.18%	40.15%	31.26%

Conclusion

Motivated by a lack of classroom games for corporate finance classes and the real-world relevance of hard-to-understand concepts in these classes, we develop a classroom exercise for *any* course that discusses the corporate financing decision. Textbook discussions of this topic focus on theories of capital structure and involve concepts such as asymmetric information that are hard for students to understand. Several aspects – conceptual and practical – of our game are unique. First, the iterative nature of the game allows us to include each element of Kolb's (1984) learning cycle – concrete experience, reflective observation, abstract conceptualization, and active experimentation. Second, it includes hypotheses that are tested using data generated by the game thereby explicitly linking textbook concepts to the game. Third, it can be incorporated into a wide range of finance classes – introductory, upper, and graduate level. The time required is also flexible since the instructor can add/delete rounds in each period. Fourth, although our game primarily focuses on asymmetric information, it also teaches additional concepts such as expected and actual payoffs to shareholders and debtholders that are core components of a finance major's knowledge base. Fifth, it requires minimal preparation and effort by the instructor: we provide a teaching supplement that includes all materials (e.g., excel files, handouts, etc.) and a slide deck to minimize the burden on the instructor. Formal feedback from students indicates that the game is a valuable exercise because students get to learn (abstract) textbook concepts in a stress-free setting that's easily relatable (i.e., negotiate a deal in a business setting), develop their decision-making and strategic thinking skills, and interact with their classmates.

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Appendix I
Handout to Teams classified as Institutional Investors

Information For Institutional Investors

Background:

You represent an institutional investor (e.g., an asset management firm such as Fidelity) that is looking to initiate a position in the Energy sector. While the sector consists of many companies, you are particularly interested in ones that will develop an oil field in a region where oil was recently discovered. For simplicity, assume that the details below apply to each company.

Each company has already purchased the land for $100,000 and requires an additional $100,000 to finance a rig. The company's internal funds have been exhausted and therefore, external funds i.e., issuing debt or equity are needed. Successful development of the oil field is not guaranteed – the average chance of success is 50%. If the development of the oil field succeeds, it will be worth $480,000. On the other hand, if it fails the company will be able to sell the land and all equipment for $120,000.

During your negotiations with a company in a particular round, you can buy the company's debt or equity, but not both. Across multiple rounds (with the same company), the source of financing can be different. Assume an investment horizon of one year for each security.

Goal:

Maximize your actual profit across all rounds. In each round you will negotiate a financing deal with the Chief Financial Officers (CFOs) of different companies. For debt, you will negotiate an interest rate. For equity, you will negotiate an equity stake i.e., % of ownership *bought*. For your convenience, the table below lists the formulas for computing the payoffs under each scenario (described above) at the end of the investment horizon. The last column lists the formula for computing your expected payoff assuming there is a 50% chance of successful development of the oil field. This probability (i) changes across multiple rounds of the game – be sure to use the correct probability in your computations, and (ii) might not always be known to you. Finally, a worksheet is attached to record all aspects of a deal and to calculate your profit or loss.

Source of External Funds	*Payoff to Investor when development of oil field is a*		*Expected Payoff* (Chance of success = 50%)
	Success [1]	*Failure* [2]	
Debt	$100,000 × (1 + negotiated interest rate)	$100,000 × (1 + negotiated interest rate), or $120,000, whichever is lower	50% × [1] + 50% × [2]
Equity	% of ownership bought × $480,000	% of ownership bought × $120,000	50% × [1] + 50% × [2]

Rules:

1. The game has three periods, and each period has multiple rounds. The instructor will announce (i) when each round starts and ends, and (ii) whether each oil field is a success or failure at the end of each round, using a result drawing with the given probability.
2. At the end of each round, you MUST report the transaction details to the instructor.

3. In each round, you can make a maximum number of three deals and each deal must be with a different CFO. In addition, you are NOT required to make a deal in each round i.e., zero deals are permitted.
4. The probability of a successful development of an oil field and the knowledge of that probability changes across the three periods.
    a) During Period I, each CFO will have a 50% chance of success.
    b) During Period II, each CFO will be assigned a probability of success (by the instructor), and the CFO needs to truthfully reveal that probability to you during the negotiations. The probabilities are different for each company, but the average across companies in this period is close to 50%.
    c) During Period III, each CFO will be assigned a different probability of success, but you, as an investor, do NOT know that information i.e., CFOs do NOT need to reveal the probability of success to you. But what you know is that the average chance of success for all CFOs is close to 50%, with a possible range between 30% and 80%.

Investor Worksheet

PERIOD I: 50% chance of success for each CFO

Round	*Chance of success*	*Which CFO*	*Negotiated Debt Interest Rate* (*Only if debt is used*)	*Negotiated Equity Stake i.e., ownership* (*Only if equity is used*)	*Expected Profit* (*= Expected Payoff – $100,000*)	*Oil Field Development (Success or Failure, based on instructor's announcement)*	*Actual Profit* (*= Actual Payoff – $100,000*)	*Cumulative Profits*
1	50%							
2	50%							

PERIOD II: Different but KNOWN chance of success for each CFO (Avg. across CFOs = 50%)

Round	*Chance of success*	*Which CFO*	*Negotiated Debt Interest Rate* (*Only if debt is used*)	*Negotiated Equity Stake i.e., ownership* (*Only if equity is used*)	*Expected Profit* (*= Expected Payoff – $100,000*)	*Oil Field Development (Success or Failure, based on instructor's announcement)*	*Actual Profit* (*= Actual Payoff – $100,000*)	*Cumulative Profits*
3-4								

PERIOD III: Different but UNKNOWN chance of success for each CFO (Avg. across CFOs = 50%)

Round	*Chance of success*	*Which CFO*	*Negotiated Debt Interest Rate* (*Only if debt is used*)	*Negotiated Equity Stake i.e., ownership* (*Only if equity is used*)	*Expected Profit* (*= Expected Payoff – $100,000*)	*Oil Field Development (Success or Failure, based on instructor's announcement)*	*Actual Profit* (*= Actual Payoff – $100,000*)	*Cumulative Profits*
5-7								

Appendix II
Handout to Teams classified as Chief Financial Officers (CFOs)

Information For CFOs

Background:

You are the CFO of a publicly traded company in the Energy sector and are responsible for determining the best mix of debt, equity, and internal financing. Your company can develop an oil field in a large region where oil has been discovered recently. The company has already purchased the land for $100,000 and requires an additional $100,000 to finance a rig. Successful development of the oil field is not guaranteed – the average chance of success is 50%. If the development of the oil field succeeds, it will be worth $480,000. On the other hand, if it fails you will be able to sell the land and all equipment for $120,000. There are other CFOs in this market who are facing the same situation as you are.

Internal funds have been exhausted; therefore, external funds i.e., issuing debt or equity are the only sources available to raise the funds needed to finance the rig. To this end, you will negotiate a deal with an investor of your choice. During your negotiations with an investor (in a particular round), you can issue EITHER debt or equity, but not both. Across multiple rounds (with the same investor), the source of financing can be different. Assume an investment horizon of one year for each security. If the negotiations fail, you will be able to sell the land at its purchase price of $100,000 and your profit will be zero.

Goal:

Maximize your actual profit across all rounds. You will achieve this by negotiating a financing deal with different investors in each round. If debt is used, you will negotiate an interest rate. On the other hand, if equity is used you will negotiate an equity stake i.e., % of ownership sold. For your convenience, the table below lists the formulas for computing the payoffs under each scenario (described above) at the end of the investment horizon. The last column lists the formula for computing your expected payoff assuming there is a 50% chance of successful development of the oil field. This probability changes across multiple rounds of the game – be sure to use the correct probability in your computations. Finally, a worksheet is attached to record all aspects of a deal and to calculate your profit or loss.

Source of External Funds	*Payoff to firm* (*CFO*) *when development of oil field turns out to be a:*		*Expected Payoff* (Chance of success = 50%)
	Success [1]	*Failure* [2]	
Debt	$480,000 – $100,000 × (1 + negotiated interest rate)	$120,000 – $100,000 × (1 + negotiated interest rate), or $0, whichever is higher	50% × [1] + 50% × [2]
Equity	(1 – % of ownership sold) × $480,000	(1 – % of ownership sold) × $120,000	50% × [1] + 50% × [2]

Rules:

1. The game has three periods, and each period has multiple rounds. The instructor will announce (i) when each round starts and ends, and (ii) whether each oil field is a success or failure at the end of each round, using a result drawing with the given probability.

2. In each round, you will negotiate a financing deal with different investors. The maximum number of deals you may accept in a round is one. This means that you are not required to make a deal in each round. If you do not make a deal, your profit will be zero in that round.
3. The probability of a successful development of an oil field and the knowledge of that probability changes across the three periods.
    a) During Period I, each CFO (i.e., you and each team classified as CFO) will have a 50% chance of success.
    b) During Period II, you will be assigned a probability of success (by the instructor), and you need to truthfully reveal that probability to each investor with whom you negotiate a deal. The average chance of success for all teams classified as CFOs in this period is close to 50%.
    c) During Period III, you will be assigned a probability of success (by the instructor), but you do NOT need to reveal that probability to any investor. The average chance of success is still close to 50%.

CFO Worksheet

PERIOD I: 50% chance of success for each CFO

Round	*Chance of success*	*Which Investor*	*Negotiated Debt Interest Rate* (*Only if debt is used*)	*Negotiated Equity Stake i.e., ownership* (*Only if equity is used*)	*Expected Profit* (*= Expected Payoff – $100,000*)	*Oil Field Development (Success or Failure, based on instructor's announcement)*	*Actual Profit* (*= Actual Payoff – $100,000*)	*Cumulative Profits*
1	50%							
2	50%							

PERIOD II: Different but KNOWN chance of success for each CFO (Avg. across CFOs = 50%)

Round	*Chance of success*	*Which Investor*	*Negotiated Debt Interest Rate* (*Only if debt is used*)	*Negotiated Equity Stake i.e., ownership* (*Only if equity is used*)	*Expected Profit* (*= Expected Payoff – $100,000*)	*Oil Field Development (Success or Failure, based on instructor's announcement)*	*Actual Profit* (*= Actual Payoff – $100,000*)	*Cumulative Profits*
3	40%							
4	60%							

PERIOD III: Different but UNKNOWN chance of success for each CFO (Avg. across CFOs = 50%)

Round	*Chance of success*	*Which investor*	*Negotiated debt interest rate* (*Only if debt is used*)	*Negotiated equity stake i.e., ownership* (*Only if equity is used*)	*Expected Profit* (*= Expected Payoff – $100,000*)	*Oil Field Development (Success or Failure, based on Instructor's announcement)*	*Actual Profit* (*= Payoff under either success or failure – $100,000*)	*Cumulative Profits*
5	70%							
6	50%							
7	30%							

Financial Wellness, Curricular, and Co-Curricular Approaches to Financial Education for College Students

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Student wellness in higher education can be defined in many ways. This article focuses on post-secondary student financial wellness—the perceived and objective aspects of a student's financial situation that impact overall life satisfaction. Financial wellness is a comprehensive concept encompassing financial attitudes, behaviors, and decisions - all of which contribute to overall well-being. In light of the emerging importance of financial wellness, and increases in financial stress experienced by students, one post-secondary institution has specifically designed a combination of curricular and co-curricular delivery of financial education for students. The Balance Your Buc$ (BY$) program envisions the use of research, teaching, and service to encourage students to lead well-balanced financial lives by providing foundational training and education in areas of personal finance. This article fuses understandings of student financial wellness with practical delivery and empirical research. In addition, focus is given to maintaining financial wellness in a crisis such as a pandemic or other economic shocks (e.g., a recession, job loss).

Keywords: Financial co-curriculum, financial curriculum, financial education, financial literacy, financial wellness,

Introduction

With the continued growth of consumer debt, student loan debt, and lack of significant savings, post-secondary students are entering a world in need of financial discipline and financial decision-making capabilities. Educators have a responsibility to help students develop the financial discipline that will help them be successful in their career and their life. This can be in terms of increased knowledge, job skills, and life skills including an understanding of how to make wise financial decisions such as saving for emergencies, managing risk, or planning for retirement. Ideally, post-secondary institutions would include a course in personal finance in their general education curriculum. However, several barriers prevent post-secondary institutions from making such a course a requirement. For example, post-secondary institutions must budget their limited resources and may be hesitant to alter well-established curricula for degree programs. Overcoming these barriers may be a paradigm shift for many institutions where the administration realizes the well-being of their student body improves with such programming as well as increasing retention for financially burdened students (Britt et al., 2017). To manage the hesitancy to require a financial management course, many post-secondary institutions have a course in personal finance, but it serves as an elective taken primarily by students interested in personal finance; not necessarily those who need the knowledge. This leaves many post-secondary graduates with little formal training on how to manage finances. One university has found a way to address this gap by

restructuring personal finance into both a one-credit course and a co-curricular program. While not specifically addressing the general education requirement, it does offer options to all students across the campus. This article addresses the delivery of financial wellness education, discusses empirical research regarding financial wellness and post-secondary student loan debt, provides an overview of one university's model of a one-credit course and a co-curricular program, and concludes with thoughts on managing finances in a crisis.

Background and Literature

Financial Wellness

Research in the field of financial wellness has been increasing but remains a challenging concept to define (Henager & Wilmarth, 2018). Financial wellness can be both subjective (i.e., perceived) and objective (i.e., measurable). Subjective financial wellness is often measured by asking survey respondents how well they think they understand financial matters, how well they manage their money on a day-to-day basis (Henager & Cude, 2016, 2019), or how satisfied they are with their current financial situation (Joo, 2008; Joo & Grable, 2004). Objective financial wellness measurements, on the other hand, can include income, assets, savings, or some financial ratios such as the measure of debt-to-income. Financial wellness scales range from low to high financial wellness and has been measured in various ways by a variety of scholars (Henager & Wilmarth, 2018; Joo, 2008; Prawitz et al., 2006). The concept of financial wellness includes overall well-being, financial well-being, financial satisfaction, and knowledge of financial management principles. Joo (1998) defined financial wellness as "a level of financial health [that] includes satisfaction with material and non-material aspects of one's financial situation, perception (subjective assessment) of financial stability including the adequacy of financial resources, and the objective amount of material and non-material financial resources that each individual possesses" (p. 12). Joo's work since 2008 has defined financial wellness by four subcomponents including the objective status of financial situation, financial attitudes (subjective perception), financial behavior, and financial satisfaction. Both definitions highlight the defining characteristics of financial wellness that include both objective and subjective parts. Joo's framework has been used to define and analyze financial wellness, choose appropriate variables to be used in multivariate regression models, and as a guide for reviewing the literature (e.g., Falahati & Paim, 2011; Malone et al., 2010; Xiao, Tang, & Shim, 2009).

To provide an explicit example of the financial wellness scale, the research by Henager and Wilmarth (2018) used a 17-point scale representing the four subcomponents (Joo, 2008). For objective status, five questions were asked about difficulty paying bills, income, insurance coverage, and financial knowledge; for the subjective perception status, four questions were asked about confidence and debt; for financial behavior, seven questions were asked about having an emergency fund, credit use, spending, and long-term saving; one question was asked regarding financial satisfaction. In this set of questions, it is possible for someone who has a fair amount of debt to score high on the scale if they have a steady income, confidence, savings, good use of credit (does not carry a credit card balance, for example) and a reasonable level of financial satisfaction. On the other hand, it is possible for an individual who has the same amount of debt, but has had a large drop in income, carries a credit card balance regularly, and does not have much savings to score lower on the financial wellness scale.

Additionally, financial wellness research in recent years has focused on specific populations (e.g., young adults), specific components of financial wellness (e.g., financial behaviors, satisfaction), and various definitions (Shim et al., 2009). Rutherford and Fox (2010) used Joo's definition and framework to assess the financial wellness of young adults. They found that all four subcomponents (listed above) were significant predictors of financial wellness for young adults (Rutherford & Fox, 2010) similar to findings by Henager and Wilmarth (2018) and Fan and Henager (2021). Focusing on young adults, Letkiewicz et al. (2019) studied the effects of student loans related to financial distress as well as the lack of awareness of debt obligations using the National Student Financial Wellness Study (a national survey of post-secondary students across the United States administered by The Ohio State University) (Letkiewicz & Heckman, 2018). Archuleta et al. (2013) also found similar results when examining the relationship between student debt and financial anxiety. In addition, Galarneau and Gibson (2020) studied student debt in Canada and found that half the graduates held student loans upon graduation and of those, 64% still held the debt three years after graduation. These data were collected prior to the COVID-19 pandemic; results from a Statistics Canada (2020) report indicated a majority of students were worried about their financial situation and their debt levels because of COVID-19. As scholars continue to study financial wellness, the impact of the pandemic/crisis is an important consideration.

Although researchers have neither settled on a firm definition of financial wellness, nor developed a universally accepted operationalization of the concept, the literature illuminates the many elements of financial wellness. In particular, the use of a comprehensive measure that incorporates finance-related behaviors and both objective and subjective aspects of financial wellness has emerged as the ideal measure on this topic.

Human Capital Theory

Investment in oneself, including education and on-the-job training, is the essence of human capital. Human Capital Theory (Becker, 1993; Becker, 1964) posits that an individual will invest in themselves when the potential benefits exceed the costs associated with the investment. These costs, such as those for education, will be offset by the potential benefits of more opportunities for employment, a higher level of earnings, and future promotions (Henager & Wilmarth, 2018). Other advantages include a higher level of job satisfaction and more appreciation for other interests (Ehrenberg & Smith, 2016), for example, Day and Newburger (2002) argue that a return on the investment for higher education is that graduates are more open-minded, have better communication skills, and have an increased knowledge of the world and global issues.

The benefits of post-secondary education are distinctly measurable financially. Lifetime earnings are 84% higher for graduates with a bachelor's degree compared to those with a high school diploma (Carnevale, Rose, & Cheah, 2013). Indeed, those with a bachelor's degree see a return on their investment of over 15%—a better return than an average year in the stock market (Abel & Deitz, 2014). It has been shown that the average four-year post-secondary graduate will earn enough money by age 36 to compensate for foregone wages while enrolled in post-secondary education for four years even while borrowing all their tuition and fees compared to a high school graduate (Baum et. al., 2013).

