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Financial Capability of Undergraduate Students: An Analysis of Time Comparison Data

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There is an ongoing need to study the effectiveness of financial education courses in higher education to inform best practices. This paper describes a study of the impact of a semester-long undergraduate personal finance course on students' financial capability, including measures of financial knowledge, performance of positive financial practices, and self-assessed financial confidence. Data were collected from students in 2017 and 2022 with two cohorts almost equally spaced apart from the official start of the COVID-19 pandemic in March 2020. Thus, this study provided a unique opportunity to study course impacts pre- and post-pandemic. Analyses were made of respondents' financial capability before and after completing the course in each subsample and then time-period comparisons were made. Evidence was found in both time periods of increased financial knowledge and confidence and performance of positive financial practices.

Introduction

The statistics are startling! In general, college students lack financial literacy and feel ill prepared and underconfident to manage their finances (Ezarik, 2022; Zapp, 2019). Over 50% of participants in a nationally representative sample of over 30,000 college students reported feeling least prepared to manage their money compared to managing time, finding resources, keeping up with coursework, and staying organized (Zapp, 2019). In addition, 36% of the respondents already had more than \$1,000 in credit card debt and 60% had taken or intended to take out student loans. Many were not fully aware of the consequences of having unpaid bills. Only 35% of their sample reported having ever taken a personal finance course in high school.

Research suggests that college students often make financial decisions without adequate information, guidance, and support (Johnson et al., 2016). For many students, college is the first time they enter the financial system (i.e., banks, insurance companies, and stock exchanges). With little or no money management experience or knowledge of personal finance, they often lack the skills necessary for a smooth transition into adulthood or newfound independence. College students also make decisions that can have lasting financial implications for years to come (Johnson et al., 2016) and their decision-making is complicated by unfamiliar terminology and intricate documents. In addition to inexperience and incomprehension, the amount of information available online can be overwhelming and unnerving. There are multiple sources of inaccurate information easily accessible to students (e.g., some TikTok videos and false online testimonials) and students may not be able to properly evaluate the reliability and credibility of available content. Financial education can curate and streamline personal finance instruction, ensuring that students

are given accurate, up-to-date information to prepare them to make informed financial decisions throughout their lives (Durband & Britt, 2012).

Although there has been an increase in the number of university financial education programs in recent years, including workshops and one-on-one consultations (McCarthy, 2021), there is still an ongoing need for financial education in higher education (Durband & Britt, 2012; Zapp, 2019). There is also a need to study the effectiveness of existing college personal finance courses to inform best practices. This paper describes a study of undergraduate students' financial capability before and after taking an undergraduate personal finance course. Data were collected from students in 2017 and 2022, resulting in two subsamples almost equally spaced apart from the official start of the COVID-19 pandemic in March 2020. Thus, this study provided a unique opportunity to study and compare course impacts in pre- and post-pandemic time periods.

Review of Literature

To inform this study of undergraduate students' financial capability before and after completing an introductory personal finance course, this literature review is divided into three sections: 1. studies of college student financial capability, 2. studies about college student debt, and 3. studies of the impact of college personal finance courses on measures of financial capability.

College Student Financial Capability

Jorgensen and Salva (2010) studied the financial literacy of young adults using a sample of 420 college students. They found evidence that many young adults have inadequate financial knowledge and poor money management practices, and that financial knowledge had a large and significant influence on financial attitude, which in turn had a large and significant influence on financial behavior. In addition, students' perception of parental influence on their finances did not have an effect on their financial knowledge. Similarly, an earlier study by Avard et al. (2005), of incoming college freshmen, concluded "recent high school graduates are not knowledgeable about everyday financial matters" (p. 321). On a 20-question test of basic financial knowledge, the average score was 34.8% with a median score of 32.5%. Only one student in the sample received the highest score of 80%.

Existing literature has well established that financial literacy is lower among women than men, at all ages, and that men do better than women on tests of financial knowledge (Lusardi & Mitchell, 2011). Similarly, older adults do better on financial knowledge tests than respondents in early adulthood (Lin et al., 2018; Yakoboski, Lusardi, & Hasler, 2022). As an example, in the 2022 P-Fin Index study comparing the financial knowledge of five generational cohorts, Gen Z (which includes current college students) had the lowest percentage of questions answered correctly (42%) versus 54% for baby boomers and the oldest silent generation (Yakoboski et al., 2022).

A study by Al-Bahrani, Buser, and Patel (2020) explored gender-based gaps in financial literacy among a sample of 529 college students at three institutions. They found that, for male students, objective math ability drives financial literacy while, for females, self-efficacy- and not objective ability- is predictive of financial literacy. The study suggests a need to increase math confidence levels at early ages because math plays a large role in the understanding of personal finance. Similarly, Brau, Holmes, and Israelsen (2019) studied the financial literacy of nearly 1,500 undergraduates with a 40-question survey and found evidence that male students are significantly

better informed about financial topics than female students. They also found that experiential learning activities have a significant and positive impact on increasing financial literacy.

College Student Debt

In an era of increasing student loan debt and student loan defaults, the issue of financial literacy among college students is even more critical. In April 2022, outstanding student loan debt totaled almost \$1.9 trillion, according to the Student Loan Debt Clock (2022). Approximately 43.4 million borrowers had federal student loans and the average student loan balance was \$37,113, and even higher including private loan debt. The average public university student with student loan debt borrows \$30,030 to attain a bachelor's degree (Hanson, 2022). Throughout the second and third quarters of 2020, following the onset of COVID-19, there was a 375% increase in student debt forbearance and an 82% decrease in debt repayment (Bustamante, 2020).

Due to rising numbers of loans and loan balances, student loan debt is now the second-largest consumer debt category in terms of outstanding amount owed. It is second only to mortgage debt and surpasses the amount owed on credit cards, auto loans, and other borrowing (Fuinhas et al., 2019; Hanson, 2021). For students with loans to attend graduate and professional schools, average outstanding student debt is in the high five- to six figures (Helhoski & Lane, 2022).

Many college students also owe credit card debt. According to a 2019 report by Sallie Mae and Ipsos, college students' credit card use has risen in recent years. In 2019, a majority of young adults had credit cards, including 57% of college students. They had, on average, five cards versus three in 2016 and their average balance was \$1,183, a 31% increase over average card balances in 2016 (Majoring in Money, 2019). The overall increase was attributed, in part, to rewards available for using retail store cards. Nearly one in five students with credit cards has only one.

Community college students reported more financial stress than students attending 4-year universities (Popovich et al., 2020). Studies show that community-college students are less likely to pay bills on time or receive financial support and guidance from their families. In a national survey of student financial wellness, 29.7% of community-college students claimed they experienced high-stress levels due to credit card debt. In comparison, 12.3% of students at 4-year public institutions and 13.6% of students at 4-year private institutions reported the same (Popovich et al., 2020).

Many students do not realize the responsibilities involved with taking out a loan. They may be unaware that loans are borrowed money that needs to be paid back with interest or what future loan payments will be. Likewise, they might not understand that they are not required to take out the total amount of financial aid offered to them and find themselves borrowing more than needed, resulting in higher expenses that must be paid (Federal Student Aid, 2017; Johnson et al., 2016). Additionally, without general money management knowledge and skills, students may struggle to repay their debts after graduation. They often find out late that student loan and credit card payments demand a large part of their take-home pay, making it challenging to support a desirable lifestyle without going more into debt than they already are (Durband & Britt, 2012).

Impact of College Personal Finance Courses

Financial literacy can significantly impact future financial well-being. Having financial resources and knowledge at an early age can inform wise financial decisions as an adult (Panos & Wilson, 2020). Studies of the impact of college financial education courses generally report

positive impacts upon student learners. As noted above, Brau et al. (2019) found that, while some types of formal learning activities (e.g., taking classes and reading or watching financial news regularly) enhance financial literacy, the most significant impact is associated with experiential learning activities including receiving income, managing a personal checking or credit card account, and stock market participation. These researchers recommended additional on-campus experiential-learning activities, e.g., simulations, internships, and student-managed investments.

Wann (2016) studied the impact of teaching personal finance to college students and found that 42 students saved a total of \$30,198 in a 15-week semester with an average savings of \$719 per student. Other positive results were that many students began to save and budget regularly and planned to start investing at a younger age and avoid the pitfalls of credit cards. Even collegiate financial education short of a full-semester course can have benefits. Rosacker and Rosacker (2016) found benefits accrued to students from a so-called “parsed approach to teaching financial literacy” (p. 1), i.e., a series of modules on ten topics commonly found in personal finance textbooks.

Brau et al. (2019) stated in their conclusion that “the efficacy of financial education among college students will only be fully revealed later in life as they have a full opportunity to engage in the financial realities of life” (p. 189). To that end, Xiao and O’Neill (2016) retrospectively studied the impact of financial education on five different measures of financial capability using data from 24,242 respondents to the 2012 National Financial Capability Study. After controlling for demographic and financial variables, respondents who ever received financial education (either from one source or from any combination of three sources: high school, college, and a workplace) had higher scores for all financial capability indicators. In addition, high school, college and workplace financial education variables, individually, showed positive associations with the financial capability indicators, providing statistically significant evidence of positive effects stemming from financial education exposure.

Purpose and Research Questions

This purpose of this study was to explore and contrast measures of undergraduate students’ financial capability before and after taking an undergraduate basic personal finance course in two time periods, spaced five years apart, almost equidistant from the start of the COVID-19 pandemic. This study adds to existing literature about the impact of college level financial education. Three research questions guided this study:

1. What were pre- and post-test results from introductory personal finance courses completed in 2017?
2. What were pre- and post-test results from introductory personal finance courses completed in 2022?
3. What were similarities and differences between 2017 and 2022 pre- and post-test results?

Methodology

This study examined undergraduate students’ financial capability before and after completing a personal and family financial planning course. Students completed a pre- and post-test with the “big three” financial literacy questions (Lusardi & Mitchell, 2011) as well as questions about financial behaviors such as tracking income and expenses, paying bills on time, checking their

credit report, saving money for emergencies, and paying credit card balances in full. Confidence in their ability to make financial decisions needed for their life situation was also examined.

The course, *Introduction to Personal and Family Financial Planning*, was the source of respondent data for this study. The course seeks to fill gaps in financial literacy and financial capability among college students by providing financial education and life skills needed to make informed decisions in everyday life and across the life cycle. Students earn points that convert to letter grades throughout the semester by completing three exams, chapter homework assignments, and a four-part financial project, based on their own financial situations, that personalizes content related to topics including budgeting, credit, and saving/investing. The course syllabus is available at [URL is removed for blind review]. Courses in both years were taught 100% online by the same instructor.

During the spring 2017 semester, students ($N = 176$) completed a financial literacy pre-test during the first week of class and a post-test during the final week of class. The pre/post-test included the “big three” financial literacy questions, created by Lusardi and Mitchell (2011) with questions about compound interest, inflation, and investment diversification. The questions have been used in more than 20 countries to measure financial literacy. In addition to the financial literacy questions, the pre/post-test included questions about seven financial management behaviors such as those noted above (e.g., paying bills on time). Pre- and post-test differences in the financial literacy and financial behavior questions were tested using a chi-square test.

Students’ perceived confidence regarding their ability to make financial decisions for their life situation was tested using a paired sample t-test. Financial confidence was measured by responses to the statement “I feel confident about my ability to make financial decisions needed for my life situation” using a five-point Likert-type scale with responses ranging from “strongly disagree” to “strongly agree.”

The same survey questions were asked of students taking the course five years later in 2022 ($N = 152$). In addition, students who completed the course in 2022 were asked two additional questions regarding if the COVID-19 pandemic affected their financial behaviors and if yes, they were asked to describe how their financial behaviors were affected by the pandemic.

Sample

Demographic characteristics of the 2017 cohort ($N = 176$) include the following: 21% male, 78% female, and 1% other; 4% freshman, 15% sophomore, 38% junior, and 43% senior. The majority of the students were White (74%), Black (16%), or Asian (5%). The majority of the students were not Hispanic (82%). Regarding student loan debt, 40% reported having student loan debt with an average debt of \$18,699 (minimum \$200 and maximum \$150,000).