A human capital investment in oneself is an appreciating asset (Fincher, 2017). In other words, the monetary benefit is not linear; if one more dollar of expense is funded with one more dollar of debt, there is not an equal reduction in the positive economic benefit, both to the individual and to

society (Fincher, 2017). This also creates an argument for low-income students to borrow for education if their well-being is improved – even more so than their higher-income peers (Walsemann, Gee, & Gentile, 2015).

One more consideration regarding human capital theory is that benefits are reaped from the completion of a post-secondary degree; these are less likely when a student does not complete a degree program. Indeed, more stress and worry about paying off student loans has been found in students who have loans, but not the corresponding degree (Steele & Williams, 2016). Even though it seems student loans are gaining a troubled reputation in the media, they are still a viable method of funding an investment that creates growth in productivity, job opportunities, and fulfilling careers. Overall, one can expect human capital investments to positively affect financial wellness despite the costs (Henager & Wilmarth, 2018).

Empirical Research Study

To support the notion behind the Human Capital Theory (Becker, 1993; Becker, 1964), this section discusses a peer-reviewed journal article entitled, *The Relationship Between Student Loan Debt and Financial Wellness,* co-authored with Melissa Wilmarth (Henager & Wilmarth, 2018) and published in the *Family and Consumer Sciences Research Journal*.

Background

As stated in the introduction of this article, attending post-secondary education is considered an investment in human capital with expectations of returns in the future for employment and financial well-being. With recent graduates carrying increasing amounts of student loan debt, this research addressed how this impacts the financial wellness of these young households. The return on investment has been demonstrated over the years, but the impact of student loan debt could be changing this dynamic.

The research study used the National Financial Capability Study (NFCS) from the FINRA Investor Education Foundation; the dataset is the 2012 NFCS State-by-State Survey of the U.S. The questionnaire was administered on a state-by-state basis to achieve approximately 500 observations from each state and the District of Columbia. The self-reported data were collected from July through October 2012 and made available to researchers in May 2013 (FINRA, 2013). The dataset contains 25,500 observations of respondents over the age of 18.

The final sample used for this study was 16,670. In light of the statistics on young households facing student loan debt (Fry, 2013; 2016), respondents over the age of 45 were dropped—as only a small portion of those indicated having a student loan—in order to focus the investigation on young households. Likewise, dropped from the sample were respondents that reported they "did not finish" high school, along with observations where the respondent chose "prefer not to say" as their answer to the questions dealing with financial behaviors and objective financial knowledge, and "prefer not to say" or "don't know" to the subjective knowledge and management questions. In the case of the objective financial knowledge questions, an answer of "don't know" was coded as incorrect.

Joo's (2008) financial wellness conceptual framework guided this research; the definition used for financial wellness included objective status (i.e., aspects of an individual's economic situation), financial satisfaction (i.e., a self-assessment of an individual's financial situation), financial

behavior (i.e., financial management behaviors, planning, consumption patterns), and subjective perception (i.e., an individual's attitude about their financial situation, beliefs, and knowledge).

The NFCS questions used to represent the above definition are as follows:

- **Objective Status:** difficulty paying bills; large drop in income; has health insurance; has life insurance; not carrying a credit card balance
- **Financial Satisfaction:** satisfied with financial situation
- **Financial Behavior:** emergency fund; spends less than income
- **Subjective Perception:** financial literacy; confidence in financial knowledge; confidence in financial management; feelings of debt level

A financial wellness index was created, using 17 variables representative of the four areas identified by Joo (2008).

- a higher total score indicated higher financial wellness
- variables were coded 0,1 and scores ranged from 0-17 with a mean of 8.9 (SD=3.7)

Data Analyses

Ordered Logistic regression analysis was conducted to determine the relationship between financial wellness and the presence of a student loan while controlling for relevant individual characteristics. The results from the regression indicate the presence of a student loan had a significant negative relationship with financial wellness. Other variables negatively related to financial wellness were the presence of dependent children in the household. Also significant was financial education, which was positively associated with financial wellness. Other variables positively associated with financial wellness were education, income, being employed, owning a home, having a retirement account, and having investments.

Employing the Human Capital Theory (Becker, 1993; Becker, 1964), we considered the positive impact of education on financial wellness and the potential negative impact of paying an ongoing student loan, by comparing respondents with no post-secondary education, those with an incomplete bachelor's degree, and those with a completed bachelor's degree (Henager & Wilmarth, 2018). Focus was placed on the trade-off between a student loan and a post-secondary education. In other words, did the positive impact of education continue to outweigh the costs of higher education even when considering acquiring a student loan to pay for post-secondary education?

Important Results for Discussion

Holding a student loan and having a post-secondary degree—as compared to having only a high school degree—were both associated with financial wellness, but in opposite directions. That said, the benefits of education on financial wellness outweighed the drawbacks of student loan debt.

The decisions students make about financing their education may indeed have impacts far beyond their debt payments and it stands to impact their overall financial wellness. However, the Human Capital Theory (Becker, 1993; Becker, 1964) explains a return on the investment in education in terms of increased income, opportunities, and the chance for career advancement. Our findings suggest that student loans lower an individual's level of financial wellness, but not as much as a post-secondary degree enhances it (Henager & Wilmarth 2018). A student needs to

understand this and weigh the decision to borrow for post-secondary education considering the costs and benefits. Overall, a post-secondary degree, in terms of human capital, is an investment that results in a return (Becker 1993).

It would be interesting to see future research in this area cover issues related to delayed home ownership, saving, retirement planning, or other types of investments due to lower financial wellness or debt burden (Henager & Wilmarth, 2018). Very few studies have analyzed these issues. Work in this area contributes to a growing body of knowledge for use by financial planners, counselors, educators, and researchers. This is a very important body of research to consider for the financial well-being of post-secondary students during school and beyond.

A Post-Secondary Institution Making a Difference

To further support the enhancement of post-secondary students' understanding pertaining to financial wellness, the following sections discuss a personal finance course offering solutions implemented by a university in the U.S. Pacific Northwest. The university decided on a two-pronged approach which included (1) a one-credit elective course, and (2) a co-curricular program.

1. Financial Education Curricular Approach (One-Credit Elective Course)

While Surdyk (2002) encouraged personal finance to be included in all economics and business courses, Newell and Newell (2012) proposed a stewardship-focused model for a personal finance course, and Poucher (2017) presented a broader model for implementing a personal finance course into the general curriculum. Based on research and experience, a private, liberal arts university located in the U.S. Pacific Northwest implemented a one-credit elective course to address the issue of financial wellness for post-secondary students. Inspired by a similar course at a larger public institution, it is titled 'Money Skills for Life after College' and is a senior-level course designed by students specifically to prepare graduating seniors for money management and financial-related decisions after their post-secondary years. The course has had the largest enrollment for an elective in the university's School of Business. The purpose is to prepare students for their future in employment, life, and financial matters for a lifetime of well-being. The course provides a variety of topics, aimed specifically with those goals in mind, and is scheduled for students to meet once a week with each week covering a separate topic.

The course does not use a textbook. Instead, books are assigned from popular authors in the personal finance field. Students are asked to choose one of five books. The course syllabus includes an outline for each book that follows the course topics by week.

Table 1
Course Topics and Books

Course Topics	Recommended Books (students choose one)
• Planning & Managing • Employee Benefits & Retirement Planning • Saving & Investing • Credit & Credit Cards • Income Taxes • Health Insurance • Protecting Credit Scores • Buying & Financing a Car • Renting vs. Buying a Home • Insurance (Home, Auto, Life) • Fraud & Identity Theft • Financial Aid & Student Loans	• *Your Money Map* (Howard Dayton), 2006, Moody Publishers • *The Total Money Makeover* (Dave Ramsey), 2003, Thomas Nelson Publishers • *The Complete Idiot's Guide to Personal Finance in Your 20s and 30s* (Sarah Fisher & Susan Shelly), 2009, Alpha • *Get a Financial Life* (Beth Kobliner), 2009, Simon and Schuster • *Personal Finance in Your 20s* (Eric Tyson), 2018, Tantor

In the context of student choice, the course assignments are also available by their topic of choice. Students are asked to choose three of the assignments described in Table 2, which are designed to be due after the topic has been covered and are therefore distributed by the due date throughout the course.

Table 2
The 'Choose 3' Assignments

Assignment	Assignment Description
Love & Money	Read a chapter in one of two books; take a quiz on your money relationship, write a brief chapter summary and answer five questions reflecting on money and your relationship
Saving & Investing	Watch a TV program OR listen to a radio program OR read three articles on saving and investing and answer three questions reflecting on your observations
Discover Your Money Habitudes	Complete in-class activity and answer eight questions reflecting on your money 'habitudes'
Stock Market Simulation	This assignment involves setting up and playing a simulated stock market game; students are expected to play this game for a minimum of six weeks • It is the VirtualStockExchange Website; founded by alumni from Stanford and Cornell Universities as an educational tool to teach about investing in the stock market • It is a simulated online brokerage firm that lets students mock trade all securities listed on the major stock exchanges in the U.S. simulating buying and selling stocks on the Internet as if they had an account with an online broker

Poverty Simulation	The event provides a snapshot of how families from low-income backgrounds live; the simulation helps develop an understanding of the challenges associated with utilizing government services, finding a job, and more
Biblical View of Money	Students are asked to read three short chapters on (1) *Finances and Your Relationship with God,* (2) *How to be a Success, and* (3) *Seek the Kingdom of God*, and *w*rite a reflection about the biblical applications
Understanding Credit Card Offers	Students are provided a handout to read and are asked to answer questions about a credit card offer and use online information to evaluate actual credit card terms
Income Taxes	Students complete a simulated federal income tax return
Buying a Car	Students read an online article, take a quiz, and research a make and model of a car to use to complete a worksheet and answer questions
Buying a Home	Students are given an online amortization calculator to use to answer questions about down payments, interest rates, and the principle of a loan
Understanding Insurance Decisions	Students read an article, take a quiz, and review insurance premiums to compare information and answer questions
Book Review	Students are asked to follow an outlined assignment to write a review of one of the five recommended books

Required Assignments

In addition to the 'Choose 3' assignments, students are asked to complete a set of required assignments. These include a (1) Pre- and Post-Test which can be used for research into the improved student learning and assessment of outcomes, (2) Financial Goal-Setting assignment, (3) Credit Report Analysis assignment, and (4) Budgeting Simulation assignment.

The **Financial Goal-Setting** assignment is completed in three parts. The first assignment is early in the course where the students are asked to create at least three financial goals. The goals need to be specific, measurable, attainable (not "I want to be a millionaire by age 30"), relevant, and time-bound (i.e., SMART goals). The goals also need to reflect short-term, medium-term, and long-term goals. Part 1 is then graded and returned to the students with comments on suggested improvements. For Part 2, the students are asked to update their respective goals and begin the process of setting a budget. Part 3 invites students to finalize their goals and budgets.

For the **Credit Report Analysis** assignment, students are tasked with accessing at least one of the three available credit reports online. This course covers credit, credit cards, and how to protect your credit score. Therefore, quite an emphasis is placed on students' credit reports and scores. Class time is used to discuss and reflect on how to access a credit report and the ways the credit score is calculated. Students who do not have a credit report yet are provided a simulated version of the assignment.

The **Budgeting Simulation** assignment is presented by representatives from a local credit union as part of their outreach to the community. The university worked in collaboration with the credit union to assure the simulation reflected post-secondary student needs. It is held in a large multi-purpose room on campus with 8-10 tables set around the room. After being provided a budget booklet and life situation card that includes their job, salary, and marital status, students visit each table with their budget book and 'buy' the things they need (e.g., housing, furniture,

transportation, food, clothing, daycare [if necessary]). In doing so, they need to be mindful of balancing their budget. If they spend too much, they are sent back to the tables to change their initial purchases to fit within their means. At the end of the simulation, prizes and gift cards are raffled, and two $500 scholarships are awarded.

Note: The Budgeting Simulation assignment was added to the course after considering research findings that indicate individuals perform a higher level of positive financial behaviors when they have confidence in their ability (Henager & Cude, 2016). This showed a stronger relationship than objective knowledge of financial topics. Affording students with opportunities to make hands-on decisions in an environment with little to no consequences is an effective way to help them gain confidence in managing money.

Positive Results: This one-credit course has been well-received by the student body; a sample of written student comments is listed in Table 3.

Table 3
Written Student Comments

Student Comments Following the Completion of the One-Credit Course
• *"Every student should be required to take this course. The concepts apply to every single individual graduating from college. If [this university] instilled these concepts in their students, we would be producing generation after generation of better informed and functional members of society."*
• *"I think this class should become a gen ed [general education] requirement because it was so useful to have this information going into the adult world."*
• *"I think that every student at [this university] should take this class because it is SO RELEVANT to our futures! Without this class, I would not have known how to budget, save, pay off student loans, get a credit card, apply for a car loan, or do many other things as it relates to money skills. … This was a great class and I definitely recommend that all seniors take it!"*
• *"This class was incredibly helpful and I feel so much more confident entering the "real world" now. I love how you gave us the "Choose 3" assignments, so we could work on assignments that were relevant to our lives. The outside readings were very helpful, and I loved all of the guest speakers."*
• *"Loved this class. Definitely the most useful class that I have taken at [this university]."*

2. Financial Education Co-Curricular Approach

The co-curricular program is grant funded by a local credit union, led by students, and hosts 6-8 workshops each semester. A graduate student intern from one of the graduate degree programs on campus runs the program and mentors its undergraduate student coordinators. Grant funding helps pay two student coordinators who schedule the program and train student advisors, who present the workshop topics. For additional information, see Table 4.

Table 4
Co-Curricular Program Description

Program Name	• **Balance Your Buc$ (BY$):** in the spirit of the university's mascot (i.e., Pirate Buccaneer)
Mission	• To provide an opportunity for students to serve other students allowing the university's School of Business to serve the broader campus by training and educating students in areas of personal finance to provide a foundation for a lifetime of financial well-being
Vision	• To use research, teaching, and service to encourage students to lead well-balanced financial lives
Objectives	• To train student leaders; to educate the overall campus student body in personal finance • To provide an outreach opportunity for students in the School of Business • To help individual students with tough questions about finances • To design and manage research studies based on the program
Workshop Topics	• Budgeting • Managing Credit and Debt • Saving and Investing • Fraud and Identity Theft • Credit Reports and Scores • Buying a Car • Income Taxes • Understanding Student Financial Aid

Additional Information: Value-Added Student Opportunities

Students who attend the most workshops are eligible to win a $500 scholarship (in the case of a tie, names are drawn for the winner). In addition to hosting workshops that are open to all students, student coordinators work with Residence Life programming to interact with students in each dorm on campus. They hold small gatherings in the common room of each dorm providing such things as Financial Jeopardy games, a brochure about 'Your Money, Your Future,' a Budgeting pamphlet, and gift bags (including chocolate coins).

Trivia Night is a highlight for students. Again, the local credit union hosts this event for the university at large. Students form teams to compete for prizes. Questions revolve around money, banking, credit, and debt. At the end of the event, a raffle is held for more prizes.

Financial Wellness Week is hosted as an event in the Student Union Building, with more raffles and prizes for students who interact with the event hosts. This is used to advertise a condensed set of workshops held each evening during the week. BY$ partnered with the Associated Students' senior coordinator to host 'Money Moves for after Graduation' during this week as well. This targeted seniors to get them thinking about life after their post-secondary years and included three booths (i.e., Saving & Investing, Credit Cards, Student Loans) where each played a short video and students completed a questionnaire. When a student completed all three questionnaires, their answers were verified, and their names were entered into the raffle. All other students received either a coffee card or a dining hall card.

Another enjoyable part of the co-curricular program is the **Ca$h Cart**. A golf cart was donated by the local credit union. The BY$ Student Coordinators randomly pick up students on their way

to class and ask them a personal finance question. If a student answers the question correctly, they are awarded a gift card to the campus coffee shop. The Ca$h Cart activities help advertise upcoming BY$ workshops, the Budgeting Simulation, and Trivia Night.

Financial Wellness in a Crisis

Even given a job loss, a housing crisis, an economic recession, or an unexpected global pandemic, saving for emergencies and paying down credit card debt are both still very important and likely crucial to a person's future. Of course, we cannot foresee the future, but regardless, it will look better with savings in place and very little debt. For those who are worried about money, you are not alone. Here are a few things that can help if money is tight, even during calm economic times (Henager, 2021).

- Choose to eat meals at home. Home-cooked meals are healthier and less expensive. Try this—pick one indulgence—perhaps, specialty coffee, a streaming service, or dessert after dinner. Try going without it for 30 days and keep track of how you are doing and feeling and see how much money you saved. Do you think you can continue to live without it?
- Instead of driving, walk or ride your bike to work. This saves gas and gets you some exercise.
- Review your cable, internet, and cell phone service bills. Are you using all the features you are paying for? You can very likely continue to have good service while cutting some of the cost.
- Shop around for things like car insurance, credit cards, and interest rates if you are borrowing to make a large purchase. On the topic of credit cards, resist using them without paying the balance off. If you currently carry a balance, pay it down by paying more than the minimum and, as soon as you can, pay off the entire balance. This will save you money in interest charges.
- A good time to consider refinancing a home mortgage is if interest rates have dropped at least 2% points from your current mortgage loan. Consider, instead of the traditional 30-year mortgage, a 20-year or 15-year mortgage. This will save money over the life of the loan.

Reducing your expenses is one way to ease some financial stress, but the best way is to make sure to save (Henager, 2020).

- Set a goal for an emergency fund of $1,000. This helps prevent unnecessary debt by allowing you to afford to pay for an emergency (e.g., flat tire, broken window, unexpected medical bill), and it will give you peace of mind. It is okay to start small; the important part is to put some money in your savings account consistently and watch it steadily grow. A commonly recommended amount to save each month is 10% of your income, but that is just a guideline. Do more if you can or less; just make it consistent. Then, once you reach a specific point, for example, half of your emergency fund is in place, celebrate. Treat yourself to something special, however small, and pat yourself on the back for a job well done.

Budgeting Support. If you need help budgeting, there are apps available to help track your expenses and keep an eye on your accounts. Table 5 contains a short list of budgeting apps available (there are many). Some are free, others have in-app purchases – just make sure you

choose one that works for you – usually simpler is better. Consider asking a friend or a family member to join you and be an accountability partner. It is important that you understand you do not have to feel alone during tough economic times. You may be surprised at the stresses you share with others; difficult times are challenging for everyone (Henager, 2021).