Demographic characteristics of the 2022 cohort ($N = 152$) include the following: 38% male, 57% female, and 2% other; 5% freshman, 27% sophomore, 38% junior, and 31% senior. The majority of the students were White (71%), Asian (17%), or Black (8%). The majority of the students were not Hispanic (80%). Regarding student loan debt, 19% reported having student loan debt with an average debt of \$16,575 (minimum \$1,500 and maximum \$90,000).

Table 1 presents a complete description of respondent characteristics in both time periods:

Table 1
Characteristics of the Respondents

	2017	2022
	<i>N</i> =176	<i>N</i> =152
Variable	%	%
Gender		
Male	21.4	38.1
Female	78.0	56.9
Other	0.6	2.0
Race		
White	73.8	70.7
Black	16.1	8.2
Asian	5.4	17.0
Other	4.8	4.1
Ethnicity		
Hispanic	18.3	19.7
Not Hispanic	81.7	80.3
Classification		
Freshman	4.1	4.8
Sophomore	15.4	26.5
Junior	37.9	38.1
Senior	42.6	30.6
Student loans		
No	60.4	81.5
Yes	39.6	18.5
<i>M</i>	\$18,699	\$16,575

Results

From the start of the course to the end, compared to students in the 2017 cohort, students in the 2022 cohort were more likely to answer the “big three” questions correctly, report positive financial behaviors, and become more confident in their ability to make financial decisions. For the 2017 cohort, an increase in the proportion of students who answered the “big three” questions correctly was found for the compound interest question and inflation question. However, a chi-square test only found statistically significant differences for the inflation question, indicating that students were more likely to answer the inflation question in 2017 ($X^2(1, N = 155) = 12.11, p = .001$) correctly on the post-test. Similar to 2017, for the 2022 cohort, an increase in the proportion of students who answered the “big three” questions correctly was found for the compound interest question and the inflation question. However, a chi-square test only found statistically significant differences for the compound interest question, indicating that students were more likely to answer the compound interest question in 2022 ($X^2(1, N = 141) = 5.16, p = .05$) correctly on the post-test. Refer to Table 2.

Table 2
2017 and 2022 “Big Three” Questions Answered Correct

“Big Three” Questions	2017		2022	
	Pre %	Post %	Pre %	Post %
Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?	91.8	93.1	94.0	96.2
Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?	81.1	85.3	91.6	93.0
Please tell me whether this statement is true or false. Buying a single company’s stock usually provides a safer return than a stock mutual fund.	84.2	76.8	91.7	85.4

For the 2017 cohort, positive financial behaviors increased across all areas from the pre-test to the post-test and a chi-square test found statistically significant increases in the proportion of students who reported checking their credit report ($X^2 (4, N = 119) = 20.13, p = .001$), tracking income and expenses ($X^2 (4, N = 152) = 26.29, p = .001$), paying bills on time ($X^2 (4, N = 136) = 65.80, p = .001$), having emergency savings ($X^2 (4, N = 150) = 21.977, p = .001$), for those who had debt, reducing their debt ($X^2 (4, N = 85) = 14.92, p = .005$), and for those who had a credit card, paying their credit card balance in full each month ($X^2 (4, N = 98) = 56.68, p = .001$) (see Table 3).

For the 2022 cohort, positive financial behaviors increased across all areas from the pre-test to the post-test and a chi-square test found statistically significant increases in the proportion of students who reported checking their credit report ($X^2 (4, N = 122) = 13.49, p = .009$), having financial goals ($X^2 (2, N = 139) = 18.48, p = .001$), tracking income and expenses ($X^2 (2, N = 141) = 12.12, p = .002$), having emergency savings ($X^2 (4, N = 140) = 9.46, p = .05$), and for those who had a credit card, paying their credit card balance in full each month ($X^2 (4, N = 105) = 18.04, p = .001$) (see Table 3).

Table 3
2017 and 2022 Financial Behaviors Before the Course and Plan to Continue After the Course

Financial Behaviors	2017		2022	
	Pre %	Post %	Pre %	Post %
Pay my credit card balance in full each month	56.9	60.8	71.3	90.8
Have an emergency fund	53.1	69.9	51.0	93.8
Reduce my debt	44.3	70.1	67.1	94.3
Check my credit report	39.4	62.4	52.8	89.7
Have financial goals	76.1	88.6	74.1	93.9
Pay my bills on time	90.7	92.5	96.2	98.6
Track income and expenses	50.0	72.5	40.0	91.2

A paired sample t-test was conducted to compare the mean pre-test score to the mean post-test score for reported confidence. A statistically significant increase in confidence regarding ability to make financial decisions for their life situation. On average, in 2017, students (N = 157) were more confident after completing the course (pre-test M = 3.41, SD = 1.044 and post-test M = 4.04, SD = 1.044). This improvement, 0.63, 95% CI, was statistically significant, $t(156) = -6.47, p = .003$. On average, in 2022, students (N = 142) were more confident after completing the course (pre-test M = 3.54, SD = 0.957 and post-test M = 4.15, SD = 0.867). This improvement, 0.61, 95% CI, was statistically significant, $t(141) = -6.06, p = .001$. Refer to Table 4.

Table 4
2017 and 2022 Confidence Levels

95% CI	2017**		2022***	
	Pre	Post	Pre	Post
I feel confident about my ability to make financial decisions needed for my life situation	3.42	4.06	3.54	4.15

Note: ** $p = .01$; *** $p = .001$

Students in the 2022 cohort were asked if COVID affected their financial behaviors. Of those who responded (n=147), 62% responded “yes”, 23% responded “no”, and 14% responded “I don’t know”. If students responded yes (n=92), they were asked to describe how their financial behaviors were affected by the pandemic. Twenty-two students provided a qualitative response. The small number of respondents limits our ability to interpret the responses in a meaningful way.

Discussion

Similar to results of studies by Brau et al. (2019), Wann (2016), and Xiao and O’Neill (2016), this study of the impact of a semester-long undergraduate personal finance course found evidence of positive results following course completion. Improvements were noted in both the 2017 and

2022 cohorts, in students' financial knowledge, performance of recommended financial practices, and financial confidence, thereby answering research questions #1 and #2 (i.e., What were pre- and post-test results from introductory personal finance courses completed in 2017 and 2022, respectively?). Whether learning resulted from attending course lectures, completing chapter homework, studying for exams, the four-part personalized financial planning project, or any combination of these course components, students benefitted in multiple ways with potentially powerful downstream effects. For example, take the statistically significant increase in students who reported having financial goals at the end of the class. Existing literature has found that the act of setting goals and a so-called "propensity to plan" have been linked with successful financial and health outcomes (O'Neill, Xiao, & Ensle, 2016).

It is concerning that fewer 2022 students (40%) tracked their income and expenses at the beginning of the course compared to 2017 students (50%). However, it is noteworthy that by the end of the course 91% of the 2022 students planned to continue tracking their income and expenses after completing the course compared to 73% of the 2017 students. In addition, 90% of the 2022 students indicated that they would continue to check the credit report compared to 62% of the 2017 students. Regarding reducing debt, 94% of the 2022 students planned to reduce their debt compared to 70% of the 2017 students. It is also very promising that 94% of the 2022 students plan to continue having emergency savings compared to 70% of the 2017 students and 91% of the 2022 students plan to continue paying of credit card balance in full each month compared to only 61% of the 2017 students.

The increase in saving money for emergencies was also noteworthy. This could later prompt savings for future goals. For example, students who start saving in their early 20s have about 45 years of compound interest before their Social Security full retirement age at age 67. If \$3,000 (about \$58 weekly) is invested annually for 45 years with a 6% average return, \$638,230 would accumulate. Ramp this savings up over time and students could easily become millionaires in later life.

Many Americans experienced financial behavior changes during the pandemic (U.S. Bureau of Labor Statistics, 2020). Many students in the 2022 cohort also reported experiencing financial behavior changes during the pandemic. Students noted job loss, decreased discretionary spending, more cautious when spending, increased awareness of the impact of the economy on personal finance, increased saving, and increased online shopping.

Limitations

This study has several limitations which constrain the generalizability of its findings. First, the sample was not randomly selected. Rather, it consisted of a convenience sample of students enrolled in an undergraduate personal finance class at one university who may or may not be representative of students nationwide. Second, respondents self-assessed their own financial practices and their scores could vary from an objective assessment made by a neutral third party. Third, the respondents, by taking the personal finance course as an elective, may have been more likely than other students to be interested in learning about personal finance topics. This could introduce sample bias. Nevertheless, the findings from this study are useful and instructive.

Implications

What are the implications of this study for college financial educators and others who teach young adults about financial topics (e.g., military personal financial managers)? First, begin personal finance instruction with a pre-test to measure students' baseline knowledge and financial behaviors. Doing so can inform subsequent instruction, such as spending more time on topics that students don't understand well or recommended financial practices that students don't currently perform. For example, the 2017 and 2022 subsample results indicated that 53% or fewer of the undergraduate student respondents reported on the pre-test that they checked their credit report or tracked their income and expenses. These topics could be emphasized.

Second, share the positive impacts of undergraduate personal finance courses with students, peer financial educators, and key institutional stakeholders such as college deans and curriculum committees (e.g., via social media and one-page research briefs). Positive "buzz" among students can increase course enrollment and short reports for administrators about course impacts can support advocacy efforts to convert an elective into a course that is required to complete a degree program. As noted above, the survey instrument used for this study is available for use by others.

Third, the course from which student data were derived included multiple learning activities that students were expected to complete. In fact, exams were worth only 25% of grades (and the lowest exam score was dropped!), while the chapter assignments were worth 40% and the four-part personal financial planning project, 35%. In other words, no student could pass this course without getting personally involved in the subject matter. Hands-on learning activities may have affected the statistically significant rise in post-test scores for financial knowledge, behaviors, and confidence and is desirable to make the study of personal finance "personal" to students.

Summary

There is a need for improved financial literacy among college students. As noted above, many students do not understand the high cost of credit, the awesome power of compound interest, or the importance of paying bills on time. Students must be financially literate before they can be financially capable and make informed financial decisions. Results of this study indicate that empowering students with financial education and skills to manage future decisions and challenges may instill knowledge, money management skills, and financial confidence, which can increase the likelihood that they will be able to manage their personal finances effectively.