Table 5
Budget Supporting Apps

Every Dollar	Available online at ramseysolutions.com, the App Store, or Google Play
Mint: Budget and Expense Tracker	Available online at mint.com, the App Store, or Google Play
Money Tracker	Available online at moneytracker.cc, the App Store, or Google Play
Mvelopes	Available online at mvelopes.com, the App Store, or Google Play
Quicken	Available online at quicken.com, the App Store, or Google Play
Wally Budget App	Available online at wally.me, the App Store, or Google Play

One more important point to consider during a crisis is to remember it will pass. Do not make long-term decisions based on short-term circumstances. Keep focused on your emergency fund and keep long-term plans (e.g., your retirement account) intact. These are important when building wealth, securing your future, and taking care of yourself and your family. Leave contributions in place if you have an employer-sponsored retirement fund (401k, 403b in the US). These generally give you the opportunity to benefit from the matching funds provided by your employer's plan (Henager, 2020).

Concluding Thoughts

This article has outlined a curricular and co-curricular approach to financial education in a post-secondary setting. In addition, empirical research was presented along with a discussion on financial wellness in a crisis. The pandemic that began in 2020 (i.e., COVID-19) impacted the global economy in unprecedented ways, but more importantly, impacted individual lives, by way of finances, employment, and education. The best time to prepare for a crisis is now. It is increasingly imperative we educate people in the handling of money and resources. Financial education, financial literacy, and financial wellness are all indicators of increased potential preparedness for our future.

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Buyer Beware - The Dark Side of the Bitcoin

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The promise that Bitcoin would be the perfect currency has not been realized due to three key areas: waste, oversight, and exploitation. First, waste centers around the inordinate amount of energy and computer hardware dedicated to the creation of Bitcoin that continues to grow. Second, there is a lack of regulation to protect investors. And third is the exploitation of unsophisticated investors who are lured into the cryptocurrency market by celebrities, many without any financial credentials.

Key words: Cryptocurrency, Bitcoin

Introduction

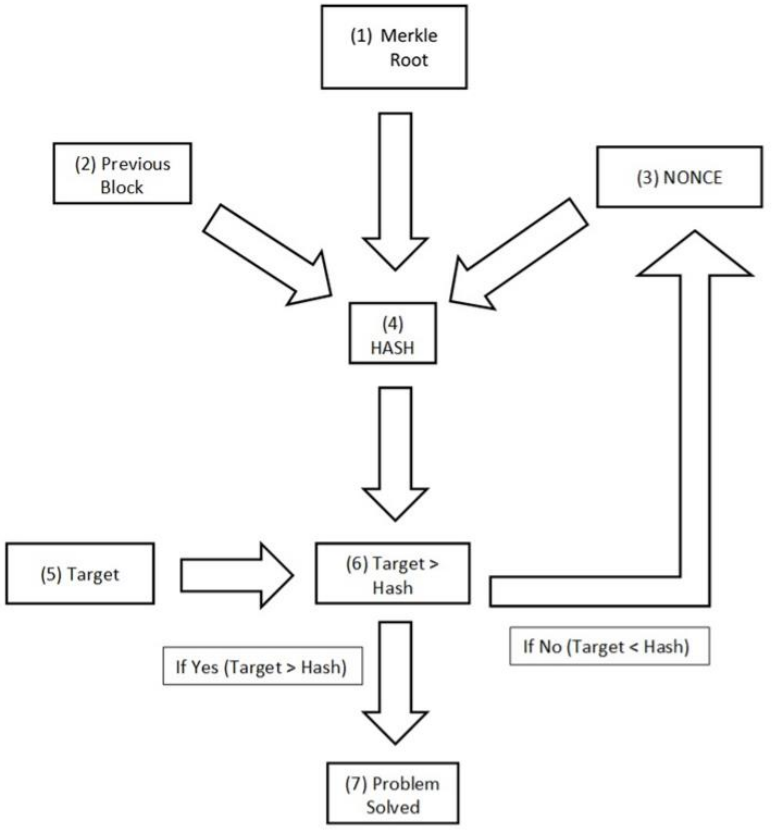
Bitcoin was the first cryptocurrency and is still one of the most used cryptocurrencies in circulation today. It was established around the principle of self-reliance. In other words, Bitcoin is not tied to any established financial institution or governmental regulatory agency. It is described as a peer-to-peer network based on equality among participants which means that each participant has equal representation based on the weighting of its CPU power. The system will work properly if no single entity or colluding entities control more than 50% of the network's CPU power. However, all is not right in the realm of Bitcoin.

Before outlining the darker side of the Bitcoin universe which we summarize in the next six sections, we briefly outline what Bitcoin is and how it functions. Bitcoins are created through a mining process that attempts to uncover a number that is lower than a targeted number or nonce that changes after each successful iteration. Nonce is an abbreviation for "number only used once" which is a number added to a hashed—or encrypted—block in a blockchain that, when rehashed, meets some restricted difficulty level. The process, developed by Satoshi Nakamoto in 2008, is based upon the Secure Hash Algorithm 256-bit (SHA-256) and Blockchain recording. The key to Bitcoin mining is its decentralized computational processes that are embedded in the blockchain to ensure verifiable transactions with the added benefit of confidentiality and equality among participants (or nodes where a node in this connotation is a computer in the Bitcoin peer-to-peer network which hosts and synchronizes a copy of the entire Bitcoin blockchain). Kufeoglu and Ozkuran (2019) explain the verification process of accepting successful hashes and the probability of success through a diagram of the mining process as depicted in Figure 1. As shown in Figure 1, a hashing iteration continues until a new block is created where a successful mining attempt is defined as a generated hash that is smaller than the designated target. Note that the hash takes input from the previous successful block, a Merkle Root hash, and nonce (Ravikiran, 2023). In general, a cryptographic hash is defined in Nakamoto (2008) as a mathematical function that for a given file produces a simplified code for identification that is unique (i.e., any two different files will

never produce the same hash) and nonreversible (i.e., the file once created cannot be re-engineered to recreate the original file).

An example of this mining process is summarized in Appendix A. Grunspan and Perez-Marco (2020) offer an alternative explanation of the Bitcoin mining process mathematically through an exponential Gamma distribution function. Historically, the average mining time for each Bitcoin block is set to approximately 10 minutes. This is undertaken through a self-adjustment mechanism built within the network which adjusts the difficulty of these hash calculations after each successful iteration. The mining process relies on large computational power. Thus, the hash rate (hash per second) is a measure of the Bitcoin miner's electric efficiency. It is typically measured in the watts/Ghash/s (where G stands for giga or billion transactions per second). But even faster notations can be reported in TH/s (where T stands for tera or trillion hashes per second); PH/s (where P stands for peta or quadrillion hashes per second); and EH/s (where E stands for exa or quintillion hashes per second).

Figure 1
Bitcoin Mining Process



(1) A new block is created approximately every 10 minutes; Merkle Root is a 256-bit hash value based on all previous transactions in the block
(2) A 256-bit hash of the previous block header
(3) The random number changed until it fits the required target value
(4) Hashing inputs
(5) Target
(6) Comparison of target and hash to determine if the hash is less than the target
(7) Problem solved and a new bitcoin is created
Source: Kufeoglu and Ozkuran (2019)

Key issues with Bitcoin and other cryptocurrencies include energy usage, the impact on the computer industry, the speculative nature of the industry, and the lack of regulation. In addition, there have been several crypto founders and/or exchanges investigated for criminal activities. Finally, the ease of access to the market, given the risks involved, can be problematic for the naïve investor. We address each of these issues in more detail in the following six sections.

Extreme use of energy

The extreme use of energy in the Bitcoin mining process is associated with not only the amount of energy for the computing aspect of mining but also the cooling costs associated with regulating the temperature within the computing warehouses. Most Bitcoin mining sites are in countries with cheap energy and in locations that are not necessarily using green energy. Several sites are in areas relying primarily on coal-generated electricity.

Kufeoglu and Ozkuran (2019) detail an extensive analysis of 269 different hardware mining models (CPU, GPU, FPGA, and ASIC) to estimate the minimum and maximum energy consumption within the Bitcoin mining sector. The various models and their efficiencies are recorded within their appendix (Tables A1 for CPU equipment, A2 for GPU equipment, A3 for FPGA equipment, and A4 for ASIC equipment). A key takeaway from their study is the increase in the efficiencies of hardware over time. They also summarized energy demand estimates from earlier research as summarized in Table 1. In their study period, 2009 through 2018, the usage values remain relatively flat for all hardware models until 2016 and beyond when the amount of mining significantly increased. Estimation of energy consumption for 2010 to 2020 is available from Digiconomist: Bitcoin Energy Consumption as shown in Figure 2 and summarized in Table 2, which highlights the average and standard deviation of energy consumption by year. The extreme amount of growth over time is associated with the number of Bitcoins mined, the number of players involved in the mining process, and the cost of energy. In a related study, de Vries (2018) incorporates not only the cost of electricity in the mining of Bitcoins but also the cost of the machines and the cooling needed within these mining facilities. Production costs are linked to the number of chips the leading manufacturer, Bitmain, utilizes over time. His estimates are on the higher end of the estimation spectrum as he includes a more complete inventory of electricity usage.

Table 1
Power demand estimates of Bitcoin mining

Source	Minimum (GW)	Maximum (GW)
O'Dwyer and Malone (2013)	0.10	10.00
McCook (2014)	3.28	6.15
Vranken (2017)	0.40	2.30
Gauer (2017)	3.83	-
de Vries (2018)	2.55	7.67
Bevand (2018)	1.62	3.14
Krause and Tolaymat (2019)	3.44	-

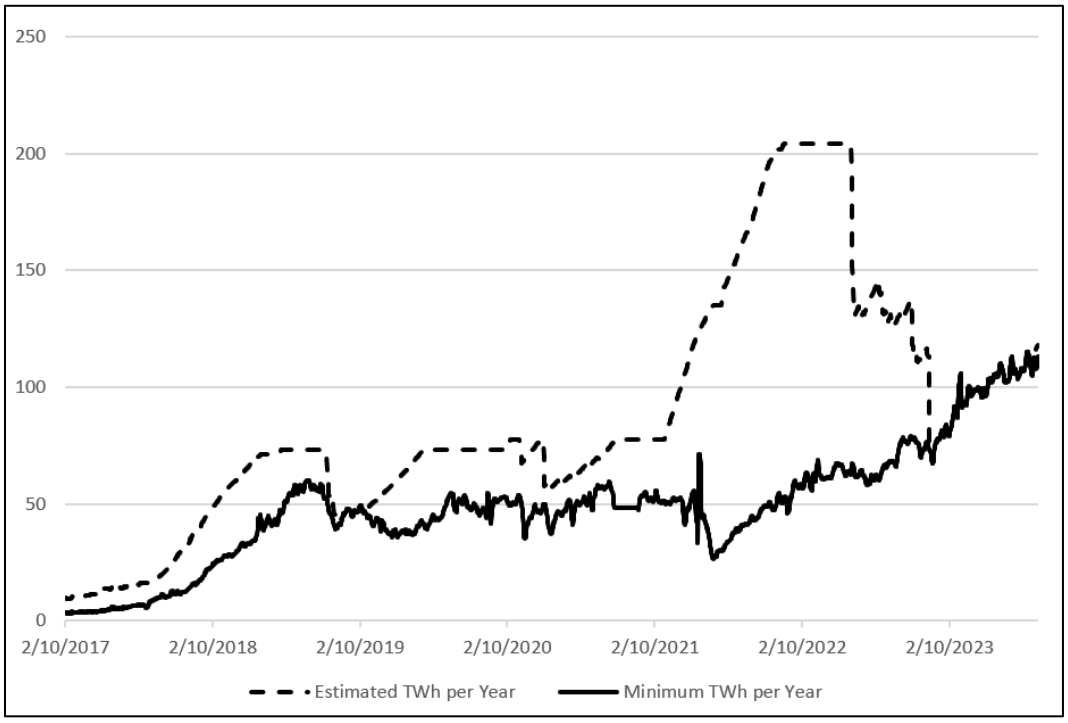
Source: Kufeoglu and Ozkuran (2019)

Table 2
Average Energy Consumption by Year

	Estimated TWh per Year		Minimum TWh per Year	
	Mean	Std Dev	Mean	Std Dev
2017	17.471485	7.486611	7.189475	3.616045
2018	62.521122	11.462183	40.106742	12.714580
2019	63.956415	10.426949	44.345681	4.880238
2020	70.321833	6.883343	49.137124	4.734326
2021	134.015419	42.101613	45.695620	8.412116
2022	186.445482	30.466143	61.008133	4.320273

Source: https://digiconomist.net/bitcoin-energy-consumption

Figure 2
Bitcoin energy consumption index



Source: https://digiconomist.net/bitcoin-energy-consumption

Computer Industry

The mining activities associated with Bitcoin affect other industries due to competition for computer chips between mining and other hardware needs. For instance, Li (2022) states that soaring chip usage in crypto mining operations is impacting at least 169 other industries such as automotive, gaming, and consumer electronics. To highlight the importance of this problem, in June 2021 the United States Senate passed the "U.S. Innovation and Competition Act" and in March 2022 they passed the "America Competes Act of 2022", which allocates over $50 billion for domestic semiconductor fabrication capacity over the FY2022 through FY2026. Intel, Samsung, and TSMC—Taiwan Semiconductor Manufacturing Company Limited, the three largest

manufacturing firms for cutting-edge ASICs (application-specific integrated circuits) have manufacturing facilities outside the United States. Matt Ranger's blog states that four percent of TSMC's production of top tier capacity (7nm and 5nm chips) went to Bitcoin mining and 0.5% of global energy use went to crypto mining of which 95% was for Bitcoin.

de Vries and Stoll (2021) documents Bitcoin's annual e-waste at 30.7 metric kilotons, which in perspective is approximately equivalent to the small IT equipment waste produced in the Netherlands. This averages out to 272 g of e-waste for each Bitcoin transaction processed on the blockchain. As Bitcoin prices rise, so does the amount of e-waste. The authors explain the increase in e-waste within the dynamics of Bitcoin mining. An increase in the processing efficiency of mining devices (i.e., more hashes per unit of energy) leads to the acquisition of newer equipment as replacements or an increase in the total amount of computational power being devoted to Bitcoin mining activities. This leads to a decline in each device's profitability. Thus, inefficient machines become obsolete and are discarded (i.e., e-waste increases).

The authors document that the average life of a Bitcoin mining device is less than 1.29 years. A driving force behind this waste is that the mining industry relies on the newest and most efficient mining equipment (i.e., the newest ASICs chips). Due to their specialized purpose, older chips cannot be repurposed for another task and thus are discarded. In addition to the chips which are a small component of the mining equipment that is discarded, the metal casings and aluminum heat-sinks could be recycled but, in many instances, it is cheaper to just dispose of them. This is especially prevalent in countries with limited recycling regulations, which are the areas where the highest concentration of crypto mining occurs.

Gambling

Peters (2022) points out that the similarity between trading in cryptocurrencies like Bitcoin and gambling is that both rely on volatility. Bitcoin's volatility is related to the wide fluctuations in its price. Grauschopf (2022) notes that gambling's volatility is incorporated in every bet you make. In the casinos, the odds are always with the house but that does not stop the gambler's participation. For instance, slot machine odds range from one-in-5,000 to one-in- about 34 million for the top price. The games with the best odds include blackjack at 49 percent and craps (betting on whether the shooter will win or lose on the next roll) and roulette (betting on black or white) at almost 50%. In both craps and roulette, betting on a specific number decreases the odds, but also increases the potential payout.

Lack of Both a Backstop and Adequate Regulations

Beck (2021) contrasts gold and Bitcoin with currencies created within a governmental entity. Both gold and Bitcoin (and other cryptocurrencies) lack the formal backstop from the taxing authority of a central government. In addition, many countries peg their currency to the U.S. dollar. Both gold and Bitcoin have no such backing mechanism. Unlike Bitcoin, gold relies on its physical properties, as well as scarce supply. Gold can also be used for something other than the backing of a country's currency such as jewelry. Bitcoin, as well as other cryptocurrencies, is very volatile in terms of pricing, does not have a physical nature, and potentially has an infinite supply, although Bitcoin is capped at 21 million Bitcoins. Bitcoin functions under a decentralized blockchain format. Like any asset of value, it relies on a secondary market for buying and selling. However, the creation of additional Bitcoins relies on an extreme waste of electricity and resources (computer

chips and computing hardware) during the mining process. Some would say the same about the mining for gold, but gold is a tangible asset. Therefore, gold can be bought and sold through a variety of channels, whereas Bitcoin must be transacted through a limited set of technological marketplaces. Bitcoin also has no intrinsic value.

Gailey (2022) states that regulation can be both good and bad. Thus, regulation and the lack of regulation can be seen from both viewpoints. Regulation should help protect investors from the fraud, theft, or the potential of failure within the crypto marketplaces. But cryptocurrencies were built on decentralized platforms, which was the draw for many of its participants. One of the key drivers behind regulating cryptocurrencies is that governmental units around the globe do not want an underground platform that can be used for avoiding taxes or for buying and selling illegal goods and services. Thus, regulations offer the potential for more stability in the crypto-marketplace, an increase in investor protection and confidence, and a safer crypto-ecosystem.

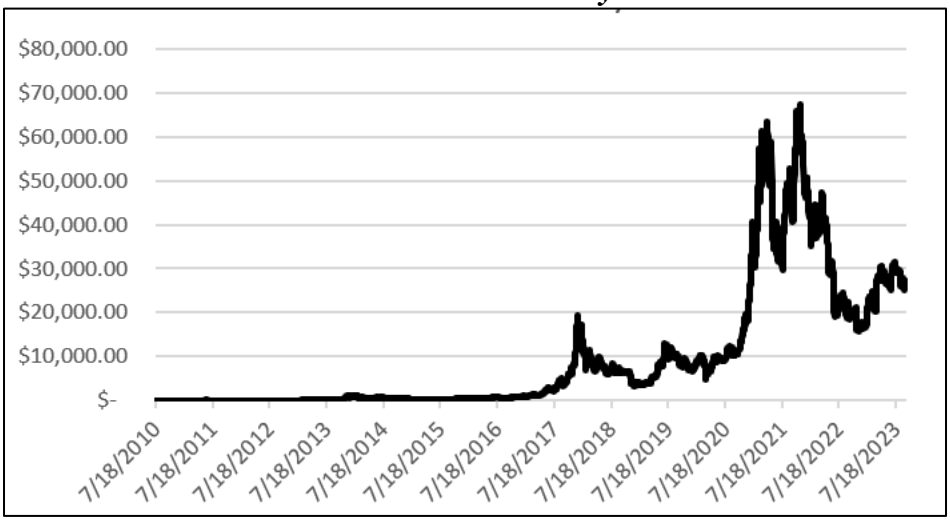
Hayes (2022) states that as of January 2022, 18.9 million of the 21 million upper limits of Bitcoins allowed have already been issued (mined), with only 2.1 million Bitcoins still to be released. Within the design of the Bitcoin protocol, new Bitcoins issued per block decrease by half approximately every four years. In 2009, Bitcoin's creative start data, the total Bitcoins available to be mined was 21 million with 50 new Bitcoins mined per block. In 2012, the rate per block was halved to 25 after 10.5 million coins were mined. This dropped further to 12.5 after an additional 5.25 million coins were mined in 2016. In 2020, the rate was adjusted to just 6.25 after an additional 2,625,000 coins were mined. The question that remains unanswered is what will happen when the number of mined coins reaches 21 million.

Ease of Access

Given the lack of regulation, traders should be cautious about the risky and speculative nature of investing in cryptocurrencies. Unlike options where both investors and traders are expected to abide by SEC Rule 6 on Options Trading (SEC Rule 6, 2004), trading in cryptocurrencies is open to all and is often marketed to the most naïve investor. Many celebrities and sports stars are being used to market the cryptocurrency market. This includes a wide range of endorses such as, Bill Gates (founder of Microsoft), Gwyneth Paltrow (actress and "Goop" owner), Paris Hilton (celebrity influencer), Snoop Dogg (singer), Ashton Kutcher (actor), Mike Tyson (boxer), Pitbull (rapper), Lionel Messi (soccer star), Mel B (singer), Floyd Mayweather Jr.(boxer), Madonna (singer), Johnny Depp (actor), and Kim Kardashian (actress) (see Ramirez and Moynihan, 2019 and Wynn, 2021).

Given the risky nature of many cryptos, it should be concerning to all that many naïve investors are being encouraged to invest in such a volatile market. Bitcoin, for example, has traded as low as $17,601.58 and as high as $68,990.90 in the 52-week period between June 2021 and June 2022. In fact, the price of Bitcoin was never above $0.40 in 2010, one year after it was introduced. Figure 3 shows the price of Bitcoin from July 18, 2010 to September 18. 2023. Appendix B provides multiple lists of trading apps that are being pushed to investors to encourage investment in cryptocurrencies. Many established brokerage firms now allow investors to buy and sell cryptocurrencies right along with stocks, bonds, and mutual funds.

Figure 3
Bitcoin Price History



Source: https://www.investing.com/crypto/bitcoin/historical-data

Potential criminality within Cryptocurrency Industry

In addition to the risk associated with investing in cryptocurrencies, investors should also be aware of the multitude of criminal investigations within the cryptocurrency industry. There is so much concern that the DOJ has appointed a National Prosecutor Network that will focus on crypto crime (Volz, 2022). In 2021 cryptocurrency-related crime was valued at $14 Billion (Sun, 2022). Here is a list of headlines that highlight a small sample of cryptocurrency crimes in 2021 (Ciphertrace, 2021):

- French Police Arrest Twenty-Nine in Cryptocurrency Terrorism Financing Scheme
- BitGo Enters into $98,830 Settlement with US Treasury Over Multiple Crypto Sanctions Violations
- Fifteen Plead Guilty After Implication in International Crypto-Crime Ring
- $2.5 Million in Crypto Stolen Through SIM Card Hacks by Iris Man

The allure of crypto investment is made more appealing by the high, yet often unexplained, valuations and the potential, although small, for a big payday. However, investors need to be aware of what they are buying and what type of activities their investment funds may be supporting.

Conclusion

The hype surrounding the creation of cryptocurrencies, starting with Bitcoin in 2008, has never quite reached the lofty expectations. Bitcoin, the wonder child of crypto, reveals the darker side of the crypto marketplace. There is extreme waste within the mining process through excessive energy usage and the misallocation of computer chips and other computing hardware. The lack of regulations, one of the key selling points within the industry, is also a major stumbling block. The lack of regulations has allowed fraud to flourish in terms of tax avoidance and insulating criminal activities, The ease of access and the promotion from celebrities, many without any financial

credentials, allows too many unsophisticated investors to be lured into the crypto marketplace with dire consequences.

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Appendix A

Crypto mining—A meaningless computer algorithm process attempting to determine a certain random number

Bitcoin mining is a process to generate random numbers based on an algorithm. The process uses three numbering methods: decimal (base 10), binary (base 2), and hexadecimal (base 16). The hash function relies on three key factors: (1) to scramble the data deterministically; (2) to accept an input of arbitrary length and produce an output of a fixed length; and (3) to manipulate the data so that it is irreversible. Ken Shirriff's "Mining Bitcoins by hand: The SHA-256 hash" details a pencil and paper example of the hashing process used in Bitcoin mining. A more detailed iteration of the entire hash function with Python code is provided by Daniel Gerep.

Shiriff's hashing example revolves around a 15-step process. Step 1 is used to initialize the hash value (h) based on hard-coded constants that represent the first 32 bits of the fractional parts of the square roots of the first eight primes (i.e., 2, 3, 5, 7, 11, 13, 17, and 19) as shown in Table A1. Step 2 converts these initial hash hexadecimal values to their binary equivalence as shown in Table A2. The first line of each hash is its hexadecimal value, and the second line is its binary conversion.

Table A1. Initialized hash values (Step 1)

Hash	Value
h0	6a09e667
h1	bb67ae85
h2	3c6ef372
h3	a54ff53a
h4	510e527f
h5	9b05688c
h6	1f83d9ab
h7	5be0cd19

Table A2. Initial hash hexadecimal values conversion to binary (Step 2)																																
h0	6				a				0				9				e				6				6				7			
	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1
h1	b				b				6				7				a				e				8				5			
	1	0	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1	0	1	0	1	1	1	0	1	0	0	0	0	1	0	1
h2	3				c				6				e				f				3				7				2			
	0	0	1	1	1	1	0	0	0	1	1	0	1	1	1	0	1	1	1	1	0	0	1	1	0	1	1	1	0	0	1	0
h3	a				5				4				f				f				5				3				a			
	1	0	1	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	0	1	0	1	0	0	1	1	1	0	1	0
h4	5				1				0				e				5				2				7				f			
	0	1	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	0	0	1	1	1	1	1	1	1
h5	9				b				0				5				6				8				8				c			
	1	0	0	1	1	0	1	1	0	0	0	0	0	1	0	1	0	1	1	0	1	0	0	0	1	0	0	0	1	1	0	0
h6	1				f				8				3				d				9				a				b			
	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	0	0	1	1	0	1	0	1	0	1	1
h7	5				b				e				0				c				d				1				9			
	0	1	0	1	1	0	1	1	1	1	1	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	1	1	0	0	1

Note: For each hash value the 1st line is the hexadecimal value and the; 2nd line is its binary conversion.

Table A3 shows the next 10 steps. Step 3 applies a majority function on the first 3 hash values (h0, h1, and h2). The majority function rule is if there are more 0s, then 0 is recorded; otherwise, if there are more 1s, then 1 is recorded. Step 4 converts this binary result into its hexadecimal value. Step 5 shifts the initial h0 values 2, 13, and 22 spaces. Step 6 sums these shifted values by applying the following rule: if there is an odd number of 1s, then the value recorded is 1. Otherwise, if there is an even number of 1s, then the value recorded is 0. Step 7 again converts the binary result to its hexadecimal equivalence. Step 8 applies a choice function to h5 where if the h5 binary digit equals 0, then record the h6 digit. Otherwise, if the h5 digit equals 1, then record the h7 digit. Step 9 is used to convert the Step 8 result to hexadecimal. Step 10 applies three shift functions (6, 11, and 25) to h4. Step 11 sums these shift values by applying the rule that if there are an odd number of 1s, then the result is 1. But if there is an even number of 1s, then record a 0. In Step 12, this Step 11 binary result is converted to hexadecimal.

Table A3. Steps 3 through 12																																	
h0	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1
h1	1	0	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1	0	1	0	1	1	1	0	1	0	0	0	0	1	0	1
h2	0	0	1	1	1	1	0	0	0	1	1	0	1	1	1	0	1	1	1	1	0	0	1	1	0	1	1	1	0	0	1	0
Step 3: Binary value after applying majority function.																																	
	0	0	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1
Step 4: Hexadecimal conversion																																	
	3				a				6				f				e				6				6				7				
Step 5: Shift h0 values by 2, 13, and 22 places.																																	
>>2	1	1	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1
>>13	0	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	1	1	1	1
>>22	0	0	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	0	1	0	1	0	0	0
Step 6: Sum the shifted numbers (if an odd number of 1s then 1; if even number of 1s, then 0)																																	
	1	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	0
Step 7: Convert the binary sum to a hexadecimal value.																																	
	c				e				2				0				b				4				7				e				
Step 8: Choice factor (if h5=0, then h6 value; otherwise, if h5=1, then h7 value)																																	
	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0	1	1	1	0	0	1	0	0	1	1	0	0	0	1	1	0	0
Step 9: Convert to a binary value from Step 8 to hexadecimal																																	
	1				f				8				5				c				9				8				c				
Step 10: Apply a shift to h4 by 6, 11, and 25 places.																																	
>>6	1	1	1	1	1	1	0	1	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	0	0	1
>>11	0	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	1	0
>>25	1	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	0	0
Step 11: Sum the shifts (if an odd number of 1s then 1; if even number of 1s, then 0)																																	
	0	0	1	1	0	1	0	1	1	0	0	0	0	1	1	1	0	0	1	0	0	1	1	1	0	0	1	0	1	0	1	1
Step 12: Convert Step 11 binary sum to hexadecimal																																	
	3				5				8				7				2				7				2				b				

Table A4 records the results from Steps 13, 14, and 15. Step 13 combines a set of values to make the first sum. In Step 14, a new h0 is computed and new h1, h2, and h3 are assigned from previous values as stated in Table A4. Similarly, in Step 15 a new h4 is computed and new h5, h6, and h7 are assigned from previous values. This ends the first round of SHA-256 hash where SHA-

256 is the shorthand notation for Secure Hash Algorithm 256-bit. Of course, there is a lot more behind the mathematics associated with the mining of Bitcoins. For instance,

Table A4. Steps 13 through 15										
Step 13: Combine the data to make the first sum.										
Input data w		0	2	0	0	0	0	0	0	data block version 2
	k	4	2	8	a	2	f	9	8	constant for each round provided by NSA
	h7	5	b	e	0	e	d	1	9	
	step 9	1	f	8	5	c	9	8	c	shift h0 choice result
	step 12	3	5	8	7	2	7	2	b	the sum of h4 shifts
		f	5	7	7	e	d	6	8	the sum of values in base 16
Step 14: Compute the new h0 value and assign new h1, h2, and h3 values.										
	step 7	c	e	2	0	b	4	7	e	the sum of h0 shifts
	step 4	3	a	6	f	e	6	6	7	majority
	step 13	f	5	7	7	e	d	6	8	previous sum
	New h0	f	e	0	8	8	8	4	d	the sum of values in base 16
	New h1	6	a	0	9	e	6	6	7	old h0
	New h2	b	b	6	7	a	e	8	5	old h1
	New h3	3	c	6	e	f	3	7	2	old h2
Step 15: Compute new h4 and assign new h5, h6, and h7 values.										
	old h3	a	5	4	f	f	5	3	a	
	step 13	f	5	7	7	e	d	6	8	sum
	New h4	9	a	c	7	e	2	0	2	the sum of values in base 16
	New h5	5	1	0	e	5	2	7	f	old h4
	New h6	9	b	0	5	6	8	8	c	old h5
	New h7	1	f	8	3	d	9	a	b	old h6

Appendix B
Cryptocurrency Trading Apps and Rankings

Table B1: Ascent's Best Cryptocurrency Exchanges and Apps

	Stars	Fees for crypto	Acct Minimum
Robinhood	4.5	$0	$0
SoFi	4	1.25%	$1
etoro	4	1% plus spread	$10
Gemini	4.5	$0.99 -$2.99 order < $200, 1.49% for orders at least $200, 0-0.40% Gemini Active Trader	$0
Coinbase	4.5	Variable (Coinbase), 0-0.60% (Coinbase advanced trade)	$2
Cash App	4	$0	$0

Source: https://www.fool.com/the-ascent/cryptocurrency/best-cryptocurrency-apps/

Table B2: Top apps/exchanges for crypto in Sept 2022

	Fees	Coins available
Bittrex	Start at 0.35% and decline for high-volume traders	More than 250
Binance	0.1% for traders with less than $50,000 and decline for high-volume traders. 25% discount if you pay fees in BNB (in-house coin)	117
eToro	Commission fee, spread mark-up 1%	63
Coinbase	At least 1.99%	174
Kraken	1.5% plus fees for cards and online banking	175
Robinhood	$0, spread mark-up	12
Webull	Commission free, spread mark-up of 1%	62
Cash App	Spread mark-up plus trading fee	1 – BITCOIN
PayPal	Spread mark-up plus trading fee	4

Source: https://www.bankrate.com/investing/best-crypto-exchanges-and-trading-apps/

Table B3

Best Apps for Cryptocurrency

Name	Stars	Fees to Trade	Features
Pionex	5	0.05% trading fee	User-friendly Mobile app interface, Excellent Email and Live chat support. and Low Trading fees.
Bitstamp	5	0-0.05% spot trading plus 1.5-5% when depositing real-world currencies depending on deposit method	From 0.05% to 0.0% spot trading plus between 1.5% to 5% when depositing real-world currencies depending on deposit method.
NAGA	4.5	0.1 pips spreads.	Up to 1,000x leveraged trading; deposit via bank, debit/credit cards and online methods.
Crypto.com	5	From 0.4% maker and taker Level 1 ($0-25,000 trading volume) to 0.04% maker and 0.1% taker fees for Level 9 ($200,000,0001 and above trading volume)	Crypto.com Visa card – 4 tiers.
Binance	5	Trading fee: 0.02 to 0.10%. It varies from 3% to 4.5% for debit card, or $15 per U.S. wire transfer.	Centralized order books with peer-to-peer support and advanced charting for traders.
Bybit	5	For spot trading, the maker fee rate is 0% & the taker fee rate is 0.1%.	Security, 24x7 multilingual support, state-of-the-art pricing system, 100K TPS matching engine, HD cold wallet, etc.
CoinSmart	4.5	0.20% for single trades and 0.40% for double trades. Buying - Up to 6% for credit card deposits, 1.5% e-Transfer, and 0% for bank wire and draft.	Same-day fiat cash out to banks. Instant crypto-crypto conversions.
Coinmama	4.5	0% for SEPA, 0% SWIFT for orders above $1000 (otherwise 20 GBP), 0% for Faster Payments in UK only, and $4.99% credit/debit card.	Buy crypto with fiat via credit card and electronic payments and cash out Bitcoin via bank account.
Kraken	5	0 to 0.26%	Android, iOS, & web apps; Exchange of USD, Canadian Dollar, Euro, & GBP into crypto.
Cash App	5	Free to send from app or bank; 3% for sending from credit card	U.K., U.S. only. No cross-border transactions elsewhere.
Bisq	5	0.1% maker and 0.3% takers	Peer-to-peer exchange with global support.
Coinbase	4.5	From $0.99 for $10 or below; to $2.99 for $200 or less. A flat 2.49% with Coinbase Card; 2% for credit transactions; up to 2% for crypto conversions; Debit cards up to 3.99% and PayPal up to 1%	Institutional grade all with custody support.
Blockfolio	4	No fees for trading or tracking. No fees to use the app.	Price tracker with precision alerts.

Source: https://www.softwaretestinghelp.com/cryptocurrency-trading-apps/ (Data retrieved 9/26/2022)

Table B4
10 Best Crypto Apps for Beginners

Rank	Crypto App
1	Gemini
2	CoinBase
3	eToro
4	BlockFi
5	WeBull
6	Blockchain.com
7	Voyager
8	Delta
9	Exodus
10	Blockfolio

Source: https://www.makeuseof.com/best-cryptocurrency-apps-beginners/

Table B4
Best Apps for Trading Crypto in 2022 – An Expert's Opinion

1. Spot Crypto Trading Apps
• eToro
• Kraken
• CEX.IO
• Changelly
• Swan Bitcoin
2. Exchange and earn interest
• BlockFi
3. Buy Gift Cards, vouchers and top up airtime
• Bitrefill

Source: https://jeangalea.com/best-cryptocurrency-trading-apps/

Pass/Fail Grading During the Corona Virus: The Decision to Exercise a Real Option

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In mid-spring semester 2020, COVID-19 caused nearly all universities to switch to online learning. Many schools allowed students to choose between a letter grade or a passing grade once the semester was done to mitigate the impact of the disruption of the learning environment, which some feared would disproportionately affect marginalized populations. At Lafayette College, however, students were required to choose their grading scheme one week prior to final exams. We model the right to elect pass/fail grading as a real option. We find the main determinants that make election of pass/fail more likely are if the student is a male, senior, Black, Latino, non-resident, has a low GPA, or is in a class where grades are dispersed.

Key Words: *Real option, Pass/Fail Grading, Corona Virus, COVID-19*

Introduction

In March 2020, colleges made the decision to shut down in-person classes with little notice to students. On March 7, the University of Washington was the first large university to move to remote learning (Balta, 2020). On March 10, Harvard University gave students five days' notice to move out of their dormitories (Hess, 2020).

This study focuses on Lafayette College, a small, elite liberal arts college located in Easton, Pennsylvania. Lafayette College announced, two days before spring break, that, upon the return from break, learning would be remote from March 23 through April 5. The college moved to remote learning for the rest of the semester following Pennsylvania Governor Wolf's March 19 announcement of a shutdown of all non-essential businesses (Satullo, 2020). In recognition of the disruption to the learning environment, Lafayette College initiated a temporary pass/fail regime for the spring 2020 semester on March 25, giving students a real option regarding their grades (Meier, 2020).

A major reason given for liberalizing pass/fail for the semester is the belief that marginalized students are more impacted by the sudden dislocation of being moved off campus (Schermele, 2020). The significant advice from Lafayette College's Academic Progress Committee and the Curriculum and Education Policy Committee (Meier, 2020) states succinctly, "The objective is to make evaluation of student learning more flexible this semester so that it equitably takes into account the diverse academic needs, interests, and concerns of our students and the very different pedagogies being employed for the balance of this academic year." The extension of the pass/fail election to May 1, one week before final exams, creates a valuable choice for students.