References

- Al-Bahrani, A., Buser, W., & Patel, D. (2020). Early causes of financial disquiet and the gender gap in financial literacy: Evidence from college students in the southeastern United States. *Journal of Family and Economic Issues*, 41, 556-571. doi.org/10.1007/s10834-020-09670-3.
- Avard, S., Manton, E., English, D., & Walker, J. (2005). The financial knowledge of college freshmen. *College Student Journal*, 39(2), 321-327.
- Brau, J.C., Holmes, A.L., & Isrealsen, C.L. (2019). Financial literacy among college students: An empirical analysis. *Journal of Financial Education*, 45(2), 179-202.
<https://www.researchgate.net/profile/James-Brau-2/publication/353224682>

- Bustamante, J. (2020). *Student loan debt statistics*. EducationData.
<https://educationdata.org/student-loan-debt-statistics>
- Durband, D., & Britt, S. (2012). *Student financial literacy: Campus-based program development*. Springer. doi: 10.1007/978-1-4614-3505-1
- Ezarik, M. (2022). Where the weaknesses are in student financial wellness. *Inside Higher Ed*.
<https://www.insidehighered.com/news/2022/02/25/survey-college-students-need-help-financial-literacy#>
- Federal student aid*. (2017). Washington, DC: U.S. Department of Education.
<https://studentaid.ed.gov/sa/types/loans>
- Fuinhas, J. A., Moutinho, V., & Silva, E. (2019). Delinquency and default in USA student debt as a proportional response to unemployment and average debt per borrower. *Economies*, 7(4), 100. <https://doi.org/10.3390/economies7040100>
- Hanson, M. (2022). *Student loan debt statistics*. Education Data Initiative.
<https://educationdata.org/student-loan-debt-statistics>
- Hanson, M. (2021). *Student loan debt vs. other debts*. Education Data Initiative.
<https://educationdata.org/student-loan-debt-vs-other-debts>
- Helhoski, A. & Lane, R. (2022). *Student loan debt statistics*. NerdWallet.
<https://www.nerdwallet.com/article/loans/student-loans/student-loan-debt>
- Johnson, C., O'Neill, B., Worthy, S.L., Lown, J., & Bowen, C. (2016). What are student loan borrowers thinking? Insights from focus groups on college selection and student loan decision making. *Journal of Financial Counseling and Planning*, 27(2), 184-198. doi: 10.1891/1052-3073.27.2.184
- Jorgensen, B. & Savia, J. (2010). Financial literacy of young adults: The importance of financial socialization. *Family Relations*, 59(4), 465-478. <https://doi.org/10.1111/j.1741-3729.2010.00616.x>
- Lin, J.T., Bumcrot, C., Mottola, G., & Walsh, G. (2019). *Investors in the United States: A report of the national financial capability study*. Washington, DC: FINRA Investor Education Foundation.
https://www.usfinancialcapability.org/downloads/NFCS_2018_Inv_Survey_Full_Report.pdf
- Lusardi, A. & Mitchell, O. (2011). Financial literacy around the world: An overview. *Journal of Pension Economics and Finance*, 10, 497-508. doi:10.1017/S1474747211000448
- Majoring in money: How college students and other young adults manage their finances*. Sallie Mae and Ipsos.
<https://www.salliemae.com/content/dam/slm/Media/images/Research/Majoring-In-Money-Report-2019.pdf>
- McCarthy, T. (2021). Top 50 college financial literacy programs of 2019. *Lendedu*.
<https://lendedu.com/blog/top-college-financial-literacy-programs/>
- O'Neill, B., Xiao, J.J., & Ensle, K. (2016). Propensity to plan: A key to health and wealth? *Journal of Financial Planning*, 29(3), 42-50.
<https://www.financialplanningassociation.org/article/journal/MAR16-propensity-plan-key-health-and-wealth>
- Panos, G. A., & Wilson, J. O. S. (2020). Financial literacy and responsible finance in the FinTech era: capabilities and challenges. *The European Journal of Finance*, 26(4-5), 297-301.
<https://doi.org/10.1080/1351847x.2020.1717569>

- Popovich, J. J., Loibl, C., Zirkle, C., & Whittington, M. S. (2020). Community college students' response to a financial literacy intervention: An exploratory study. *International Review of Economics Education*, 34, 100182. <https://doi.org/10.1016/j.iree.2020.100182>
- Rosacker, K.M. & Rosacker, R. E. (2016). An exploratory study of financial literacy training for accounting and business majors. *The International Journal of Management Education*, 14(1), 2016, 1-7. <https://doi.org/10.1016/j.ijme.2015.11.002>
- Student loan debt clock* (2022). Finaid. <https://finaid.org/loans/studentloandebtclock/>
- U.S. Bureau of Labor Statistics. (2020). *Changes in consumer behaviors and financial well-being during the coronavirus pandemic: Results from the U.S. Household Pulse Survey*. <https://www.bls.gov/opub/mlr/2020/article/changes-in-consumer-behaviors-and-financial-well-being-during-the-coronavirus-pandemic.htm>
- Wann, C. (2017). The impact of teaching financial literacy to college students. *Journal of Economics and Finance Education*, 16(2), 98-109. <https://ssrn.com/abstract=2815150>
- Xiao, J.J. & O'Neill, B. (2016). Consumer financial education and financial capability. *International Journal of Consumer Studies*, 40(6), 712-721. <https://doi.org/10.1111/ijcs.12285>
- Yakoboski, P.J., Lusardi, A., & Hasler, A. (2022). *How financial literacy varies among U.S. adults: The 2022 TIAA Institute-GFLEC personal finance index*. <https://gflec.org/wp-content/uploads/2022/04/TIAA-Institute-GFLEC-2022-Personal-Finance-P-Fin-Index.pdf?x43581>
- Zapp, D. (2019). 2019 *Money matters on campus*. AIG Retirement Services. <https://everfi.com/wp-content/uploads/2019/05/MoneyMatters-2019.pdf>

Effectiveness of Personal Finance Standards: Insights from Tennessee's Teachers

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Since 2013, Tennessee has maintained a nine-week personal finance course as a secondary graduation requirement, making the state one of eight who have done so as of 2023. We survey instructors throughout the state to evaluate the course standards and determine if said standards are working based on the following criteria: effectiveness, student engagement, conciseness, relevance, clarity, and confidence level. Under the criteria, the instructors, although confident in their ability to teach the course, rate the standards a 79 out of 100, citing time to be the greatest factor in limiting the success of their course.

Keywords: Personal Finance, Education, Secondary Education, Survey.

Introduction

The importance of personal finance education has continued to advance in state legislatures. Entities, such as NextGen Personal Finance, have developed annual reports gauging the level of access to financial education across the United States. In the report, a rating system is used to classify the level of access to a personal finance course for students. The highest level of access, or “Guarantee Standard,” is given to a state that maintains a requirement of a standalone semester course to graduate (NGPF, 2023, p.4). This standard distinction only applies to eight states thus far, but seventeen states are in the process of implementing the requirement. The majority maintain the “Silver Standard,” as personal finance education is offered as an elective course, not a requirement for graduation.

Despite these standards being in place and more states implementing course requirements, studies have shown that the level of financial literacy has not progressed enough. Existing research shows evidence that financial literacy is low, even in developed economies and at high levels of educational attainment (Lusardi & Mitchell, 2011). Studies such as theirs are continually being conducted and often display poor test results regardless of the level of overall economic development of the participants' countries. For example, Lusardi and Mitchell also found in the United States that the largest differences in financial literacy occurred in different racial groups. Rural areas, however, are at an advantage in terms of financial education as “smaller schools may have easier times implementing the requirements” (Urban, 2022, p.4).

Most of Tennessee counties are rural, with sixty-five percent of Tennessee falling under 49,999 residents. Twenty percent are sub-urban with 50,000 to 99,999 residents. and fifteen percent, are urban with over 100,000 residents. This definition is based on the USDA's definition of rural provided by their site. We have expanded their definition to include sub-urban, areas between 50,000 and 100,000 residents.

The state is also split into three distinct grand divisions labeled West Tennessee, Middle Tennessee, and East Tennessee, respectively. Each division contains at least one of the major cities. Beyond these cities and their respective counties, there is a mix of suburban and rural counties.

The majority of counties in each division are rural. These divisions have been in place for nearly two hundred years, having first been used to separate the areas in the 1835 Public Chapter 3 of the Tennessee Code, and they are represented on the state's flag as each of the three stars represents a division.

Though Tennessee is diverse in nature, formal education for the majority of its residents ends with a high school diploma. A recent statistic through the census showed that while 88.8 percent of Tennesseans possess a high school diploma or higher, only 29 percent go to obtain a bachelor's degree or higher. Unless financial knowledge was passed down from parents in the home, young adults must rely on the quality of the personal finance education they received in their high school classroom. Personal finance is considered a "just in time" educational topic. Most of the information provided will be most relevant when the time comes to use it. While the course is required to graduate, students may take it any semester while in high school. This makes the relevance of the course material differ between the students as the older students will have been more likely to deal with financial matters than their counterparts. As in any academic institution, the overall goal of secondary education is to get the students to graduation day. A recent study conducted by Dr. Carly Urban contradicts the argument that imposing this course as a graduation requirement could create a barrier for some, essentially lowering graduation rates overall. Her results suggest the opposite; enforcing this requirement either helped or did not affect the graduation rate. She also agreed that "teacher training is often cited as an important component of an effective financial education program" (Urban, 2023, p.6).

Tennessee has maintained the same course standards, with minor amendments in 2016 and 2020, since April 2015. The course includes seventeen standards divided into six categories: Financial Responsibility and Personal Decision-Making; Education, Career, and Income; Planning and Money Management; Credit and Debt; Risk Management; and Savings and Investing (e.g., See Appendix A).

Tennessee's legislation regarding personal finance is the result of the Financial Literacy Program Act of 2010 (TN Code § 49-6-1704). To teach this course, the instructors are trained in a "two-day training workshop provided by one of the three approved organizations: Tennessee JumpStart, the Federal Reserve, or the University of Tennessee Extension" (Barnes, 2019, p.14). The workshop is only required once in an educator's career and supplies the teacher with adaptable material for their classrooms via an online forum. Teachers can also choose to opt out of the workshop if they have endorsements in corresponding fields.

The personal finance requirement also does not include any state-wide standardized tests or official textbooks, due in part to the continuing evolution of finance. To properly teach the subject, the materials provided must account for new developments. For example, a textbook developed only a few years ago would not be able to predict the recent rise of cryptocurrency or the advancements in bank apps and instant transactions via Venmo, CashApp, Zelle, or any app of the same caliber. For this reason, the use of supplementary materials is crucial to the success of these courses as they can be adapted frequently and made available online.

Due to its flexible nature, many outside sources have offered updated sets of financial education standards to be implemented. Pairing these with the supplementary materials provided at training conferences, such as JumpStart, helps prepare the teachers for the classroom as the information provided not only instructs the students but the teachers as well.

When evaluations are done for academic classes, the students are surveyed, and their responses often determine the overall success of the course. Student-led examinations may be sufficient for the courses that are heavily vetted, but for financial education and many others that do evolve so

frequently, it is crucial to obtain the opinion of the instructors to assess how effective the standards and supplementary materials provided are. Moreover, Personal finance courses in Tennessee do not have a state-standard exam to allow for a consistent analysis of how the students processed the material over time. The standards are implemented and taught to the teacher's strengths. It is because of this that surveying the teachers to examine the quality is important. If the standards prove to be difficult to implement for the teachers, the students will also struggle to understand them conceptually. For this reason, the survey is broken down by each section of the standards, allowing the teachers to reread the standards, rate them according to their experience teaching them to the students, and give them the option to provide additional context through personalized responses.

Using Tennessee as the stage to conduct the survey can reveal issues that are beyond its borders. Given Tennessee's status as one of the top personal finance education states, issues that present themselves within the scope of this study could very likely affect other states, particularly ones with similar backgrounds. Evaluating and encouraging growth at this level will also encourage other states to follow suit.

Survey

The following survey allows the teachers to rate each section of the standards by the following metrics: effectiveness, student engagement, conciseness, relevance, clarity, and confidence level. These metrics rely on the teachers' outside expertise with the topic and if the standard adequately teaches the basics of the subject, given that it is formatted for the classroom. The teacher must scale the standard by each of the metrics, with '1' being poor quality and '10' being high quality. We received sixty-four complete responses from three delivery methods: email, paper mail, and conference participants.

Survey Construction

The survey consisted of forty-nine total questions: eight demographic, and forty standard-specific (See Appendix B). The survey assesses the confidence levels of the instructors for each of the six standard sections as well as the individual standards and the resources used to teach them. The survey also allowed for personalized responses to provide additional clarification.

Student Engagement refers to how the students understand and interact with the section. This takes into account the academic progress, active participation, and intrinsic motivation to interact and apply the standards within the course.

Conciseness measures the strictness of the section and how well supplemental documents can be created and followed based on the standards within the section.

Relevance measures how the section will impact the student outside of the classroom. This refers both to the mechanics of the individual standards but also the integration of new technology.

Clarity refers to the presentation of the standards. More specifically, it means that the educational objectives and expectations for students are well-defined, precise, and free from ambiguity.

Effectiveness refers to the overall quality of the section and its ability to navigate the student through the standards. Moreover, it measures how the standards also affect the students' understanding and real-world application of the subject as well as how it develops their soft skills, such as problem-solving, communication, and critical thinking.