The purpose of this study is to determine if students' pass/fail election behavior is consistent with the stated goals of the college. We model the election of pass/fail at Lafayette College in Spring 2020 to assess the determinants of the option exercise decision. We then attempt to determine if students' pass/fail election behavior is consistent with the effort to equitably account for the diverse academic needs, interests, and concerns of Lafayette students.

Literature Review

Denning, Eide, Mumford, Patterson, and Wallach (2022) document the extent and history of grade inflation in higher education. Some of the grade inflation literature examines the effect of ungraded work or pass/fail grading on student success. Grove and Wasserman (2006) find that having graded problems sets increases the exam grades of freshmen in an economics course by one-third to two-thirds of a letter grade. Artes and Rahona (2013) show that having graded problem sets (versus ungraded problem sets) raises final exam scores by nearly a full grade.

LePage, Li, and Zafar (2022) consider students' choice of pass/fail grading. Using data from the Fall 2020 and Winter 2021 terms at a large midwestern state university, they find that women are less likely to elect to replace a letter grade with a pass/fail grade than men. They attribute this difference to labor market discrimination where women perceive that they will experience a higher penalty for a pass/fail grade on their transcript then men.

Several other studies examine the effect of pass/fail grading. Rohe, Barrier, Clarke, Cook, Vickers, and Decker (2006) show that a pass/fail option for medical students reduces stress and encourages group cooperation. Ange, Wood, Thomas, and Wallach (2018) show that the implementation of first-year pass/fail grading for medical students has little effect on medical exam performance and subsequent school performance. Bullock, Seligman, Lai, O'Sullivan, and Hauer (2022) use student survey data from medical clerkships to assess the replacement of honors/pass/fail with pass/fail assessment and find that student perceptions of grading improved. Perceptions of bias are not improved. Frank and Sutherland-Smith (2021) examine a switch to pass/fail grading for veterinarian clinical rotations and find no effect on final GPA. Ramaswamy, Veremis and Nalliah (2019) argue for the use of pass/fail grading in dental schools based upon increased student well-being, increased student motivation for learning rather than grade improvement, and the increased use of competency-based assessments.

Pass/fail grading has potential downsides. Gershenson (2020) provides evidence that more rigorous grading policies lead to more student learning. Burke (2020) notes that overall GPA and individual course grades impact scholarship decisions, graduate school admissions, and the transfer of credits to other institutions; therefore, the election of pass/fail can negatively affect all these items. Butcher, McEwan, and Weerapana (2022) show that a first semester pass/fail requirement at Wellesley College leads to lower student effort in those courses.

Our work complements the existing literature in pass/fail grading. The COVID-19 emergency in the Spring 2020 semester led to several snap decisions by college faculties and adminstrations, an important one of which was to allow students to replace letter grades with pass/fail. A major reason given for liberalizing pass/fail for the semester is the belief that marginalized students are more impacted by the sudden dislocation of being moved off campus (Schermele, 2020). We find support for this hypothesis since both Black students and Non-resident (International) students are significantly more likely to elect pass/fail than other students, after adjusting for the effects of GPA and other variables. We also find that students with lower GPAs are more likely to elect pass/fail and that there was a significant senior "check out" effect in 2020, where seniors were more likely

to elect pass/fail. Like LePage et al (2022), we find that women are less likely to elect pass/fail than men, even accounting for women's higher average GPA than men.

Methodology

The option to elect pass/fail provides insurance to the student. If a disruption in the learning environment, or any other reason, negatively affects the student's grade, the student can replace that grade with pass (if the student passes the course). The option analogue to insurance is a put option. If something bad happens, the student can exercise the put.

The value of the put is the put premium and is denoted with the letter P. In standard financial option theory, P depends upon the following variables:

$$P = f(S, K, T, r, \sigma)$$

where the put premium is:

- negatively related to the stock price, S
- positively related to the strike price, K
- For European style puts nearly always positively related to the time to expiration, T, while for American Style puts, always non-negatively related to time.
- nearly always negatively related to interest rates, r
- positively related to volatility, σ

To reframe the pass/fail election option as a real option, we map the traditional variables from standard financial option theory to the choice variables available to the student. All of these variables apply to a single course for a given student. We model each student as making a choice to elect pass/fail independently for each course that the student is taking.

The variable, S, maps to the current grade in the course. This is the student's grade in a class when the student must make the decision to exercise the pass/fail option (May 1) which occurs before the end of the semester. This grade may differ from the student's expected grade at the end of the course. For instance, path-dependency may exist. A student who has had declining grades during the semester may be more likely to exercise the pass/fail option than a student who has had increasing grades all semester, even if both have the same current grade in the course.

The variable, K, maps to the highest grade for which the student exercises the pass/fail option. K can be thought of as a "reservation grade". If $K - S > 0$, the option is considered to be "in-the-money", i.e., the option has value if exercised. K is idiosyncratic and differs from student to student. A variety of factors may affect K including demographic differences. For instance, international students, many of whom returned to countries in different time zones than the college, may find the disruption to learning more significant. These students may be willing to elect pass/fail with a relatively higher grade in the class on May 1 because of the difficulty of maintaining continued effort in the class. Hence, international students may be more likely to elect pass/fail even compared to a similarly situated non-international student.

With respect to time, all decisions take place within the semester, hence the interest rate, r, does not play a role. However, we map the variable T to the percent of the grade that is to be determined on May 1, the completion measure of the semester's grade average for a course. A greater T implies a lower percentage of the semester grade being determined as of May 1.

The variable σ is how volatile the change in the semester grade will be from May 1 to semester's end. Like K, σ is affected by a variety of factors including demographic differences. T

and σ together determine the speculative value of the option and affect the probability that the option will be exercised.

Figures 1 and 2 show how the speculative value of the pass/fail option is affected by T and σ. Figure 1 shows the case of the same σ but different grade completions (T). A lower grade completion means a wider possible range of final letter grades in the course than for a higher grade completion. Figure 2 shows the effect of varying σ for the same grade completion level. A higher σ implies a wider possible range of final letter grades in the course than a lower σ. A wider band of possible final grades denotes greater speculative value, and ceterus paribus, a greater likelihood of exercising the option.

Figure 1
Speculative Value as a Function of T and σ – Same σ, Different T

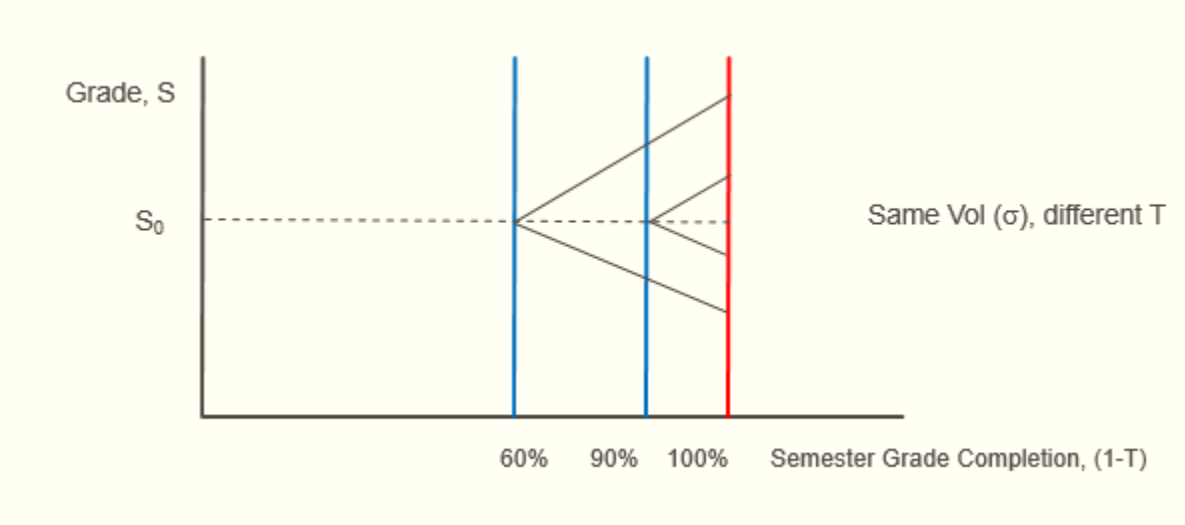
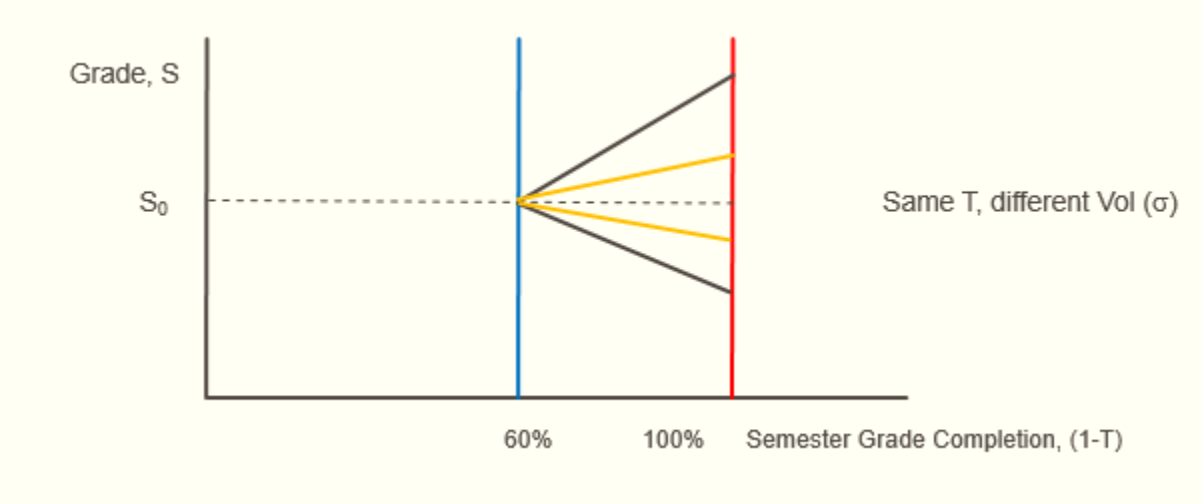


Figure 2
Speculative Value as a Function of T and σ – Same T, Different σ



The option to elect pass/fail does differ from a standard financial put option. The student must choose to exercise the put before the final intrinsic value is revealed. That is, the put must be

exercised on May 1, prior to the revelation of the final grade. Also, the student replaces a letter grade with a "P," unless the student fails, in which case the student receives the same grade of F. This is more closely related to an exchange option since the payout is P rather than $K - S$. Finally, the option's value depends upon the evolution of the grade throughout the semester, meaning that path dependency can affect the probability of exercise. With these caveats, the put option analogy is useful for understanding the student's decision to elect pass/fail as well as to model student pass/fail behavior and interpret the results of the data analysis.

Data

The dataset was provided by the Registrar's office at Lafayette College and includes data for the Spring 2020 semester. Institutional Review Board approval was received August 31, 2020. The dataset includes a unique record key for each student, class year, gender (M or F), cumulative GPA, ethnicity, state of home address (if applicable), origin nation, primary major, and secondary major. We also have course information for each course taken by each student which includes a unique course ID, subject, course number, course title, grade type (Pass/Fail or Not Pass/Fail), final grade (letter grade or P), and instructor name. With each of the 2,462 Lafayette students averaging approximately 4 courses for the semester, the total number of observations is 10,175. Lafayette's college catalog was used to determine which majors required calculus (used to create the CALC_REQUIRED dummy).

The grade type (P or N) was used to create the dependent dummy variable PF. PF equals 1 if pass/fail is elected and 0 otherwise. We use or create four variables to reflect the option exercise choice faced by the student. CUM_GPA is the cumulative GPA on a 0.0-4.0 scale. We posit that a higher cumulative GPA (CUM_GPA) implies a higher S, that is, an academically stronger student is expected to do better in a given course. A higher GPA also implies a higher K. An academically stronger student is expected to have a higher reservation grade in a given course. Together, these two effects have an ambiguous result on the probability of exercise. A higher GPA also lowers σ. We expect stronger academic students to be more consistent in their course grade completion. Overall, a high GPA implies consistently high grades (low σ), suggesting that these students are less likely to exercise the pass/fail option.

High grade variable (HIGH_GRADE_DUM) is a dummy variable created for each course based upon the grades observed within each course. We cannot observe the letter grade that a pass/fail electing student would have received if they had not elected pass/fail; however, we do observe the letter grades for students in the same course who did not exercise the pass/fail option. If students perceive that a given class is being assigned high grades, we expect them to be less likely to elect pass/fail. HIGH_GRADE_DUM is 1 if the lowest observed letter grade in a given class is A- or better. HIGH_GRADE_DUM is 0 otherwise. We also note that if HIGH_GRADE_DUM equals 1, σ is necessarily lower. If everyone is getting good grades, volatility is low and leads to a lower probability of pass/fail exercise.

The calculus variable (CALC_REQUIRED) is a dummy variable created for each course based upon the major of the course. If calculus is required for the course's major, CALC_REQUIRED = 1; otherwise, CALC_REQUIRED = 0. These courses may be more analytical, possibly affecting the difficulty of the course, ceteris paribus. We hypothesize that course difficulty has an ambiguous effect on the election of pass/fail. While harder courses make for lower letter grades in a disrupted environment, stronger students tend to self-select into more difficult courses and weaker students

tend to self-select into less difficult courses. Given the ambiguity of difficulty, we are uncertain as to how CALC_REQUIRED influences the probability of exercise.

The course in major variable (INMAJOR) is a dummy variable created for each course that a student takes. If the course is in the student's major (or multiple majors), INMAJOR = 1; otherwise, INMAJOR = 0. INMAJOR likely affects the variable, S. Since the student has more choice in courses outside of the major, selectivity bias may imply that courses in the major are more difficult and advanced while courses outside of the major are less challenging. On the other hand, students are more prepared for courses in the major and likely have more interest and engagement in these courses. Overall, the two possibilities offset one another, leading to an ambiguous effect of INMAJOR on S. There is also a potential effect on K. If a course is in a student's major and the student is trying to preserve the major GPA, the student's K for that course could increase, increasing the probability of exercise. Because of the different channels and implications for how INMAJOR might affect the probability of exercise, we leave the sign of the expected coefficient as indeterminate and only resolved upon estimation.

We expect demographics to influence the choice to elect pass/fail. Demographic data include gender, class year, race, and US state of home address. The gender variable (GEN) is a dummy variable that is 1 if the student is female and 0 if the student is male. Only those two choices are available in the registrar's records. The choices for race are Asian, Biracial, Black, Latino, Nonres (Non-resident), Unknown, and White. Dummy variables are created for each of these choices (ASIAN, BIRACIAL, BLACK, LATINO, NONRES, and UNKNOWN) with White being the choice if all the other dummy variables are zero. We do not have access to parental income, so we expect to see the effect of parental income manifest itself in the racial dummy variables. New York City was especially hard-hit by COVID-19 in early 2020, with a high proportion of US COVID deaths as well as tight living conditions making studying difficult during lockdown. While we do not have the ability to create a dummy variable for New York City, we instead create one for students who have a New York State home address (NYS). Class year was used to create the dummy variables: SOPH, JUNIOR, and SENIOR with freshman being the choice if all the other dummy variables are zero.

Table 1 provides summary data for the student-related variables used in our analysis. The student population is evenly split between male and female and is predominantly White (65%). Seniors and juniors are slightly over-represented in the sample. Students with a home address in New York State make up about one-fifth of the sample.

Table 2 provides summary data for the course-related variables used in our analysis. Nearly 47% of all classes have A- as the lowest letter grade in the class. Pass/fail was elected for 15% of all course enrollments. Approximately 70% of all courses are from majors that require calculus and about 70% of all courses are within a student's major.

Table 1
Summary Data – Students

Total Number of Students	2462
Gender (%)	
Male	50.0
Female	50.0
Race (%)	
Asian	4.4
Biracial	3.3
Black	5.2
Latino	7.4
Non-Resident	9.9
Unknown	5.0
White	64.8
Class Year (%)	
2020	23.2
2021	20.1
2022	28.4
2023	28.2
New York State Address (%)	
Yes	16.8
No	83.2

Table 2
Summary Data – Classes

Total Number of Class Records	10175
Class with lowest letter grade of A- (%)	
Lowest Grade is A- or better	46.8
Lowest Grade less than A-	53.2
Pass/Fail or Letter Grade (%)	
Letter Grade	85.1
Pass	14.9
Course in Calculus Requiring Major (%)	
Yes	69.7
No	30.3
Course in Student's Major (%)	
Yes	69.3
No	30.7

Figure 3 provides detail on the final grade frequencies. Although pass/fail makes up about 15% of grades, A and A- combine to equal 64% of all grades awarded. This is consistent with the Walker and Grimm (2021) result showing a 0.278 grade inflation for students at the University of Oregon in spring 2020. The distribution of high grades is a motivating reason for including HIGH_GRADE_DUM in our analysis.

Figure 3
Final Grade Frequencies

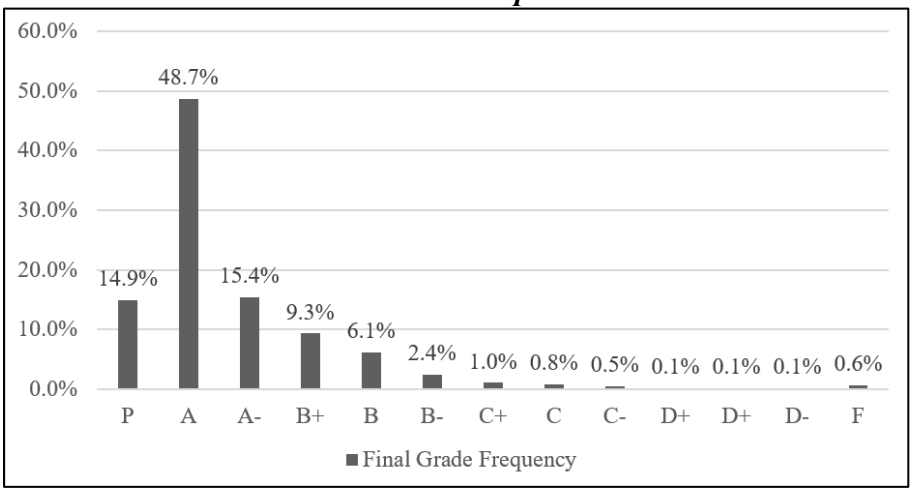
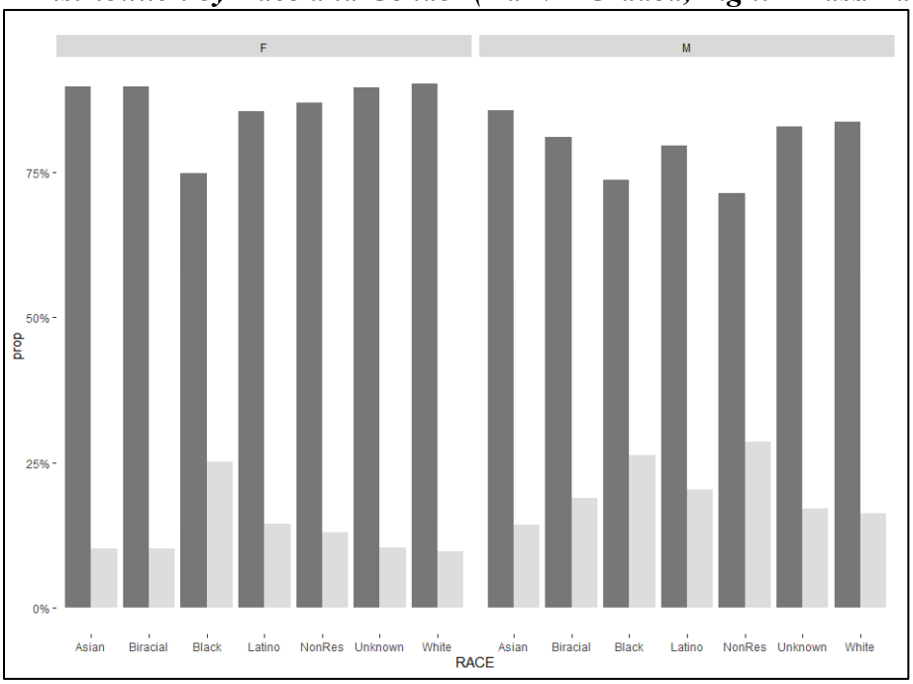


Figure 4 shows the pass/fail election percentages by race and gender. Significant variation exists. By building a model for optimal exercise of the pass/fail election and considering demographic factors, we attempt to disentangle this raw data and identify the demographics factors that are not subsumed by overall GPA or course grading policy.

Figure 4
P/F Distribution by Race and Gender (Dark = Graded, Light = Pass/Fail)



Results

Table 3 presents the pass/fail logistic regressions results. Statistically significant variables include CUM_GPA, HIGH_GRADE_DUM and demographic dummy variables: GEN, SENIOR, BLACK, LATINO and NONRES. The logistic regression is run on the dataset where all courses and students are pooled, i.e., each course record per student is an individual record in the dataset.

CUM_GPA and HIGH_GRADE_DUM both have negative coefficients, as expected. A higher GPA and overall higher grades in a course both lead to a lower likelihood that a student elects pass/fail. GEN has a negative coefficient. Women are less likely to elect pass/fail than men. SENIOR has a positive coefficient showing that seniors, having been sent home in the middle of their last semester, are more likely to elect pass/fail. BLACK, LATINO, and NONRES all have positive coefficients, as expected, although LATINO is statistically significant only at the 10% level. The signs of the BLACK, LATINO, and NONRERS dummy variables are consistent with the hypothesis that marginalized groups are more likely to exercise the option to elect pass/fail.

Table 3
Logistic Regression Results

Dependent variable: PF	
Independent Variable	**Coefficient (p)**
GEN	-0.392*** (0.061)
SENIOR	0.472*** (0.083)
JUNIOR	0.097 (0.087)
SOPH	-0.095 (0.079)
CALC_REQUIRED	0.018 (0.068)
INMAJOR	-0.042 (0.067)
ASIAN	-0.067 (0.152)
BIRACIAL	0.030 (0.165)
BLACK	0.459*** (0.115)
LATINO	0.192* (0.108)
NONRES	0.592*** (0.087)
UNKNOWN	-0.012 (0.140)
NYS	-0.007 (0.080)
CUM_GPA	-0.734*** (0.062)
HIGH_GRADE_DUM	-1.098*** (0.102)
Constant	0.815*** (0.222)
Observations	10,175
Log Likelihood	-4,003.661
Akaike Inf. Crit.	8,039.322

Note: *p<0.1; **p<0.05; ***p<0.01

Since the logistic model is a non-linear model, the marginal effect of a change in an independent variable varies across the sample. We follow Greene (2008) to compute average marginal effects that represent the difference in the probability of the dependent variable based upon a unit change in the independent variable. The average marginal effect for a variable is computed by calculating the marginal effect for a particular independent variable at each observation using the actual values of the other independent variables for that observation. These individual marginal effects are then averaged across all observations.

The average marginal effect estimates the effect of a one unit change on the probability of a student electing pass/fail. For a dummy variable, this is the difference between the probabilities of the two states. Table 4 shows the average marginal effects for the independent variables.

Table 4
Average Marginal Effects

Variable	AME	Std Error	Z	Prob	Lower	Upper
GEN	-0.0468	0.0073	-6.42	0.00	-0.0611	-0.0325
SENIOR	0.0564	0.0099	5.67	0.00	0.0369	0.0759
JUNIOR	0.0116	0.0104	1.11	0.27	-0.0088	0.0320
SOPH	-0.0113	0.0095	-1.19	0.23	-0.0299	0.0073
CALC_REQUIRED	0.0022	0.0081	0.27	0.79	-0.0136	0.0180
INMAJOR	-0.0050	0.0080	-0.62	0.53	-0.0206	0.0107
ASIAN	-0.0080	0.0181	-0.44	0.66	-0.0436	0.0276
BIRACIAL	0.0036	0.0197	0.18	0.86	-0.0351	0.0422
BLACK	0.0548	0.0137	4.00	0.00	0.0280	0.0817
LATINO	0.0229	0.0129	1.78	0.08	-0.0023	0.0481
NONRES	0.0707	0.0104	6.80	0.00	0.0503	0.0911
UNKNOWN	-0.0015	0.0168	-0.09	0.93	-0.0343	0.0314
NYS	-0.0009	0.0095	-0.09	0.93	-0.0195	0.0178
CUM_GPA	-0.0876	0.0073	-12.03	0.00	-0.1019	-0.0734
HIGH_GRADE_DUM	-0.1024	0.0071	-14.42	0.00	-0.1163	-0.0885

Students elected pass/fail in 14.9% of classes and that can be thought of as the unconditional probability of electing pass/fail. Being Black increases the probability of pass/fail election by 5.5%. This variable may be capturing the disparate effects of COVID-19 on the Black community as well as the effect of lower parental income (since we did not have that variable available for analysis). A one-point increase in GPA (equivalent to a full letter grade change) decreases probability of pass/fail election by 8.8%. Although the predicted effect of GPA on pass/fail election was ambiguous, a higher GPA leads to a lower probability of pass/fail election. Being female decreases probability of pass/fail election by 4.7%, even holding constant GPA, which is higher for females.

Being in a class whose final revealed grades are not less than A- (HIGH_GRADE_DUM = 1) decreases the probability of pass/fail election by 10.2%. Students appear perceptive about the grading policy of their classes. Being a non-resident increases the probability of pass/fail election by 7.1%. Non-resident students experienced significant disruption from the sudden dislocation from campus. Being a senior increases the probability of pass/fail election by 5.6%. Thus, having been sent home for their final semester, some seniors appear to have "checked out" of class.

Overall, the policy appears to have given flexibility to the groups for whom it was intended. Students with lower GPAs and from marginalized groups who face significant disruption from the shift to remote learning appear to have taken advantage of the pass/fail option. While some seniors do seem to "check out", the policy appears to have been used more by the groups it was intended to benefit.

Conclusion

When colleges interrupted the spring 2020 semester and moved to remote work, many colleges implemented policies to mitigate the effect of this disruption on students. One such policy was an enhanced pass/fail policy. At Lafayette College, the goal of this policy was to "to make evaluation of student learning more flexible this semester so that it equitably takes into account the diverse academic needs, interests, and concerns of our students and the very different pedagogies being employed for the balance of this academic year."

To assess whether this policy has its intended effect, we model the exercise of the pass/fail option. We then implement a logistic model which includes variables related to the option exercise and certain demographic and other descriptive features of the students. We find that students who were most expected to be adversely affected by the disruption of the learning environment were considerably more likely to elect pass/fail. This includes Blacks, Non-residents, and Latinos. We also find that men were more likely to elect pass/fail than women and that there was a significant senior "check out" effect.

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Enterprise to Equity Value Adjustments in DCF Valuation: A Case Study of Coca-Cola

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This case study examines the challenges faced in practice when determining equity value and share price for firms characterized by complexities including dilutive securities, equity investments, noncontrolling interests, leases, and underfunded pension plans. Coca-Cola Company is used as a case study to demonstrate how to accurately account for such items when deriving equity value and implied share price from enterprise value.

Key words: Discounted cash flow, valuation, Enterprise value, Valuation adjustments, noncontrolling interests, equity method investments

Context

After completing her graduate studies, Andrea Coleman landed her dream job working as an equity research associate at a bulge bracket investment bank. She began working in the summer of 2020 in the consumer staples group. Unlike many of her colleagues, Andrea did not intern at an investment bank. Her prior work experience was as a financial analyst at Mondelez International. While she had a solid understanding of corporate finance, Andrea found some aspects of valuation challenging and was eager to master these and further strengthen her credentials.

As a research associate in consumer staples, Andrea is responsible for covering several firms in the sector including Coca-Cola Company (Coke). She works with Jeff Boadle, the senior analyst for her team, to understand industry and firm trends, analyze financial statements, build Excel models for financial forecasting, and assist with stock valuations.

Coke just released its fourth quarter 2020 results and Andrea has been tasked with updating the financial model and discounted cash flow (DCF) valuation. The forecast and valuation are nearly complete, and the results are summarized below. Jeff has reviewed and approved the forecast update and asked Andrea to complete the equity valuation and implied share price. He has been experiencing some health issues and is headed to the hospital for diagnostic testing. Before leaving he told Andrea to be certain she used an accurate share count since Coke has dilutive securities and to carefully consider enterprise value to equity adjustments.

Discounted Cash Flow Valuation for Coca-Cola Company						
	Actual 31-Dec-20	Projected 31-Dec-21	Projected 31-Dec-22	Projected 31-Dec-23	Projected 31-Dec-24	Projected 31-Dec-25
All numbers in USDm unless otherwise stated						
Forecast year		1	2	3	4	5
Free cash flows						
EBIT	9,770	11,029	11,907	12,761	13,957	14,755
Long-term effective tax rate	20.0%	20.5%	22.0%	22.0%	22.0%	22.0%
NOPAT	7,816	8,768	9,287	9,954	10,886	11,509
Depreciation & amortization		1,600	1,640	1,688	1,740	1,798
Change in operating working capital & other		(175)	(200)	(245)	(290)	(300)
Capex		(1,900)	(2,000)	(2,075)	(2,150)	(2,225)
Unlevered free cash flow		**8,293**	**8,727**	**9,322**	**10,186**	**10,782**
WACC	6.0%					
Long term growth rate	2.0%					
Terminal value from perpetuity						**274,938**
PV of free cash flows		7,824	7,767	7,827	8,069	8,057
PV of terminal value						205,450
Enterprise value	**244,993**					

In the valuation above, EBIT is earnings before interest and after tax. NOPAT is net operating profit after tax. WACC is the weighted average cost of capital used as the discount rate, and PV is present value.

The enterprise value of $244.993 billion is calculated by summing the present value of the unlevered free cash flows over the five years plus the present value of the terminal value. The terminal value captures value from Year 6 on and is calculated using the perpetuity method. Here the terminal value equals the year 5 free cash flow of 10,782 * (1 + long term growth rate) / (WACC – long term growth rate) = 274,938.

Andrea now needs to determine equity value and implied share price. She remembers from her studies that to find equity value from enterprise value you must subtract debt and other claims. Implied share price equals the equity value divided by the diluted shares currently outstanding. To confirm the process, she does some quick research and is puzzled since the formula for enterprise value (EV) seems to vary depending on the source. Her quick search of enterprise and equity value adjustments returns the following:

Corporate Finance Institute:

- EV = (share price * number of shares) + total debt - cash

Investopedia:

- EV = Market capitalization + Debt + Preferred stock – cash – cash equivalents

Aswath Damodaran (NYU):

- EV = Debt + Equity – Cash – Nonoperating assets

S&P Capital IQ uses the term TEV or total enterprise value:

- TEV = market capitalization – Cash & short-term investments + Total debt + Preferred Equity + Total Minority Interest – Long-term marketable securities.

Andrea reaches out to a more senior colleague who notes her confusion is well founded since there is not a consensus on the terminology used to describe firm value. Some refer the value of the entire firm (as opposed to just the equity component) as ***enterprise value*** while others distinguish the core operations and refer to this as enterprise value and use the term ***total enterprise value*** for the value of the firm including any nonoperating assets and other investments. Unfortunately, there is often ambiguity surrounding what is included in enterprise value. As an example, he notes that one of the firms he follows, Nestle, owns about 20% of L'Oreal. When discussing the enterprise value of Nestle some analysts focus on the core Nestle operations while others would include the value of the equity investment in L'Oreal. The stock price of Nestle includes the stake in L'Oreal but when valuing Nestle many analysts will focus on valuing the core food business in a DCF and will then add the value of the stake in L'Oreal. Andrea is aware that Coke has investments, and these are shown on the balance sheet and detailed in the notes. She must consider what to do with this as she completes the valuation.

Her colleague adds that in practice some equity research analysts may also adjust for noncontrolling interests, leases, investments, underfunded pension plans and other non-operating assets. However, this seems to depend on the analyst and the industry. His advice is to look at the financial statements and the notes to the financial statements to determine if the DCF has fully captured the value of all assets and adjusted for all claims. Andrea is not certain if Coke has leases and underfunded pensions but there is noncontrolling interest (NCI) shown on the balance sheet. She is unclear about exactly what this is but recalls she has seen valuations where this is an adjustment to get from enterprise value (EV) to equity value.

Andrea lists the tasks she needs to complete:

1. Identify any claims not included in the DCF that will reduce equity value and share price.
    a. Identify potential claims.
    b. Research noncontrolling interest and determine how to treat this.
    c. Determine if Coke has leases and if so, should she make any adjustments for the leases.
2. Identify any assets that have not been valued in the DCF that increase equity value and share price.
    a. Find the value of cash and cash equivalents.
    b. Identify and research other assets that may impact value including investments.
    c. Determine if these assets have been incorporated in the DCF valuation.
3. Adjust enterprise value from the DCF valuation by the above items to determine equity value.
4. Find the diluted shares outstanding.
5. Convert the equity value to implied share price.

For this case study use the just released 2020 10K to assist in calculations (in practice the 10Q and other SEC filings may also be of help but for this case study we focus on the 10K to utilize the more detailed disclosures). You can access the 2020 10K from Coke's website under investor relations at the following link. Annual Filings (10-K) :: The Coca-Cola Company (KO)

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NOTE: For most cases published in the *Journal of Financial Education*, the Teaching Note is not included with the case but instead made available to interested subscribers upon request. For this present case study, however, because the Teaching Note is an integral part of the case, it is included below. Subscribers are free to use the case and the Teaching Note in their classes without specific permission from the author or from the *Journal of Financial Education*.

Enterprise to Equity Value Adjustments in DCF Valuation: A Case Study of Coca-Cola Teaching Note

Synopsis

In thirty years spent working as a banker, consultant, professor of finance and trainer of investment banking and equity research analysts and associates, I have developed, audited or reviewed thousands of discounted cash flow valuations (DCF) of firms. While much has been written about best practice in developing forecast assumptions, estimating terminal value and calculating an appropriate weighted average cost of capital, far less attention has been devoted to the complex adjustments sometimes required to move from the firm value estimated in the DCF valuation to derive the implied equity value and share price. Yet in my experience, many mistakes, such as ignoring or underestimating the impact of noncontrolling interests, underfunded pension obligations and dilutive securities, derive from errors in these adjustments and can significantly impact equity and share price valuations. Confusion surrounding the new accounting for operating leases has introduced another potential source of error.

In this case study, Coca-Cola Company is used as a case study to review best practice tips consistent with guidelines at major investment banks.

Intended Use

A common assignment in an upper-level undergraduate course in finance or in an MBA or graduate program in finance, is to value a firm and determine the implied share price. This case study extends the typical analysis to highlight complexities faced when moving from enterprise value to equity value and implied share price.

The case uses Coke's 2020 10K and the link is provided in the case study but an instructor might also use the case as an opportunity to highlight the information provided on a firm's website under investor relations. Instructors might discuss updating a forecast using information from the 10Q, 8K and Management calls. Finally the case provides an opportunity to talk about the equity research role and perhaps opportunities available on both the buy and sell side.

Suggested Approach

The case is designed to have students focus on understanding enterprise value and the adjustments from enterprise value to equity value and share price. Emphasis is on calculating diluted shares outstanding using the treasury method and identifying and valuing assets and claims not incorporated in the DCF valuation. If appropriate, the steps in building a forecast for a DCF valuation can be reviewed. The case information could be altered so that the DCF valuation is only partially complete so an instructor could teach or review the basics of DCF valuation. Alternatively, and depending on the course, student preparation and time available for the

assignment, the instructor can also build the forecasted financial statements. or simply use the assignment to review DCF valuation steps.

The case can be used by providing only the above case information. This less directed approach will be challenging unless students have a firm understanding of valuation. For those without much valuation experience, a directed version of the case would provide the following questions to solve in teams or as homework or instructors could use the case for an in class session on valuation complexities in practice following instruction on the basics of valuation.

Case Questions

Throughout the case exercise, the following can be discussed. It may also be useful to highlight where relevant information can be found in the firm's 10K.

a. What do we value in the DCF calculation of enterprise value?
b. How do we derive equity value from firm value?
c. What claims reduce the value of equity?
d. Are there assets not valued in the DCF that belong to common shareholders?
e. Once we have equity value, how do we determine the share count to use to calculate implied share price?