Teachers are asked to identify which specific standards, if any, they have difficulty teaching/implementing. They are also asked if they use any supplemental sources provided by the various training programs (JumpStart, FED Reserve, etc) and external sources of information such as EverFi or Dave Ramsey. The survey also allowed for personalized responses by way of a writing block. This qualitative set-up is meant to provide additional clarification for anything the instructor wished to discuss in regard to that section, including more specific issues with a given standard, improvements they felt should be made, new subjects that should be included, etc. These responses allowed for more context, given the answers they provided before, and would allow us to move forward with recommending specific changes within the standards themselves.

Results

General Overview

Although the standards were all close to each other, personal responses revealed various aspects of each section that required improvement as well as supplementary materials and methods used to bridge the gap between the standards and new developments in finance. As shown in the figure, the highest section overall was Planning and Money Management, and the lowest was Risk Management.

Figure 1
Average standard ratings by instructors



Figure 2
Average confidence levels of each section

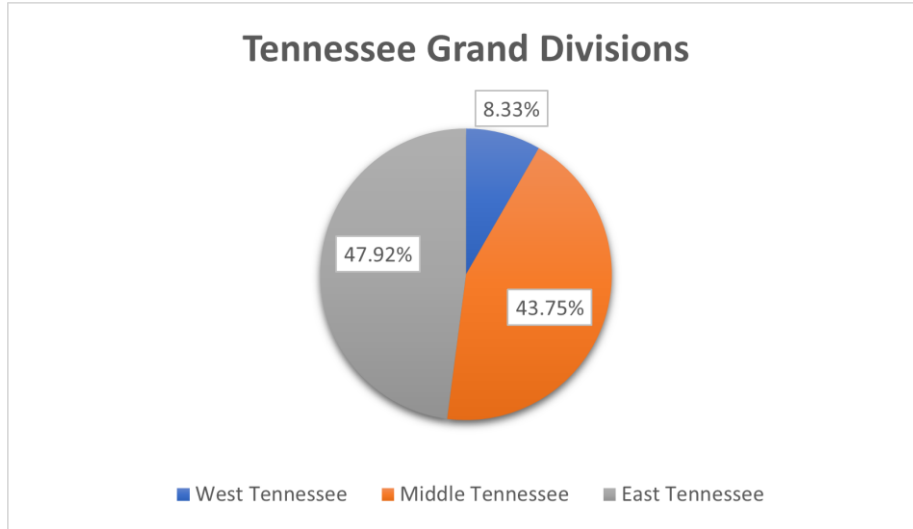


Figures 1 and 2 show the averages of the rating criteria for the survey. Overall, the aggregated average rating for the standards is 76.4 out of 100, and the average confidence in teaching the material is 89.32 out of 100. Instructors were confident in their ability to teach the standards overall. That being said, confidence would fall as the topics in the semester progressed. Relevance received the highest rating, with student engagement receiving the lowest. The standards are shown in chronological order, showing that as the weeks progress, confidence in the subject matter falters. A notable exception was in section two: Education, Careers, and Income, where instructors found difficulty discussing post-graduate opportunities. The personalized responses gave a clearer understanding of the areas that need improvement within the standards as well as preferred supplementary materials that have been used in the courses. The standards were seen as relevant but lacked in their ability to engage the students. Instructors often felt that the standards were bulky in nature, often vague, and their effectiveness overall suffered due to a combination of these factors. It was noted that the quality of the course is reliant on the teacher's ability to understand the standards as well. If the standards themselves are not clear, teachers will not be able to instruct the students in a concise manner.

Demographics

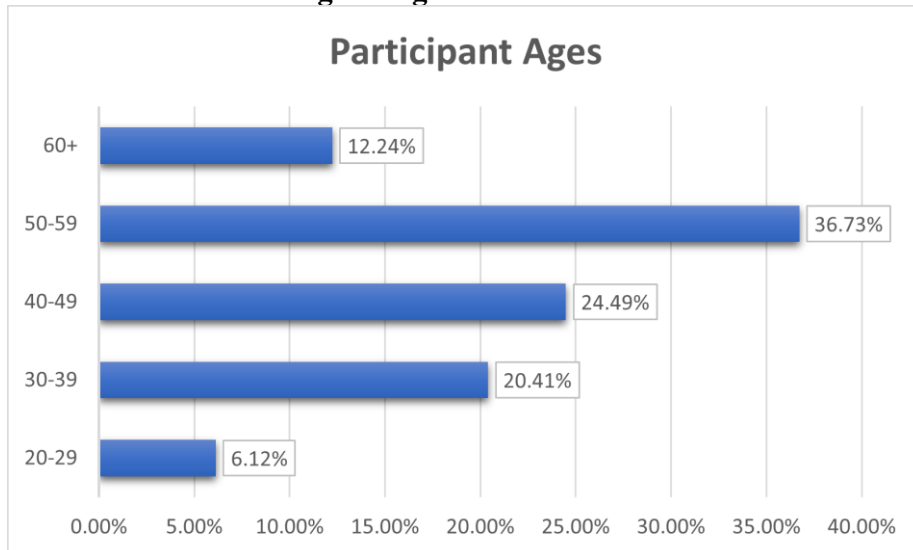
The demographics used for the survey were location, age, and education specific. Teachers were asked to identify which Tennessee Grand Division they were located in, their age, education level, and area of expertise.

Figure 3
Grand Division location of the instructors.



The distribution of the survey via mail targeted all three divisions, and attending the JumpStart conference in June 2022 would have targeted East Tennessee and Middle Tennessee more than West due to distance. This could potentially explain the majority of responses originating from Middle and East Tennessee as opposed to the 8.33 percent from West Tennessee.

Figure 4
Age Range of Instructors



Most of the participants were between the ages of thirty and sixty, with the majority at 36.73 percent falling between fifty to fifty-nine. The smallest category was that of the younger teachers, with only 6.12 percent in their twenties.

The majority of personal finance instructors, at 59.18 percent, hold a master's degree, with 20.41 percent holding an education specialist degree (Ed.S.), and 18.37 percent holding a bachelor's.

Figure 5
Education Level of Instructors

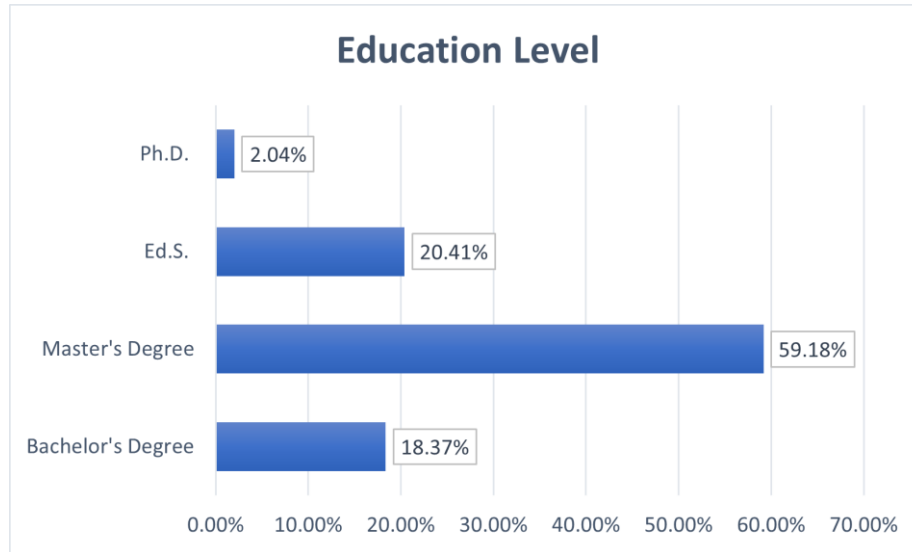


Figure 6
Degree focus of Instructors

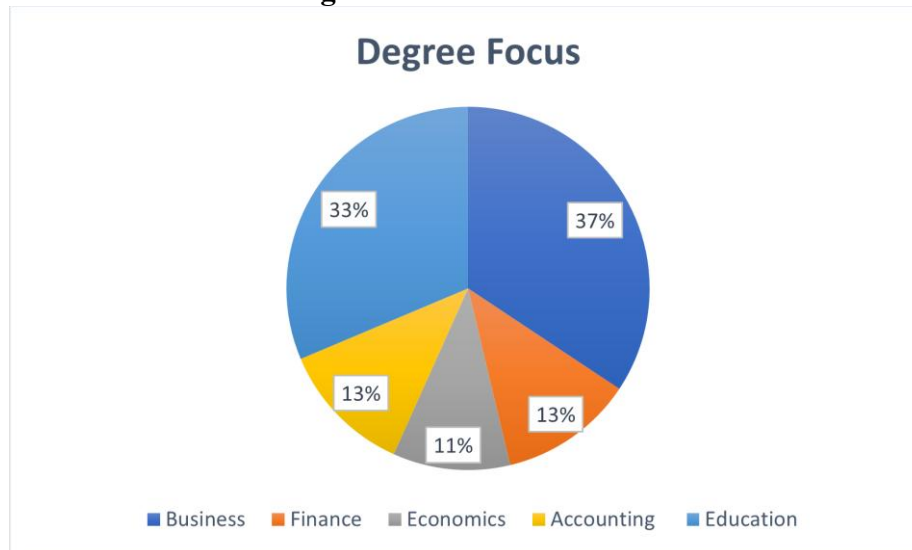


Table 1
Ratings by the Instructors

	Financial Responsibility and Personal Decision-Making	Educations, Careers, and Income	Planning and Money Management	Credit and Debt	Risk Management	Saving and Investing
Effectiveness	7.14	6.95	7.7	7.68	6.78	7.18
Student - Engagement	6.55	6.73	7.73	7.61	6.79	7.38
Conciseness	6.92	6.93	7.58	7.67	7.31	7.64
Relevance	8.54	8.45	8.73	8.70	8.18	8.03
Clarity	8.26	7.78	8.4	8.05	7.77	8.05

Instructors can be certified to teach Personal Finance without a business specific degree so long as they attend one of the training workshops. In the case of an instructor having a specified degree, they can often teach the course from their degree alone, though they may still choose to attend the workshops to learn newer techniques or gain access to supplementary material. As shown in Figure 5, most of the participants did indeed have a business-related degree, with only 33 percent of the instructors having an education focus.

Table 1 reported the rating for each of the six sections. Each of the ratings were supplemented by the personal response sections. As shown within the table, each section was rating highly in terms of relevance but some areas proved to be less effective in engaging and preparing the students for real-world applications.

Figure 7
Difficulty with standards in section 1

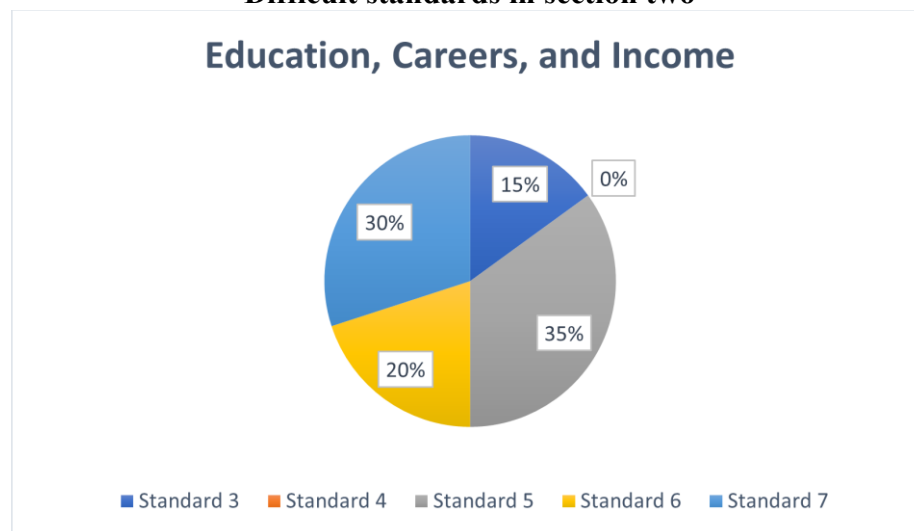


Financial Responsibility and Personal Decision-Making

Section one had the highest confidence overall, and instructors felt that the standards in this section were the most straightforward. While teaching this section, instructors pulled from various curriculum pieces to supplement their instruction, including NEFE, NextGen, Dave Ramsey, and EverFi.