Case Answers/Discussion Points

a. What do we value in the DCF calculation of enterprise value?

Firm Valuation using the Discounted Cash Flow Valuation Technique

There are numerous valuation techniques used to find firm value depending on the context – for example, a minority stake versus a controlling stake - and the approach – valuation relative to peers (often called comparables analysis) versus intrinsic valuation based on the present value of future cash flows (commonly referred to as DCF).

Here we focus on applying the DCF technique to estimate firm value of a minority stake by finding the present value of projected future cash flows where the discount rate used is the weighted average cost of capital (WACC).

The cash flows are often referred to as ***unlevered free cash flows*** and are typically defined as:

*Earnings before interest and taxes *(1 – firm tax rate)*

Plus depreciation and amortization

Less investment in capital expenditures

Less any new investment in operating working capital and other long term operating items

The DCF approach to firm valuation is widely used in practice and financial education and is included in most corporate finance, investments and valuation texts. Once the firm value has been determined, the implied equity value can be estimated from the firm value and used to determine share price.

What is valued in the DCF calculation of enterprise value?

Free cash flow begins with EBIT and includes adjustments for taxes paid, non-cash expenses and new investments in working capital, plant and equipment and perhaps other long term operating assets and liabilities. The results for Coca-Cola are shown above. Unlevered free cash flow does not include any repayment of debt or any interest expense due the providers of debt nor does it include interest income earned on cash or income from other investments. Therefore, these items are not part of the enterprise value. The resulting enterprise value is the value of Coca-Cola's core business operations.

Enterprise Value Versus Equity Value

In any valuation it is essential to distinguish the value of the entire business – often referred to as enterprise or firm value – from the value belonging to the common shareholders – equity value. An analogy commonly used is that we can differentiate the value of a house from the equity of the owner of the house. The difference is the mortgage used to fund the house. The value of the house includes both the debt and equity.

The formula for enterprise value (EV) varies depending on the source. Here are some common definitions that were provided in the case.

Corporate Finance Institute:

EV = (share price * number of shares) + total debt - cash

Investopedia:

EV = Market capitalization + Debt + Preferred stock – cash – cash equivalents

Aswath Damodaran (NYU):

EV = Debt + Equity – Cash – Nonoperating assets

S&P Capital IQ uses the term TEV or total enterprise value:

TEV = market capitalization – Cash & short-term investments + Total debt + Preferred Equity + Total Minority Interest – Long-term marketable securities.

As the case notes, in practice equity research analysts, investment bankers and other valuation professionals may also adjust for noncontrolling interests, leases, investments, underfunded pension plans and other non-operating assets.

b. How do we derive equity value from firm value?

Consider what adjustments to make when deriving equity value from enterprise value. Ask:

- How was free cash flow determined?
- What obligations and claims not captured in free cash flow will impact the cash flows available to common equity owners (question c)?
- What nonoperating assets does the firm own that are not valued in free cash flow but provide value to common equity owners (question d)?

Discussion point

The Coca-Cola balance sheet appears below.

First, identify nonoperating assets and any obligations that should be considered in deriving equity value from enterprise value.

Then ask if the balance sheet value of each account is likely to represent market value. If not, how can we estimate market value?

Start with the balance sheet. Many students will recognize that we need to add the value of cash, short term investments and marketable securities since the income from these assets does not impact EBIT and so the value of the assets is not incorporated in the DCF valuation. Many will be unsure about how to treat equity method and other investments. Students may be unsure of what noncontrolling interests are and whether to consider these.

THE COCA-COLA COMPANY AND SUBSIDIARIES
CONSOLIDATED BALANCE SHEETS
(In millions except par value)

December 31,		2020		2019
ASSETS				
Current Assets				
Cash and cash equivalents	$	6,795	$	6,480
Short-term investments		1,771		1,467
Total Cash, Cash Equivalents and Short-Term Investments		8,566		7,947
Marketable securities		2,348		3,228
Trade accounts receivable, less allowances of $526 and $524, respectively		3,144		3,971
Inventories		3,266		3,379
Prepaid expenses and other assets		1,916		1,886
Total Current Assets		19,240		20,411
Equity method investments		19,273		19,025
Other investments		812		854
Other assets		6,184		6,075
Deferred income tax assets		2,460		2,412
Property, plant and equipment — net		10,777		10,838
Trademarks with indefinite lives		10,395		9,266
Goodwill		17,506		16,764
Other intangible assets		649		736
Total Assets	$	87,296	$	86,381
LIABILITIES AND EQUITY				
Current Liabilities				
Accounts payable and accrued expenses	$	11,145	$	11,312
Loans and notes payable		2,183		10,994
Current maturities of long-term debt		485		4,253
Accrued income taxes		788		414
Total Current Liabilities		14,601		26,973
Long-term debt		40,125		27,516
Other liabilities		9,453		8,510
Deferred income tax liabilities		1,833		2,284
The Coca-Cola Company Shareowners' Equity				
Common stock, $0.25 par value; authorized — 11,200 shares; issued — 7,040 shares		1,760		1,760
Capital surplus		17,601		17,154
Reinvested earnings		66,555		65,855
Accumulated other comprehensive income (loss)		(14,601)		(13,544)
Treasury stock, at cost — 2,738 and 2,760 shares, respectively		(52,016)		(52,244)
Equity Attributable to Shareowners of The Coca-Cola Company		19,299		18,981
Equity attributable to noncontrolling interests		1,985		2,117
Total Equity		21,284		21,098
Total Liabilities and Equity	$	87,296	$	86,381

c. What claims reduce the value of equity?

Consider the claims which may impact equity value. These commonly include debt and preferred stock. Other claims may exist including noncontrolling interests, leases, underfunded pension plans, unfunded environmental remediation or litigation liabilities.

Debt

If a firm has debt, these claims reduce the value to common shareholders and must be considered. The value of debt is available on the balance sheet and even if the debt trades publicly it is often close to book value so the adjustment is generally straightforward. Note that debt includes only interest bearing, financial liabilities not operating liabilities such as accounts payable. Since unlevered free cash flow did not adjust for interest expense or repayment of principal we have not yet accounted for the debt. We incorporate interest expense through the discount rate and then subtract the current value of outstanding debt when deriving equity value from enterprise value. At 12/31/2020 Coke had Loans and notes payable of $2.183 billion, Current maturities of long term debt of $485 million and Long-term debt of $40.125 billion for a total debt of $42.793 billion.

Preferred stock

Coke does not have preferred stock. If it did, we would see the account on the balance sheet listed at book value. While the book and market values of debt are often very close, the market value of publicly trading preferred stock may differ from book value so it is worth checking the current price of preferred stock that trades publicly when making an adjustment for preferred stock. If the market value exceeds the book value we would over value the equity if we adjusted from EV to equity using book values.

As an example, JP Morgan has preferred stock with a balance sheet value at 9/30/2021 of 34.838 billion. While the preferred stock trades publicly, the 52 week range is fairly narrow so adjusting at book value to derive equity value seems reasonable. Best practice is to use market values when available.

Noncontrolling Interest

Firms will often invest in the equity of other firms. The stake of the investment may range from a small percentage to full ownership of 100% of the firm. Under U.S. Generally Accepted Accounting Principles (GAAP) when a firm's investment stake comprises voting control, the subsidiary must be **fully** consolidated. If the parent has voting control but owns less than 100% of the consolidated subsidiary this results in a Noncontrolling interest (NCI) which some refer to as a minority interest. In the consolidated financial statements, the parent firm reports 100% of the subsidiary's income and expenses. The income attributable to the NCI is reported at the bottom of the income statement and the equity invested is shown in the equity section of the balance sheet. It is essential to adjust for NCI since the equity owners of the parent firm should only value the stake in the subsidiary that they own. As an example: if Firm A owns 80% of Company B and has voting control it will report 100% of Company B's revenues and expenses in its consolidated income statement. But since Firm A only actually has a claim on 80% of Company B, the share price of Firm A should only reflect 80% of the value of Company B. If a DCF valuation is not adjusted for the NCI stake in Company B, Firm A's shares will be overvalued.

Coke has Equity attributable to noncontrolling interests shown in the equity section of its balance sheet. The value at 12/31/2020 is shown as $1.985 billion. When a firm makes an investment in another firm the investment is recorded at cost. Simplifying a bit, the accounting for NCI works similar to the accounting for retained earnings where the value rises over time with share of net income and falls with dividends. Just as retained earnings may not reflect the market value of equity, the value of the NCI on the balance sheet may not reflect market values.

There are several possible approaches to estimate market value. If the subsidiary is a separately listed firm that trades publicly, use the current share price and number of shares held to estimate value. If it does not trade publicly, check the notes to the financial statements to see if the firm provides any information on fair value. A third approach is to use the net income attributable to the NCI and apply a Price/Earnings (P/E) multiple to estimate value. The P/E multiple should be appropriate given the subsidiary's operations.

A portion of Coke's income statement is shown below, highlighting the net income attributable to the NCI. In early 2020, Coke was trading at a P/E multiple of about 30. The subsidiaries related to the NCI are in the same general business so we will apply the multiple of 30 as an estimate of the market value of the NCI.

Consolidated Net Income	**7,768**	8,985	6,476
Less: Net income (loss) attributable to noncontrolling interests	**21**	65	42
Net Income Attributable to Shareowners of The Coca-Cola Company	**$ 7,747**	$ 8,920	$ 6,434

Using the P/E multiple of 30 and multiplying by the 2020 NCI income we get 21 million * 30 = $630 million. This is well below the value on the balance sheet. But earnings at the time were quite low due to Covid related issues so we can check by using the 2019 earnings of $65 million and the value = 30 * 65 = 1.950 billion.

Summarizing, the book value of the NCI is $1.985 billion. The value estimated using a P/E multiple is $1.950 billion, which is quite close to the book value of 1,985 so we will use the book value. US GAAP requires firms to write down the value of any assets if the balance sheet value exceeds market value. Here we can then assume the book value of NCI is not overstated.

Discussion point

At this point we have identified three standard claims we would deduct from enterprise value to get to the residual equity value: debt, preferred stock and noncontrolling interest. What if the firm has other potential obligations like underfunded pension plans?

Note **defined contribution pension plans** are not an issue since the firm makes annual contributions and has no further obligation. These obligations are captured in expenses and have already impacted free cash flow through EBIT. **Defined benefit pension plans** are a risk for firms since they bear the risk of funding future uncertain obligations related to pension and other benefits. In the US the plans must be at least partially funded so there is an annual expense related to the pension and health care obligations recorded in the income statement. But what if the plan is not fully funded?

When in doubt it helps to consider two firm which are identical except in the one respect you are analyzing. Here, assume one firm has fully funded its pension and health care obligations while the other firm has not. The deficit is an obligation which reduces the equity value of the second firm compared to the first, so must be considered.

Underfunded Pension Plans

Pension accounting is notoriously complicated, but the funded status of defined benefit plans can be an important valuation consideration especially in firms where there is a large unfunded balance. An underfunded pension obligation may not be obvious when looking at the balance sheet and Coke does not show any such liability. However, the notes to the financial statements contain information about the funded status of pension and other post-retirement benefit plans. Note 13 of the 2020 10K reports on Coke's pension and postretirement benefit plans. An excerpt follows. The last line in the table shows that the pension obligations exceeded plan assets by 775 million dollars at the end of 2020 while other benefits had an underfunded value of 373 million dollars. This totals 1.148 billion dollars.

In the US, additional contributions to improve the funded status would generally be tax deductible expenses, so we can look at the obligation on an after-tax basis. Using a tax rate of 22% we can estimate this obligation as 1.148*(1-.22) = 895 million dollars. These values can be considered market values since the assets and obligations are estimated at least annually.

Other unfunded or underfunded obligations, perhaps related to environmental remediation or a lawsuit may also be considered as claims on equity. The key is to consider whether the free cash flow estimate includes an expense related to the obligation. If not, and if it is likely to occur, then it represents a claim on equity that should be considered. Such future liabilities should be described in the 10K.

Obligations and Funded Status

The following table sets forth the changes in benefit obligations and the fair value of plan assets for our pension and other postretirement benefit plans (in millions):

	Pension Plans		Other Postretirement Benefit Plans	
Year Ended December 31,	**2020**	2019	**2020**	2019
Benefit obligation at beginning of year[1]	**$ 8,757**	$ 8,015	**$ 757**	$ 719
Service cost	**112**	104	**11**	9
Interest cost	**235**	291	**21**	28
Participant contributions	**1**	1	**12**	20
Foreign currency exchange rate changes	**67**	(28)	**(1)**	(2)
Amendments	**3**	(1)	**—**	—
Net actuarial loss[2]	**746**	931	**22**	71
Benefits paid	**(485)**	(537)	**(59)**	(86)
Settlements[3]	**(81)**	(19)	**—**	—
Curtailments[3]	**(15)**	(2)	**6**	(2)
Special termination benefits	**2**	1	**—**	—
Other	**72**	1	**—**	—
Benefit obligation at end of year[4]	**$ 9,414**	$ 8,757	**$ 769**	$ 757
Fair value of plan assets at beginning of year	**$ 8,080**	$ 7,429	**$ 339**	$ 289
Actual return on plan assets	**830**	1,111	**51**	38
Employer contributions	**30**	36	**—**	—
Participant contributions	**1**	1	**7**	15
Foreign currency exchange rate changes	**97**	(26)	**—**	—
Benefits paid	**(419)**	(453)	**(1)**	(3)
Settlements[3]	**(53)**	(18)	**—**	—
Other	**73**	—	**—**	—
Fair value of plan assets at end of year	**$ 8,639**	$ 8,080	**$ 396**	$ 339
Net liability recognized	**$ (775)**	$ (677)	**$ (373)**	$ (418)

Operating leases

The accounting for operating leases has recently changed so that under US GAAP, operating leases now appear on balance sheets as a liability offset by a right of use asset. Prior to the new rule, Accounting Standards Codification Topic 842, financial leases were on balance sheet and treated like debt, while operating leases were off balance sheet. Further complicating the issue, under IFRS operating leases no longer exist, all leases are considered finance leases. To facilitate

comparison across firms and accounting standards, most data providers including Cap IQ, FactSet and Bloomberg treat operating leases like finance leases and therefore include operating leases as debt in enterprise value calculations. This may be appropriate, especially when calculating enterprise value for earnings multiples such as Enterprise value / EBITDAR. However, care must be taken in a DCF valuation not to double count the operating lease. If the free cash flow is calculated after incorporating the expenses related to operating leases, then this claim has already been incorporated into the valuation. If we adjust for the operating lease again in the EV to equity calculation, we will double count the claim and equity will be undervalued. Alternatively, we could calculate free cash flow ***pre*** operating lease by adding the lease expense back. In our DCF the operating lease expense is included in operating expenses deducted to get to EBIT so we do not need to make an adjustment.

Information on operating and financial leases must be provided in the notes. Coke provides information in Note 9. If we wanted to account for operating leases outside the DCF calculation, we would need to project and add back the projected lease expense in our forecasted years (in 2020 =) $353 million and instead include the lease liability of $1,622 million in total debt. I do not recommend this since we would then need to consider future capital expenditure and depreciation equivalents of operating leases as is done with finance leases. For DCF valuation it is more straightforward to include operating lease as an expense in free cash flow and then we do not need to adjust for operating leases in the EV to equity adjustments. Finance leases will be adjusted for, like debt, since the related expenses on the income statement are allocated to depreciation and interest expense and are not included in free cash flow.

NOTE 9: LEASES

We have operating leases primarily for real estate, aircraft, vehicles, and manufacturing and other equipment.

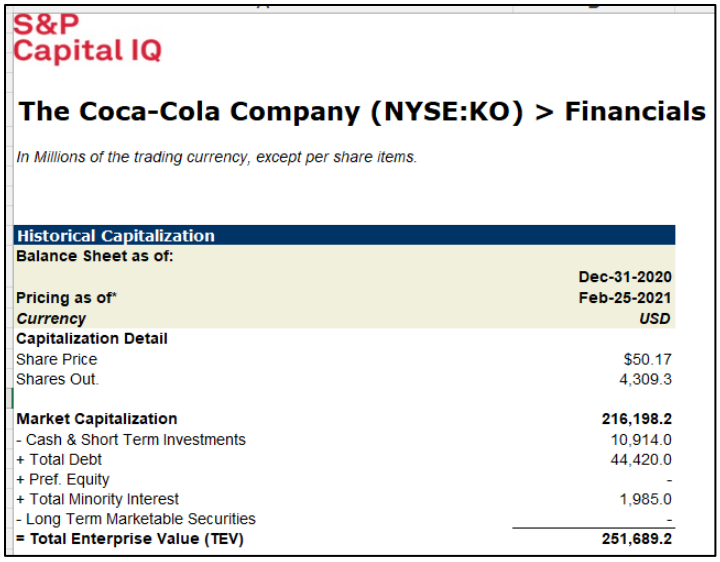
Balance sheet information related to operating leases is as follows (in millions):

December 31,		2020	2019
Operating lease ROU assets[1]	$	1,548	$ 1,372
Current portion of operating lease liabilities[2]	$	322	$ 281
Noncurrent portion of operating lease liabilities[3]		1,300	1,111
Total operating lease liabilities	$	1,622	$ 1,392

[1] Operating lease ROU assets are recorded in the line item other assets in our consolidated balance sheet.
[2] The current portion of operating lease liabilities is recorded in the line item accounts payable and accrued expenses in our consolidated balance sheet.
[3] The noncurrent portion of operating lease liabilities is recorded in the line item other liabilities in our consolidated balance sheet.

We had operating lease costs of $353 million and $327 million for the years ended December 31, 2020 and 2019, respectively. During 2020 and 2019, cash paid for amounts included in the measurement of operating lease liabilities was $365 million and $339 million, respectively. Operating lease ROU assets obtained in exchange for operating lease obligations were $528 million and $308 million for the years ended December 31, 2020 and 2019, respectively.

Below is the enterprise value from S&P Capital IQ. Note it includes operating leases in the debt calculation so uses 44,420 which is equal to the total debt we used of 42,793 plus the operating lease value of 1,622 plus an additional 5 of financial derivatives.



S&P Capital IQ

The Coca-Cola Company (NYSE:KO) > Financials

In Millions of the trading currency, except per share items.