Standard two, which referred to establishing short-term and long-term financial goals and factors that may influence them, was selected as the most difficult to teach. Personal responses revealed a concern for long-term planning among secondary students and showed support for adding additional economic understanding within the set of standards. Additionally, there is concern regarding the amount of time teaching the standard thoroughly would take.

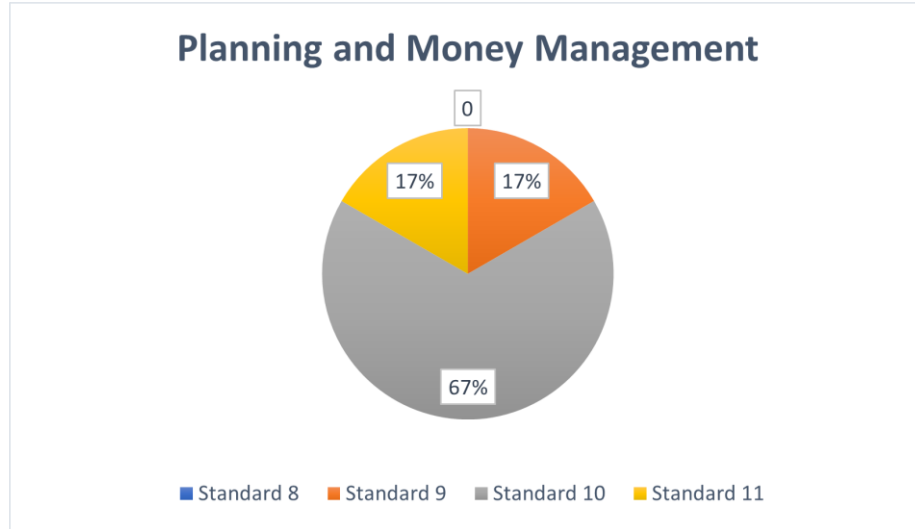
Figure 8
Difficult standards in section two



Educations, Careers, and Income

All standards in section two, apart from standard four, were selected for their difficulty. The difficult standards referred to career choices, FASFA and funding, managing debt, and filing taxes, respectively. Many of the teachers felt conflicted discussing college and potential debt and would utilize Dave Ramsey's ideologies to discuss debt with their students. The majority of instructors found difficulty with standard five, which discussed FASFA and preparing for post-secondary education. Personal responses discuss a concern regarding postsecondary education funding and career goals that match the students' skill sets. There is support for more discussion of careers that do not require a college education as well as more information regarding changes in the employment market.

Figure 9
Difficult standards in section three

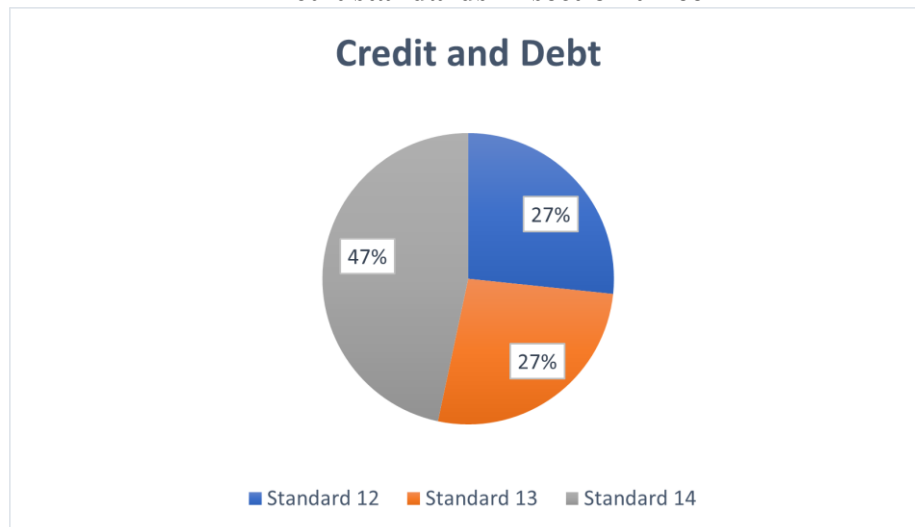


Planning and Money Management

Planning and Money Management had the second highest confidence level for the instructors. That being said, many agreed this section required updated information regarding newer methods of money management, such as mobile banking and money transfer apps. Additionally, instructors felt that the material should cater more to different economic backgrounds and their limitations as financial discussions and struggles differ greatly between different income levels.

The majority of difficulty expressed in section three referred to the concepts discussed in standard ten. Instructors felt the standard should be split and written more concisely as the subject is challenging to both the instructors and the students.

Figure 10
Difficult standards in section three



Credit and Debt

Credit and Debt posed a challenge for some of the instructors due to various ideologies surrounding the subject. Some felt that teaching the students about debt would encourage them to utilize it and ultimately make bad financial decisions. For that reason, some chose to use Dave Ramsey materials to teach debt. Other instructors felt the standards needed to be more specified to cater to the students as they would be unable to utilize either part for some time.

Difficulty with the standards is widespread in this section, with equal difficulty in both discussing loans and credit reports and a majority in financing forms of credit and their application processes. Personal responses show a preference towards Dave Ramsey's ideology and the use of outside sources to supplement the instruction of these standards.

Figure 11
Difficult standards in section five



Risk Management

Personal responses revealed that the instructors had difficulty with both standards. Standard fifteen allows students to explore the importance of various types of insurance and its role within their finances(Appendix A). Some instructors felt that the students were not able to engage properly with the standard given that the majority of it would not be relevant to them for some time. For this reason, many have chosen to only teach auto insurance as it is the main form of insurance that the students interact with outside of the classroom.

Standard sixteen informs the students of identity theft and how to mitigate the risks of becoming a victim(Appendix A). Some instructors felt that there was not enough interesting material on the subject to truly engage the students. Others felt the standard needed to be more specific in terms of fraud and scams and that the standard should be expanded to discuss cybersecurity and cyber insurance.

Saving and Investing

Due to this section having only one robust standard, there is no need for a difficulty breakdown. However, the standard under this section had the most personal responses. Personal responses discuss great difficulty as the standard is complex in origin and some suggest the standard be split into smaller sections. Another issue is a concern for time, as this standard is the last one to be covered in the curriculum, making it difficult for instructors to teach it entirely. Lastly, many of the instructors emphasize a need for additional resources to teach the standard as their own personal experience with the intended subjects may be limited, especially for newer subjects such as cryptocurrency.

Discussion

Time is a critical element in the success of personal finance courses, not only in the overall length of the course but also in the current development stage of the students. Personal responses from the instructors echoed concern for the current nine-week course as the time constraint requires them to cut out more difficult sections of the standards. While there is no pattern in the sections that were cut out, there is a singular element that is shared: relevance to the student. Instructors often expressed difficulty in sections that would not be relevant to all the students for some time, such as preparing for secondary education, retirement, investing, and most forms of insurance outside of auto. Additionally, there is a call for updated standards that include relevant topics such as the rise of cryptocurrency and the growing need for more cybersecurity.

The instructors used a variety of sources to supplement their courses, such as EverFi and Dave Ramsey. They also rely on the materials provided during their training courses, such as those provided by Tennessee JumpStart.

Despite the quick changes of the past few years, financial education has not changed to match it. Supplementary materials are the closest attempt to do so, and there are even attempts to restrict it via more broad educational bills, such as Tennessee SB659, a proposed bill to prohibit the use of non-approved supplementary materials in K-12 classrooms which was denied fruition in early 2022. Finance education is not an area where education should be restricted. It is one area where full transparency is needed, and one could argue that many of the issues we currently have are from the lack of information that is being constantly updated and shared.

In the case of revamping the standards, personal responses were quick to announce sections they felt needed alteration, either due to the concept being “out of time” to be relevant to the students or the standard just being too bulky and needing to be split, such as in the Risk Management and Saving and Investing Section. There is also a call for more practical additions to the standards, such as understanding a potential job market and the potential impact of a chosen career path as well as more inclusive instruction that discusses the various income levels and environments such as rural, suburban, and urban and the various opportunities that exist in each category. Last, the standards were quoted to be “outdated” several times by the instructors, specifically with banking methods, cryptocurrency, cybersecurity, and potential fraud. With all the advancements of the past few years, many of the stated methods that are required in the standards are no longer relevant.

Adult Financial Education “moguls” such as Dave Ramsey are favored by many teachers, likely due to easy access to teaching material. Personal responses and general questions about supplementary materials showed that instructors were quick to jump to mogul teachings, especially

if the instructor uses that ideology in their own life. Teachers of these courses are put in a situation where they teach what they know and trust. This methodology is supported by the model Tennessee uses to train the teachers, where teachers learn as students in a seminar-style conference. This type of training is supposed to raise financial understanding overall and allow the instructors to better understand and relate to the struggles their students might face while learning the material. Some personal responses even felt that teaching certain sections, such as loans and debt, could lead their students to make bad financial decisions in the future. Due to this belief, they prefer to teach those sections by showing the students the tips given by their chosen financial moguls.

Despite its importance, financial education at its finest, i.e., Guarantee Standard, is still only a nine-week course in secondary schools. With the standards as they currently are, there is just not enough time to discuss everything. Confidence in their own instructor lessens with each standard, and the personal responses were quick to discuss the time constraint. Once the timing is an issue, all difficult concepts are altered or removed entirely. Some teachers even expressed a want to remove teaching post-secondary standards as they felt many of their students would not attend college. More specifically, they felt the standard and learning about FASFA to be unnecessary when these students could be learning about alternative career choices such as those provided by technical schools.

With the issues discussed within the survey, there is a clear call for revision. The standards, as they are currently, have many areas that are too broad to be taught in a secondary school given the time constraints placed upon them. Additionally, there are standards that are critical to teaching but are not updated and inclusive enough to cater to the diverse nature of the students, such as in the case of the personal responses regarding college versus technical schools and the discussion of rural versus urban opportunities. Given Tennessee's status as a top personal finance education state, it is likely that these issues are present within other states as well. Working towards extending to a full course and revising the standards to better cater to the students' backgrounds would prove to be beneficial and could encourage other states to do the same.

References

- Barnes, J. (2019). The State of Financial Literacy in Tennessee: Do Students Need Higher Quality Financial Education? (Publication No. 1194) [Honors thesis, University of Tennessee Chattanooga]. UTC Scholar.
<https://scholar.utc.edu/cgi/viewcontent.cgi?article=1194&context=honors-theses>
- Lusardi, A., & Mitchell, O. S. (2011). Financial literacy around the world: An overview. *Journal of Pension Economics and Finance*, 10(4), 497-508.
<https://doi.org/10.1017/s1474747211000448>
- Next Gen Personal Finance. (2023, March). NGPF's 2023 State of Financial Education Report. Next Gen Personal Finance Annual Reports. https://d3f7q2msm2165u.cloudfront.net/aaa-content/user/files/Files/NGPF_Annual_Report_2023.pdf
- Urban, C. (2023). Does State-mandated financial education reduce high school graduation rates? *Economics of Education Review*, 95, 102427.
<https://doi.org/10.1016/j.econedurev.2023.102427>
- Urban, C. (2022, April 6). Eight Takeaways on Access to Personal Finance in US High Schools: 2021-2022 Academic Year. Carly Urban's Paper Repository.
https://papers.carlyurban.com/HSReport_2022.pdf

Appendix A



Department of
Education

College, Career and
Technical Education

Published for the 2020-21 school year.

Personal Finance

Primary Career Cluster:	Finance
Program Manager:	CTE.Standards@tn.gov
Course Code(s):	C12H24
Prerequisite(s):	None
Credit:	½
Grade Level:	9 - 12
Graduation Requirements:	<i>Personal Finance</i> is required for graduation.
Programs of Study and Sequence:	This is an elective course in the Finance career cluster.
Aligned Student Organization(s):	DECA: http://www.decatn.org FBLA: http://www.fblatn.org
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/content/tn/education/career-and-technical-education/work-based-learning.html
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are currently dual credit opportunities available for this course at specific community colleges. Reach out to your local postsecondary institution(s) for more information.
Teacher Endorsements:	024, 030, 031, 032, 033, 034, 035, 036, 037, 038, 039, 041, 050, 051, 052, 054, 055, 056, 057, 130, 152, 153, 158, 201, 202, 203, 204, 311, 424, 430, 431, 432, 433, 434, 435, 436, 450, 471, 472, 474, 475, 476, OR any CTE Professional license with state approved training
Required Teacher Certifications/Training	Training is only required for those endorsements that are NOT specified. Teachers who do not have the endorsements listed must attend the state approved training to teach personal finance.
Teacher Resources:	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-finance.html .

Course Description

Personal Finance is a foundational course designed to inform students how individual choices directly influence occupational goals, future earning potential, and long term financial well-being. The standards in this course cover decision-making skills related to goal setting, producing income, budgeting, saving, borrowing, managing risk, and investing. The course helps students meet the

Approved April 10, 2015; Amended April 15, 2016; May 29, 2020

growing complexities of personal financial management and consumer decision making. Upon completion of this course, proficient students will understand how their decisions will impact their future financial well-being.

Program of Study Application

This is an elective course in the finance career cluster. For more information on the benefits and requirements of implementing finance programs, please see the program of study description documents found on the Finance career cluster website <https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-finance.html>

Personal Finance is a required course for graduation for all Tennessee high school students.

Course Standards

Financial Responsibility and Personal Decision Making

- 1) Define the concept of personal finance. Consider how personal finance concepts fit into key life events or stages and explain the importance of personal financial planning using information sources such as instructional materials, news articles, blogs from reputable sources, personal narratives, and industry publications.
- 2) Write short term (a year or less), mid-term (1 – 5 years), and long term (over 5 years), personal financial goals, defining desired education, career, and earning milestones, and saving and spending plans. Evaluate factors that may influence the goals, including family responsibilities, individual values, financial factors, and economic conditions.

Education, Careers, and Income

- 3) Complete one or more career aptitude surveys, analyze the results, and relate how the identified career aptitudes align with the student's strengths and interests. Evaluate education and training path options to prepare for identified jobs or careers of interest.
- 4) Using the career focus identified in standard 3, create an annotated chart, table, or graphic to evaluate:
 - a. Education and training including admission requirements and tuition requirements
 - b. Available positions
 - c. Salaries
 - d. Cost vs. benefits of educational/training
 - e. Potential lifetime earning
 - f. Employer benefits
 - g. Possible need for relocation to advance
- 5) Explore and evaluate options for financing postsecondary education. Demonstrate an understanding of Free Application for Federal Student Aid (FAFSA) requirements to apply for postsecondary education financial aid by completing an application. Identify strategies for reducing the overall cost of postsecondary education, including the impact of scholarships, grants, work study, and other assistance and the application process

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growing complexities of personal financial management and consumer decision making. Upon completion of this course, proficient students will understand how their decisions will impact their future financial well-being.

Program of Study Application

This is an elective course in the finance career cluster. For more information on the benefits and requirements of implementing finance programs, please see the program of study description documents found on the Finance career cluster website <https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-finance.html>

Personal Finance is a required course for graduation for all Tennessee high school students.

Course Standards

Financial Responsibility and Personal Decision Making

- 1) Define the concept of personal finance. Consider how personal finance concepts fit into key life events or stages and explain the importance of personal financial planning using information sources such as instructional materials, news articles, blogs from reputable sources, personal narratives, and industry publications.
- 2) Write short term (a year or less), mid-term (1 – 5 years), and long term (over 5 years), personal financial goals, defining desired education, career, and earning milestones, and saving and spending plans. Evaluate factors that may influence the goals, including family responsibilities, individual values, financial factors, and economic conditions.

Education, Careers, and Income

- 3) Complete one or more career aptitude surveys, analyze the results, and relate how the identified career aptitudes align with the student's strengths and interests. Evaluate education and training path options to prepare for identified jobs or careers of interest.
- 4) Using the career focus identified in standard 3, create an annotated chart, table, or graphic to evaluate:
 - a. Education and training including admission requirements and tuition requirements
 - b. Available positions
 - c. Salaries
 - d. Cost vs. benefits of educational/training
 - e. Potential lifetime earning
 - f. Employer benefits
 - g. Possible need for relocation to advance
- 5) Explore and evaluate options for financing postsecondary education. Demonstrate an understanding of Free Application for Federal Student Aid (FAFSA) requirements to apply for postsecondary education financial aid by completing an application. Identify strategies for reducing the overall cost of postsecondary education, including the impact of scholarships, grants, work study, and other assistance and the application process

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- 6) Explain the impact borrowing money to finance college could have on future financial stability and security. Research multiple viewpoints that support or question the use of student loan debt in paying for postsecondary education. Assess the extent to which the reasoning and evidence presented support the author's claim. Citing specific textual evidence, craft an argumentative essay that either supports or opposes the use of student loan debt, developing both claim(s) and counterclaim(s) fairly.
- 7) Describe factors affecting take-home pay such as tax withholdings, benefits (e.g., insurance, 401k), and plan payroll deductions. Complete a 1040 and a W-4 Employee's Withholding Allowance paperwork and analyze the W-2 Wage and Tax Statement for federal income tax purposes.

Planning and Money Management

- 8) Using money management tools such as online computer-based budgeting tools or hardcopy forms, create a personal balance sheet, determine assets and liabilities, and calculate net worth for an identified career.
- 9) Using research from local sources (such as cost of living calculators, newspapers, chambers of commerce, local government, and company websites), create a monthly personal budget that reflects household living expenses, taxes, potential savings, and an emergency fund. Develop a saving/spending plan for a week and track actual spending for comparison.
- 10) Understand the availability of consumer protection laws, agencies, and resources. Investigate the availability and reliability of resources to assist consumers in making buying decisions (include national, state, and local resources, as appropriate).
- 11) Research a variety of financial institutions including digital financial services. Compare and contrast services and products such as checking accounts, savings accounts, certificates of deposits, etc. Identify one service that best supports the student's personal financial goals and craft an argumentative essay supporting the choice. Using a banking transaction scenario, demonstrate an ability to:
 - a. Reconcile an account
 - b. Write a check
 - c. Verify account accuracy

Credit and Debt

- 12) Evaluate the various sources and types of consumer credit, such as student loans, auto loans, store credit cards, flex loans, consumer installment loans, title loans, and payday loans. Draw conclusions about the types of credit best suited for financing and/or purchasing various goods and services, defending claims with specific textual evidence. Explain how taking on debt early in life may affect financial stability and security later in life.
- 13) Examine information from sources such as major credit reporting agencies, federal agencies, or other credible organizations to describe credit reports and credit scores. Describe the

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relationship between consumers and credit reports/credit scores, discussing their importance and citing specific textual evidence from research. Analyze a sample credit report and interpret how the contents may affect the credit score. Explain how the credit score may impact borrowing opportunities and the cost of credit. Summarize specific activities used to maintain a good credit score.

- 14) Citing evidence found in credit applications, compare and contrast various types of credit and calculate the real cost of borrowing. Explain factors that can affect the approval process associated with each type. Identify typical information and procedures required in the credit application process. Analyze factors associated with the purchase of an automobile and defend a specific buying decision, including:
- Define and understand factors most often included in negotiations (such as cash vs. financing, inclusion of trade-in, etc.).
 - Evaluate costs and benefits of different service contract and/or warranty options.
 - Compare and contrast available financing options based on consumer characteristics and size of down payment.
 - Discuss the differences in owning vs. leasing a car (such as down payment, terms, and contracts).

Risk Management

- 15) Differentiate the benefits and costs associated with various types of insurance, such as health, life, property, and auto. Describe the risks associated with a lack of appropriate coverage in specific situations. Determine the role of insurance in personal financial planning to preserve and build wealth with financial stability and security.
- 16) Conduct assessments of various types of identity theft situations and scams, then determine strategies and present a plan to safeguard and protect against identity theft. Design and present a plan to significantly lower and protect against risks. Determine steps that should be taken by a victim of identity theft to report the incident and re-establish identity.

Saving and Investing

- 17) Explain how saving and investing contribute to financial well-being, building wealth, and helping meet personal financial goals. Compare and contrast saving and investment strategies, such as savings accounts, certificates of deposit, stocks, bonds, mutual funds, employer sponsored savings plans, physical assets, and commodities. Design a diversified saving and investment plan that includes strategies compatible with personal goals. Include time value of money and compound interest calculations in analysis.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)

Appendix B

Assessing the Effectiveness of Personal Finance Standards in Tennessee Study

Q1 Primary Investigator: Patricia Hummel

PI Department & College: Economics and Finance, Jones College of Business

Faculty Advisor: Keith Gamble

Protocol Title: Assessing the Effectiveness of Personal Finance Standards in Tennessee

Protocol ID: 22-1069 2q Approval Date: 11/30/2021 Expiration Date: 12/31/2022

Information and Disclosure Section

1. Purpose: The purpose of the proposed study is to test the effectiveness of personal finance standards in Tennessee as a means to assist teachers and provide a higher quality set of standards for the students.
2. Description: In recent years, the United States has taken great strides to improve the quality of personal finance education. In this pursuit, Tennessee is held in high regard as it ranks one of the highest states in the country in regards to personal finance education requirements. In order to continuing improving the quality of education in Tennessee, the survey serves to interview personal finance teachers to give an educator's perspective on the standards' quality.
3. Duration: The whole activity should take about 15-20 minutes. The participants must at least take 0 minutes. Here are your rights as a participant: Your participation in this research is voluntary. You may skip any item that you don't want to answer, and you may stop the survey at any time. If you leave an item blank by either not clicking or entering a response, you may be warned that you missed one, just in case it was an accident. But you can continue the study without entering a response if you didn't want to answer any questions. Some items may require a response to accurately present the survey.
4. Risks & Discomforts: There are minimal risks to participating in this survey. No sensitive data will be collected. No personally identifiable data will be collected.
5. Benefits: We expect the results of the study to help improve the standards for personal finance in Tennessee as well as provide support for the teachers/participants.
6. Identifiable Information: You will NOT be asked to provide identifiable personal information in the survey.
7. Compensation: No direct compensation. Five participants will be selected to receive an honorarium from the Council of Economic Education.
8. Confidentiality: All efforts, within reason, will be made to keep the personal information private, but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, if you or someone else is in danger or if we are required to do so by law.

Q2 Participant Response Section (Please select all that apply.)

- ☐ I have read this informed consent document pertaining to the above identified research. (1)
- ☐ The research procedures to be conducted are clear to me. (2)
- ☐ I confirm that I am 18 years or older. (3)
- ☐ I am aware of the potential risks of the study. (4)

Q3 By clicking below, I affirm that I freely and voluntarily choose to participate in this study. I understand I can withdraw from this study at any time without facing any consequences.

- ☐ No, I do not consent. (1)
- ☐ Yes, I consent. (2)

Demographics

Q4 What is your age?

- ☐ 20-29 (1)
- ☐ 30-39 (2)
- ☐ 40-49 (3)
- ☐ 50-59 (4)
- ☐ 60+ (5)

Q5 Indicate your education level.

- ☐ Bachelor's Degree (1)
- ☐ Master's Degree (2)
- ☐ E.D.S. (3)
- ☐ P.h.D (4)

Q6 Did your degree have a focus in any of the following areas?

- ☐ Business (1)
- ☐ Finance (2)
- ☐ Economics (3)
- ☐ Accounting (4)
- ☐ No (5)

Q7 Did you attend the 14-Hour Personal Finance Training Course to receive employment qualification? If so, with which institution?