Historical Capitalization	
Balance Sheet as of:	
	Dec-31-2020
Pricing as of*	**Feb-25-2021**
Currency	***USD***
Capitalization Detail	
Share Price	$50.17
Shares Out.	4,309.3
Market Capitalization	**216,198.2**
- Cash & Short Term Investments	10,914.0
+ Total Debt	44,420.0
+ Pref. Equity	-
+ Total Minority Interest	1,985.0
- Long Term Marketable Securities	-
= Total Enterprise Value (TEV)	**251,689.2**

Summarizing – the claims on equity we have identified are:

Claims not included in EV		
Debt	42,793	
Preferred stock	0	
NCI	1,985	
Underfunded retirement obligations (after-tax)	895	
Operating leases		*ignored here since the lease epxpense is captured in free cash flow*

d. Are there assets not valued in the DCF that belong to common shareholders?

Discussion point

Are there assets which provide value to the equity owners which have not been included in enterprise value?

A quick review of the balance sheet shows cash, short-term investments, marketable securities, Equity method investments and other investments. Consider whether EBIT includes income related to any of these items. Generally, EBIT should exclude interest income and investment income, and these have been excluded in our forecasted EBIT. Shareholders have a claim on these assets but if they have not been incorporated into enterprise value, we need to add these items at market value to get to an accurate equity value.

THE COCA-COLA COMPANY AND SUBSIDIARIES
CONSOLIDATED BALANCE SHEETS
(In millions except par value)

December 31,		2020
ASSETS		
Current Assets		
Cash and cash equivalents	$	6,795 $
Short-term investments		1,771
Total Cash, Cash Equivalents and Short-Term Investments		8,566
Marketable securities		2,348
Trade accounts receivable, less allowances of $526 and $524, respectively		3,144
Inventories		3,266
Prepaid expenses and other assets		1,916
Total Current Assets		19,240
Equity method investments		19,273
Other investments		812
Other assets		6,184
Deferred income tax assets		2,460
Property, plant and equipment — net		10,777
Trademarks with indefinite lives		10,395
Goodwill		17,506
Other intangible assets		649
Total Assets	$	87,296 $

Cash and Short-Term Investments

Page 73 of Coke's 10K includes the following. This suggests we should include the cash and equivalents of $6,795 million but not the restricted cash since the restricted cash has been set aside for pension obligations.

Cash, Cash Equivalents, Restricted Cash and Restricted Cash Equivalents

We classify time deposits and other investments that are highly liquid and have maturities ofthree months or less at the date of purchase as cash equivalents or restricted cash equivalents, as applicable. Restricted cash and restricted cash equivalents generally consist of amounts held by our captive insurance companies, which are included in the line item other assets on our consolidated balance sheet. We manage our exposure to counterparty credit risk through specific minimum credit standards, diversification of counterparties and procedures to monitor our concentrations of credit risk.

The following table provides a summary of cash, cash equivalents, restricted cash and restricted cash equivalents that constitute the total amounts shown in the consolidated statements of cash flows (in millions):

December 31,		2020	2019	2018
Cash and cash equivalents	$	6,795 $	6,480 $	9,077
Restricted cash and restricted cash equivalents included in other assets[1]		315	257	241
Cash, cash equivalents, restricted cash and restricted cash equivalents	$	7,110 $	6,737 $	9,318

[1] Amounts represent restricted cash and restricted cash equivalents in our solvency capital portfolio set aside primarily to cover pension obligations in certain of our European and Canadian pension plans. Refer to Note 4.

From Note 16 (excerpt below) we can conclude that the reported $1,771 of short-term investments reflects market value.

Other Fair Value Disclosures

The carrying amounts of cash and cash equivalents; short-term investments; trade accounts receivable; accounts payable and accrued expenses; and loans and notes payable approximate their fair values because of the relatively short-term maturities of these financial instruments. As of December 31, 2020, the carrying amount and fair value of our long-term debt, including the current portion, were $40,610 million and $43,218 million, respectively. As of December 31, 2019, the carrying amount and fair value of our long-term debt, including the current portion, were $31,769 million and $32,725 million, respectively.

Marketable Securities

On page 83 of the 10K Coke reports information related to its marketable securities, valued on the balance sheet at $2,348 million. If we add the $330 million in equity securities that are fairly valued to the trading and available for sale securities of $38 million and $1,980 million, we arrive at the $2,348 million reported on the balance sheet and can conclude these values approximate market value.

Equity Securities

The carrying values of our equity securities were included in the following line items in our consolidated balance sheets (in millions):

	Fair Value with Changes Recognized in Income
December 31, 2020	
Marketable securities	$ 330
Other investments	762
Other assets	1,282
Total equity securities	$ 2,374

The carrying values of our debt securities were included in the following line items in our consolidated balance sheets (in millions):

	December 31, 2020	
	Trading Securities	Available-for-Sale Securities
Cash and cash equivalents	$ —	$ —
Marketable securities	38	1,980
Other assets	—	285
Total debt securities	$ 38	$ 2,265

Investments

When a firm makes an investment in another firm the investment is recorded at cost. In investments of 20 to 50%, the investment is usually reported over time using an approach called the equity method. Simplifying a bit, the accounting works similar to the accounting for retained earnings where the value rises over time with share of net income and falls with dividends. As with NCI the value on the balance sheet may not approximate market value.

If income from investments is **NOT INCLUDED in EBIT** (and often it is not) then the value of these investments must be added to the core enterprise value estimated in the DCF valuation to find equity value. We have not included income from investments in the EBIT values used in the DCF valuation so must value and adjust for these investments since shareholders of Coke have a claim on the investments.

Coca-Cola reports Other investments of $812 million on the balance sheet. Note 4 (part of which is shown below) describes the Other investments.

Equity Securities

The carrying values of our equity securities were included in the following line items in our consolidated balance sheets (in millions):

	Fair Value with Changes Recognized in Income	Measurement Alternative — No Readily Determinable Fair Value
December 31, 2020		
Marketable securities	$ 330	$ —
Other investments	762	50
Other assets	1,282	—
Total equity securities	$ 2,374	$ 50

$762 million of the amount in Other investments is fair valued while the remaining $50 million does not have a readily determinable value. Since most of this has been fairly valued, we can adjust for this account by adding the $812 million value reported on the balance sheet to enterprise value.

Coca-Cola reports Equity method investments of $19,273 million on the balance sheet. Note 6 provides details on the fair values and carrying values. The table shows that the equity method investments total $19,273 million of which $12,604 million relate to publicly traded securities. The publicly traded securities have a market value of $23,129 million. The difference of $10,525 million (fair value less carrying value) has not been reflected in the balance sheet value. This suggests the book value differs significantly from market value so we should estimate the market value of the equity method investments. There are several approaches we could use.

1. Add the difference of $10,525 million to the balance sheet value of $19,273 million. This totals $29,798 million and incorporates the additional value of the publicly trading investments.
2. Look at the market/book ratio of the investments that are fair valued and apply this multiple to the TOTAL equity method investment (including the equity investments that do not trade publicly). The fair value of publicly traded securities of $23,129 divided by the corresponding book value of $12,604 equals 1.835. If we multiply the balance sheet value of the total equity investments of $19,273 by 1.835, we can estimate market value at $35,366 million. This value is higher than approach 1 since we are assuming there is also a fair value differential on the investments that do not trade publicly.
3. Apply a P/E multiple to the income from the investments. The second table below shows Income from equity investments of $978 million. If we value this using a P/E multiple of 30 (as noted earlier this is where Coke traded at the time), the result is $29,340.

The three approaches lead to fairly similar results and suggest a market value exceeding the book value. We will estimate the value at approximately $30,000 million, based on the three approaches.

From Note 6:

Company equity method investments	**$ 19,273**	$	19,025

Net sales to equity method investees, the majority of which are located outside the United States, were $13,041 million, $14,832 million and $14,799 million in 2020, 2019 and 2018, respectively. Total payments, primarily related to marketing, made to equity method investees were $547 million, $897 million and $1,131 million in 2020, 2019 and 2018, respectively. The decrease in net sales to, and payments made to, equity method investees in 2020 was primarily due to the impact of the COVID-19 pandemic. The decrease in payments made to equity method investees in 2019 was primarily due to changes in bottler funding arrangements. In addition, purchases of beverage products from equity method investees were $452 million, $426 million and $536 million in 2020, 2019 and 2018, respectively. The decrease in purchases of beverage products in 2019 was primarily due to reduced purchases of Monster products as a result of the North America refranchising activities. Refer to Note 2.

The following table presents the difference between calculated fair value, based on quoted closing prices of publicly traded shares, and our Company's carrying value in investments in publicly traded companies accounted for under the equity method (in millions):

December 31, 2020	Fair Value	Carrying Value	Difference
Monster Beverage Corporation	$ 9,444	$ 4,020	$ **5,424**
Coca-Cola European Partners plc	4,383	3,959	**424**
Coca-Cola FEMSA, S.A.B. de C.V.	2,657	1,632	**1,025**
Coca-Cola HBC AG	2,657	1,282	**1,375**
Coca-Cola Amatil Limited	2,222	707	**1,515**
Coca-Cola Consolidated, Inc.	661	169	**492**
Coca-Cola Bottlers Japan Holdings Inc.	522	522	—
Coca-Cola İçecek A.Ş.	440	197	**243**
Embotelladora Andina S.A.	143	116	**27**
Total	$ 23,129	$ 12,604	$ **10,525**

The Company's equity method investments include, but are not limited to, our ownership interests in Coca-Cola European Partners plc ("CCEP"), Monster, AC Bebidas, Coca-Cola FEMSA, Coca-Cola HBC AG ("Coca-Cola Hellenic") and Coca-Cola Bottlers Japan Holdings Inc. ("CCBJHI"). As of December 31, 2020, we owned approximately 19 percent, 19 percent, 20 percent, 28 percent, 23 percent and 19 percent, respectively, of these companies' outstanding shares. As of December 31, 2020, our investments in our equity method investees in the aggregate exceeded our proportionate share of the net assets of these equity method investees by $8,762 million. This difference is not amortized.

A summary of financial information for our equity method investees in the aggregate is as follows (in millions):

Year Ended December 31,[1]	2020	2019	2018
Net operating revenues	$ 69,384	$ 75,980	$ 75,482
Cost of goods sold	41,139	44,881	44,933
Gross profit	$ 28,245	$ 31,099	$ 30,549
Operating income	$ 7,056	$ 7,748	$ 7,511
Consolidated net income	$ 4,176	$ 4,597	$ 4,646
Less: Net income attributable to noncontrolling interests	54	63	101
Net income attributable to common shareowners	$ 4,122	$ 4,534	$ 4,545
Company equity income (loss) — net	$ 978	$ 1,049	$ 1,008

Implied Equity Value

Pulling our adjustments together, we can find the implied equity value. Recall we valued operating leases as an expense in free cash flow so there is no need to adjust for operating leases.

Enterprise value	**276,043**
Less Claims not included in EV	
Debt	42,793
Preferred stock	0
NCI	1,985
Underfunded retirement obligations (after-tax)	895
Operating leases	
Total	**45,673**
Plus Assets not included in EV	
Cash	6,795
Short-term Investments	1,771
Marketable securities	2,348
Equity method investments	30,000
Other investments	812
Total	**41,726**
Equals Equity value	**272,096**

e. Once we have equity value, how do we determine the share count to use to calculate implied share price?

Implied Share Price

Next, find the implied share price by dividing the equity value by the current number of shares outstanding.

Discussion point

Should we use the current basic shares outstanding, or do we need to consider dilutive securities?

The current shares outstanding are shown on the front of the 10K. In valuation, always use current rather than weighted average shares outstanding since the relevant number of shares is the number at the valuation date.

The aggregate market value of the common equity held by non-affiliates of the Registrant (assuming for these purposes, but without conceding, that all executive officers and Directors are "affiliates" of the Registrant) as of June 26, 2020, the last business day of the Registrant's most recently completed second fiscal quarter, was $185,656,336,397 (based on the closing sale price of the Registrant's Common Stock on that date as reported on the New York Stock Exchange).

The number of shares outstanding of the Registrant's Common Stock as of February 22, 2021 was 4,309,311,676.

Next consider potential dilution. We assume "the market" is rational and prices in any potential dilution since investors would be expected to pay less for shares in a firm where the investment stake could be diluted. Dilution can occur from stock options, restricted stock units, and other potentially dilutive and convertible securities.

Note 12 details options. Generally, the treasury method approach is used to calculate the impact of stock options on diluted shares outstanding. Common practice is to use total outstanding options (rather than vested since all outstanding options can be potentially dilutive) that are in the money and estimate impact assuming any cash related to exercising the option is used to minimize dilution.

Assume the current price of Coke is $50.88. Then find the impact on shares as:

(Current price – Weighted Avg Exercise price)/Current price * Number of options.

= (50.88 – 40.55)/50.88 * 88 = 17.8663522

Stock option activity during the year ended December 31, 2020 was as follows:

	Shares (In millions)	Weighted-Average Exercise Price	Weighted-Average Remaining Contractual Life	Aggregate Intrinsic Value (In millions)
Outstanding on January 1, 2020	105	$ 38.43		
Granted	7	59.38		
Exercised	(23)	35.67		
Forfeited/expired	(1)	53.82		
Outstanding on December 31, 2020	88	$ 40.55	4.16 years	$ 1,289
Expected to vest	87	$ 40.44	4.11 years	$ 1,283
Exercisable on December 31, 2020	72	$ 38.43	3.29 years	$ 1,188

The total intrinsic value of the stock options exercised was $453 million, $609 million and $721 million in 2020, 2019 and 2018, respectively. The total number of stock options exercised was 23 million, 34 million and 47 million in 2020, 2019 and 2018, respectively.

In addition to stock options, Coca-Cola has performance-based share units, performance-based restricted stock units, and time-based restricted stock units. None of these are included in the current shares outstanding but are all potentially dilutive. We can think of these as having an exercise price of zero so simply add the number of associated shares. Take care with the units. In the tables below Coke reports shares in thousands while the options table above uses millions. Reporting in different units throughout a 10K is common and is a cause of numerous analyst errors.

The following table summarizes information about performance share units and growth share units based on the target award amounts:

	Performance Share Units and Growth Share Units (In thousands)	Weighted-Average Grant Date Fair Value
Outstanding on January 1, 2020	6,831	$ 38.57
Granted	1,983	57.00
Conversions into restricted stock units[1]	(2,662)	35.30
Paid in cash equivalent	(5)	38.20
Canceled/forfeited	(504)	46.36
Outstanding on December 31, 2020[2]	5,643	$ 45.89

The following table summarizes information about performance-based restricted stock units based on the performance share units' certified award level:

	Restricted Stock Units (In thousands)	Weighted-Average Grant Date Fair Value
Nonvested on January 1, 2020	3,195	$ 39.70
Conversions from performance share units	3,785	35.30
Vested and released	(3,189)	39.72
Canceled/forfeited	(63)	35.71
Nonvested on December 31, 2020	3,728	$ 35.30

The total intrinsic value of restricted shares that were vested and released was $91 million, $118 million and $305 million in 2020, 2019 and 2018, respectively.

Time-Based Restricted Stock and Restricted Stock Unit Awards

Prior to the release date, time-based restricted stock and restricted stock units granted from the 2014 Equity Plan do not entitle recipients to vote or receive dividends and will be forfeited in the event of the recipient's termination of employment, except for reasons such as death or disability. Certain other time-based restricted stock awards entitle recipients to vote and receive dividends. The fair value of the restricted stock and restricted stock units expected to vest and be released is expensed on a straight-line basis over the vesting period. As of December 31, 2020, the Company had outstanding nonvested time-based restricted stock and restricted stock units totaling approximately 4,162,000, most of which do not have voting rights or pay dividends.

The following table summarizes information about time-based restricted stock and restricted stock units:

	Restricted Stock and Restricted Stock Units (In thousands)	Weighted-Average Grant Date Fair Value
Nonvested on January 1, 2020	4,054	$ 40.73
Granted	1,354	53.90
Vested and released	(735)	41.52
Canceled/forfeited	(511)	46.30
Nonvested on December 31, 2020	4,162	$ 44.18

These can be added to arrive at the total diluted shares outstanding to use to find implied share price.

Share in millions:

# shares - basic	4,309.311676
Net shares from:	
options	17.866352
performance share units	5.643000
perf based restricted stock	3.728000
Time based restricted stock	4.162000
diluted shares	**4,340.711028**

Now that we have the total diluted number of shares outstanding at the valuation date, we can calculate the implied share price by dividing equity value of $272,096 million by the diluted shares outstanding. **The result is an implied share price of $55.53**.

If we ignored the complex adjustments to our DCF valuation and made only simple adjustments, we would get a significantly different result - $49.45 - as shown below.

Basic Valuation Ignoring Complex Adjustments

Enterprise value	**244,993**
Basic Adjustments only	
Debt	42,793
Preferred stock	
NCI	
Underfunded retirement obligations (after-tax)	
Operating leases	
Total	**42,793**
Basic Adjustments only	
Cash	6,795
Short-term Investments	1,771
Marketable securities	2,348
Equity method investments	
Other investments	
Total	**10,914**
Equity value	**213,114**
Basic shares outstanding	4,309.311676
diluted shares	**4,309.311676**
Implied share price	$49.45

During 2021 Coke traded between about $48 and $59. Valuing the firm in early 2021 based on our DCF valuation, we might conclude the shares are slightly under-valued.

Observations and Conclusions

Making appropriate adjustments when deriving equity value from enterprise value can be challenging. It helps to start by reviewing the firm's balance sheet to identify claims on equity holders and assets belonging to equity holders that are not included in the DCF free cash flow based enterprise value. The notes to the financial statements provide detailed information to assist in this task.

Errors commonly made during the adjustment process are to ignore or value at book value claims like noncontrolling interests and underfunded pensions. When such claims are ignored or undervalued, equity and share price are over-valued. At the same time, the firm may have assets which have not been included in enterprise value and these can add potential value to equity holders. Again, these adjustments should be done at market value. Finally, it is essential to use an accurate share count and this involves considering the impact of potentially dilutive securities. The basic valuation above ignores many of these complexities and shows a common but overly simplistic approach to estimating equity value from enterprise value. In this example the result is a lower implied equity value and stock price of $49.45 versus our earlier price of $55.53. Depending on the nature of the complex adjustments the movement could be in the opposite

direction for other valuations. For example, equity is often over-valued when large under-funded pension obligations are ignored or noncontrolling interests are ignored or valued at book value when the market value is significantly higher.

Disguised Information

Andrea and Jeff are made up but the setting and tasks are typical.