- ☐ Yes; Tennessee JumpStart June Conference in Gatlinburg (1)
- ☐ Yes; University of Tennessee Extension (2)
- ☐ Yes; Federal Reserve Bank of Atlanta – Nashville Branch and MTSU Center for Economic Education (3)
- ☐ Yes; Federal Reserve Bank of St. Louis – Memphis Branch (4)
- ☐ No. (5)

Q8 Is teaching your first career? If not, was your previous employment related to finance?

- ☐ Yes. (1)
- ☐ No; Yes, it was related to Finance (2)
- ☐ No; No, it was not related to Finance (3)

Q9 Which Grand Division of Tennessee do you reside in?

- ☐ West Tennessee (1)
- ☐ Middle Tennessee (2)
- ☐ East Tennessee (3)

Q10 How would you define your district?

- ☐ Urban (1)
- ☐ Suburban (2)
- ☐ Rural (3)

Q11 Do you teach the traditional course or JORTC?

- ☐ Traditional (1)
- ☐ JORTC (2)
- ☐ Unsure (3)

Standards

Q12

The following text contains the current Tennessee Personal Finance Standards for the following area:

Financial Responsibility and Decision Making

- 1) Define the concept of personal finance. Consider how personal finance concepts fit into key life events or stages and explain the importance of personal financial planning using information sources such as instructional materials, news articles, blogs from reputable sources, personal narratives, and industry publications.
- 2) Write short term (a year or less), mid-term (1 – 5 years), and long term (over 5 years), personal financial goals, defining desired education, career, and earning milestones, and saving and spending plans. Evaluate factors that may influence the goals, including family responsibilities, individual values, financial factors, and economic conditions.

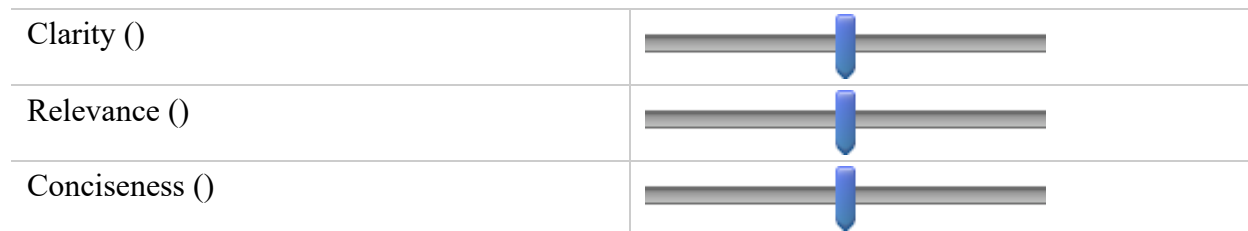
Q13 How would you rate your confidence level in teaching these standards?



0 1 2 3 4 5



Q14 How would you rate these standards based on the following criteria?

0 1 2 3 4 5 6 7 8 9 10



Student Engagement ()	
Effectiveness ()	

Q15 Are there parts of this area "Financial Responsibility and Decision-Making" that you have difficulty teaching?

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)
- ☐ Unsure (4)

Q16 If yes, which section(s) do you have difficulty teaching?

- ☐ Define the concept of personal finance. Consider how personal finance concepts fit into key life events or stages and explain the importance of personal financial planning using information sources such as instructional materials, news articles, blogs from reputable sources, personal narratives, and industry publications. (1)
- ☐ Write short term (a year or less), mid-term (1 – 5 years), and long term (over 5 years), personal financial goals, defining desired education, career, and earning milestones, and saving and spending plans. Evaluate factors that may influence the goals, including family responsibilities, individual values, financial factors, and economic conditions. (2)
- ☐ Not Applicable. (3)

Q17 While teaching the standards in this section, have you utilized the online resources provided by any of the training programs?

- ☐ Yes; NEFE Curriculum (1)
- ☐ Yes; College GPS – Infographic Posters and Related Materials (2)
- ☐ Yes; Econ Low Down (3)
- ☐ Yes; Various Curriculum Pieces (4)
- ☐ No. (5)

Q18 Do you use external sources to supplement your classroom, such as Everfi or Dave Ramsey?
? If so, can you indicate which sources you use?

Q19 Is there anything you would like to add in regards to these standards?

Q20 The following text contains the current Tennessee Personal Finance Standards for the following area:

Education, Careers, and Income

- 3) Complete one or more career aptitude surveys, analyze the results, and relate how the identified career aptitudes align with the student's strengths and interests. Evaluate education and training path options to prepare for identified jobs or careers of interest.
- 4) Using the career focus identified in standard 3, create an annotated chart, table, or graphic to evaluate: a. Education and training including admission requirements and tuition requirements b. Available positions c. Salaries d. Cost vs. benefits of educational/training e. Potential lifetime earning f. Employer benefits g. Possible need for relocation to advance
- 5) Explore and evaluate options for financing postsecondary education. Demonstrate an understanding of Free Application for Federal Student Aid (FAFSA) requirements to apply for postsecondary education financial aid by completing an application. Identify strategies for reducing the overall cost of postsecondary education, including the impact of scholarships, grants, work study, and other assistance and the application process.
- 6) Explain the impact borrowing money to finance college could have on future financial stability and security. Research multiple view points that support or question the use of student loan debt in paying for postsecondary education. Assess the extent to which the reasoning and evidence presented support the author's claim. Citing specific textual evidence, craft an argumentative essay that either supports or opposes the use of student loan debt, developing both claim(s) and counterclaim(s) fairly.
- 7) Describe factors affecting take-home pay such as tax withholdings, benefits (e.g., insurance, 401k), and plan payroll deductions. Complete a 1040 and a W-4 Employee's Withholding Allowance paperwork and analyze the W-2 Wage and Tax Statement for federal income tax purposes.

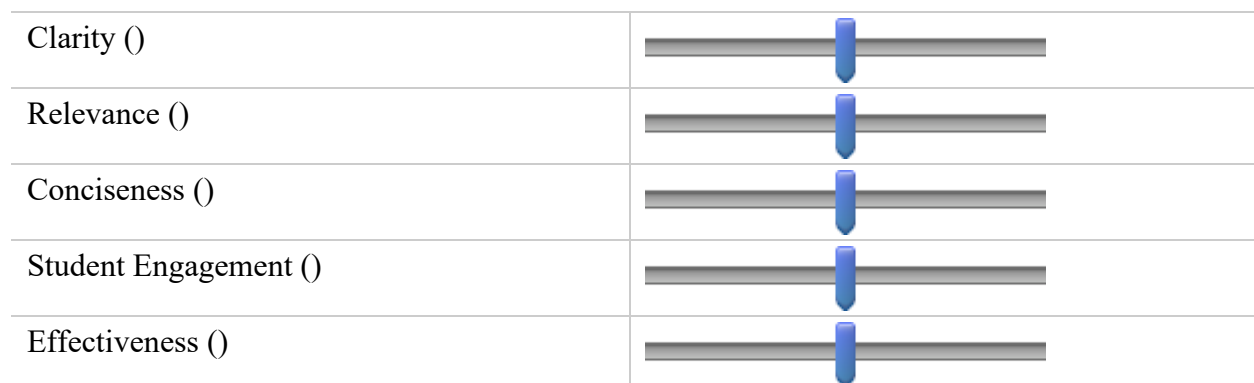
Q21 How would you rate your confidence level in teaching these standards?

0 1 2 3 4 5



Q22 How would you rate these standards based on the following criteria?

0 1 2 3 4 5 6 7 8 9 10



Q23 Are there parts of this area "Education, Careers, and Income" that you have difficulty teaching?

- Yes (1)
- Maybe (2)
- No (3)
- Unsure (4)

Q24 If yes, which section(s) do you have difficulty teaching?

- 3) Complete one or more career aptitude surveys, analyze the results, and relate how the identified career aptitudes align with the student's strengths and interests. Evaluate education and training path options to prepare for identified jobs or careers of interest. (1)
- 4) Using the career focus identified in standard 3, create an annotated chart, table, or graphic to evaluate: a. Education and training including admission requirements and tuition requirements b. Available positions c. Salaries d. Cost vs. benefits of educational/training e. Potential lifetime earning f. Employer benefits g. Possible need for relocation to advance (2)
- 5) Explore and evaluate options for financing postsecondary education. Demonstrate an understanding of Free Application for Federal Student Aid (FAFSA) requirements to apply for postsecondary education financial aid by completing an application. Identify strategies for reducing the overall cost of postsecondary education, including the impact of scholarships, grants, work study, and other assistance and the application process. (3)
- 6) Explain the impact borrowing money to finance college could have on future financial stability and security. Research multiple view points that support or question the use of student loan debt in paying for postsecondary education. Assess the extent to which the reasoning and evidence presented support the author's claim. Citing specific textual evidence, craft an argumentative essay that either supports or opposes the use of student loan debt, developing both claim(s) and counterclaim(s) fairly. (4)
- 7) Describe factors affecting take-home pay such as tax withholdings, benefits (e.g., insurance, 401k), and plan payroll deductions. Complete a 1040 and a W-4 Employee's Withholding Allowance paperwork and analyze the W-2 Wage and Tax Statement for federal income tax purposes. (5)

Q25 While teaching the standards in this section, have you utilized the online resources provided by any of the training programs?

- Yes; NEFE Curriculum (1)
- Yes; College GPS – Infographic Posters and Related Materials (2)
- Yes; Econ Low Down (3)
- Yes; Various Curriculum Pieces (4)
- No (5)

Q26 Do you use external sources to supplement your classroom, such as Everfi or Dave Ramsey?
? If so, can you indicate which sources you use?

Q27 Is there anything you would like to add in regards to these standards?

Q28 The following text contains the current Tennessee Personal Finance Standards for the following area:

Planning and Money Management

- 8) Using money management tools such as online computer-based budgeting tools or hardcopy forms, create a personal balance sheet, determine assets and liabilities, and calculate net worth for an identified career.
- 9) Using research from local sources (such as cost of living calculators, newspapers, chambers of commerce, local government, and company websites), create a monthly personal budget that reflects household living expenses, taxes, potential savings, and an emergency fund. Develop a saving/spending plan for a week and track actual spending for comparison.
- 10) Understand the availability of consumer protection laws, agencies, and resources. Investigate the availability and reliability of resources to assist consumers in making buying decisions (include national, state, and local resources, as appropriate).
- 11) Research a variety of financial institutions including digital financial services. Compare and contrast services and products such as checking accounts, savings accounts, certificates of deposits, etc. Identify one service that best supports the student's personal financial goals and craft an argumentative essay supporting the choice. Using a banking transaction scenario, demonstrate an ability to:
 - a. Reconcile an account
 - b. Write a check
 - c. Verify account accuracy

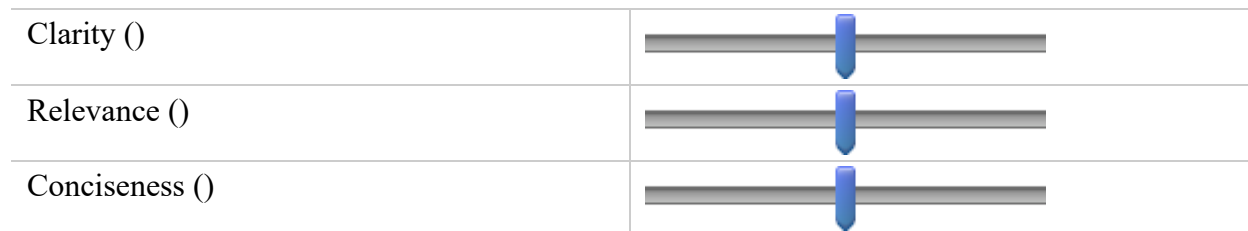
Q29 How would you rate your confidence level in teaching these standards?



0 1 2 3 4 5



Q30 How would you rate these standards based on the following criteria?

0 1 2 3 4 5 6 7 8 9 10



Student Engagement ()	
Effectiveness ()	

Q31 Are there parts of this area "Planning and Money Management" that you have difficulty teaching?

- Yes (1)
- Maybe (2)
- No (3)
- Unsure (4)

Q32 If yes, which section(s) do you have difficulty teaching?

- 8) Using money management tools such as online computer-based budgeting tools or hardcopy forms, create a personal balance sheet, determine assets and liabilities, and calculate net worth for an identified career. (1)
- 9) Using research from local sources (such as cost of living calculators, newspapers, chambers of commerce, local government, and company websites), create a monthly personal budget that reflects household living expenses, taxes, potential savings, and an emergency fund. Develop a saving/spending plan for a week and track actual spending for comparison. (2)
- 10) Understand the availability of consumer protection laws, agencies, and resources. Investigate the availability and reliability of resources to assist consumers in making buying decisions (include national, state, and local resources, as appropriate). (3)
- Research a variety of financial institutions including digital financial services. Compare and contrast services and products such as checking accounts, savings accounts, certificates of deposits, etc. Identify one service that best supports the student's personal financial goals and craft an argumentative essay supporting the choice. Using a banking transaction scenario, demonstrate an ability to: a. Reconcile an account, b. Write a check, c. Verify account accuracy (4)

Q33 While teaching the standards in this section, have you utilized the online resources provided by any of the training programs?

- Yes; NEFE Curriculum (1)
- Yes; College GPS – Infographic Posters and Related Materials (2)
- Yes; Econ Low Down (3)
- Yes; Various Curriculum Pieces (4)
- No. (5)

Q34 Do you use external sources to supplement your classroom, such as Everfi or Dave Ramsey?
? If so, can you indicate which sources you use?

Q35 Is there anything you would like to add in regards to these standards?

Q36 The following text contains the current Tennessee Personal Finance Standards for the following area:

Credit and Debt

- 12) Evaluate the various sources and types of consumer credit, such as student loans, auto loans, store credit cards, flex loans, consumer installment loans, title loans, and payday loans. Draw conclusions about the types of credit best suited for financing and/or purchasing various goods and services, defending claims with specific textual evidence. Explain how taking on debt early in life may affect financial stability and security later in life.
- 13) Examine information from sources such as major credit reporting agencies, federal agencies, or other credible organizations to describe credit reports and credit scores. Describe the relationship between consumers and credit reports/credit scores, discussing their importance and citing specific textual evidence from research. Analyze a sample credit report and interpret how the contents may affect the credit score. Explain how the credit score may impact borrowing opportunities and the cost of credit. Summarize specific activities used to maintain a good credit score.
- 14) Citing evidence found in credit applications, compare and contrast various types of credit and calculate the real cost of borrowing. Explain factors that can affect the approval process associated with each type. Identify typical information and procedures required in the credit application process. Analyze factors associated with the purchase of an automobile and defend a specific buying decision, including: a. Define and understand factors most often included in negotiations (such as cash vs. financing, inclusion of trade-in, etc.). b. Evaluate costs and benefits of different service contract and/or warranty options. c. Compare and contrast available financing options based on consumer characteristics and size of down payment. d. Discuss the differences in owning vs. leasing a car (such as down payment, terms, and contracts).

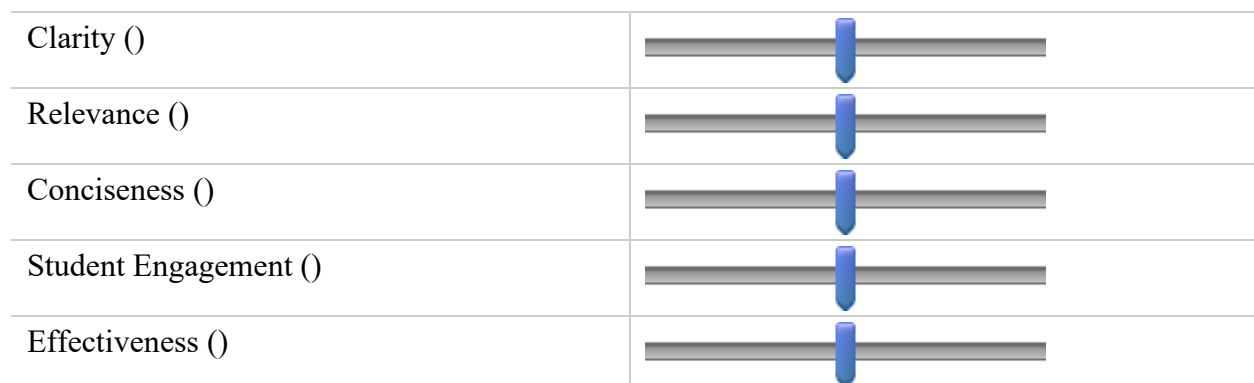
Q37 How would you rate your confidence level in teaching these standards?

0 1 2 3 4 5



Q38 How would you rate these standards based on the following criteria?

0 1 2 3 4 5 6 7 8 9 10



Q39 Are there parts of this area "Credit and Debt" that you have difficulty teaching?

- Yes (1)
- Maybe (2)
- No (3)
- Unsure (4)

Q40 If yes, which section(s) do you have difficulty teaching?

- 12) Evaluate the various sources and types of consumer credit, such as student loans, auto loans, store credit cards, flex loans, consumer installment loans, title loans, and payday loans. Draw conclusions about the types of credit best suited for financing and/or purchasing various goods and services, defending claims with specific textual evidence. Explain how taking on debt early in life may affect financial stability and security later in life. (1)
- 13) Examine information from sources such as major credit reporting agencies, federal agencies, or other credible organizations to describe credit reports and credit scores. Describe the relationship between consumers and credit reports/credit scores, discussing their importance and citing specific textual evidence from research. Analyze a sample credit report and interpret how the contents may affect the credit score. Explain how the credit score may impact borrowing opportunities and the cost of credit. Summarize specific activities used to maintain a good credit score. (2)
- 14) Citing evidence found in credit applications, compare and contrast various types of credit and calculate the real cost of borrowing. Explain factors that can affect the approval process associated with each type. Identify typical information and procedures required in the credit application process. Analyze factors associated with the purchase of an automobile and defend a specific buying decision, including: a. Define and understand factors most often included in negotiations (such as cash vs. financing, inclusion of trade-in, etc.). b. Evaluate costs and benefits of different service contract and/or warranty options. c. Compare and contrast available financing options based on consumer characteristics and size of down payment. d. Discuss the differences in owning vs. leasing a car (such as down payment, terms, and contracts). (3)

Q41 While teaching the standards in this section, have you utilized the online resources provided by any of the training programs?

- Yes; NEFE Curriculum (1)
- Yes; College GPS – Infographic Posters and Related Materials (2)
- Yes; Econ Low Down (3)
- Yes; Various Curriculum Pieces (4)
- No. (5)

Q42 Do you use external sources to supplement your classroom, such as Everfi or Dave Ramsey?
? If so, can you indicate which sources you use?

Q43 Is there anything you would like to add in regards to these standards?

Q44 The following text contains the current Tennessee Personal Finance Standards for the following area:

Risk Management

- 15) Differentiate the benefits and costs associated with various types of insurance, such as health, life, property, and auto. Describe the risks associated with a lack of appropriate coverage in specific situations. Determine the role of insurance in personal financial planning to preserve and build wealth with financial stability and security.
- 16) Conduct assessments of various types of identity theft situations and scams, then determine strategies and present a plan to safeguard and protect against identity theft. Design and present a plan to significantly lower and protect against risks. Determine steps that should be taken by a victim of identity theft to report the incident and re-establish identity.

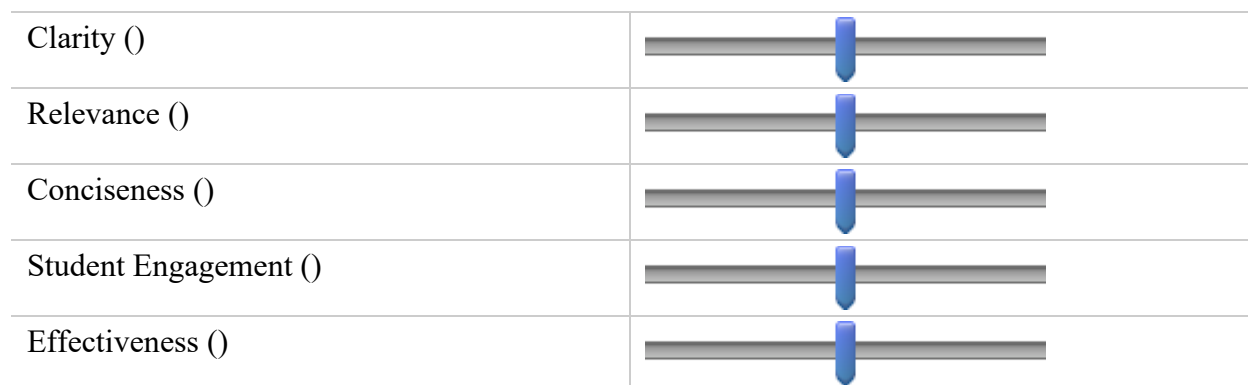
Q45 How would you rate your confidence level in teaching these standards?

0 1 2 3 4 5



Q46 How would you rate these standards based on the following criteria?

0 1 2 3 4 5 6 7 8 9 10



Q47 Are there parts of this area "Risk Management" that you have difficulty teaching?

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)
- ☐ Unsure (4)

Q48 If yes, which section(s) do you have difficulty teaching?

- ☐ 15) Differentiate the benefits and costs associated with various types of insurance, such as health, life, property, and auto. Describe the risks associated with a lack of appropriate coverage in specific situations. Determine the role of insurance in personal financial planning to preserve and build wealth with financial stability and security. (1)
- ☐ 16) Conduct assessments of various types of identity theft situations and scams, then determine strategies and present a plan to safeguard and protect against identity theft.

Design and present a plan to significantly lower and protect against risks. Determine steps that should be taken by a victim of identity theft to report the incident and re-establish identity. (2)

Q49 While teaching the standards in this section, have you utilized the online resources provided by any of the training programs?

- ☐ Yes; NEFE Curriculum (1)
- ☐ Yes; College GPS – Infographic Posters and Related Materials (2)
- ☐ Yes; Econ Low Down (3)
- ☐ Yes; Various Curriculum Pieces (4)
- ☐ No. (5)

Q50 Do you use external sources to supplement your classroom, such as Everfi or Dave Ramsey? If so, can you indicate which sources you use?

Q51 Is there anything you would like to add in regards to these standards?

Q52 The following text contains the current Tennessee Personal Finance Standards for the following area:

Saving and Investing

17) Explain how saving and investing contribute to financial well-being, building wealth, and helping meet personal financial goals. Compare and contrast saving and investment strategies, such as savings accounts, certificates of deposit, stocks, bonds, mutual funds, employer sponsored savings plans, physical assets, and commodities. Design a diversified saving and investment plan that includes strategies compatible with personal goals. Include time value of money and compound interest calculations in analysis.

Q53 How would you rate your confidence level in teaching these standards?






0 1 2 3 4 5

Confidence Level ()



Q54 How would you rate these standards based on the following criteria?

0 1 2 3 4 5 6 7 8 9 10

Clarity ()	
Relevance ()	
Conciseness ()	
Student Engagement ()	
Effectiveness ()	

Q55 Are there parts of this area "Saving and Investing" that you have difficulty teaching?

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)
- ☐ Unsure (4)

Q56 While teaching the standards in this section, have you utilized the online resources provided by any of the training programs?

- ☐ Yes; NEFE Curriculum (1)
- ☐ Yes; College GPS – Infographic Posters and Related Materials (2)
- ☐ Yes; Econ Low Down (3)
- ☐ Yes; Various Curriculum Pieces (4)
- ☐ No. (5)

Q57 Do you use external sources to supplement your classroom, such as Everfi or Dave Ramsey?
? If so, can you indicate which sources you use?

Q58 Is there anything you would like to add in regards to these standards?

Emerging Frontiers: Exploring the Impact of Generative AI Platforms on University Quantitative Finance Examinations¹

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This study evaluated three Artificial Intelligence (AI) large language model (LLM) enabled platforms—ChatGPT, BARD, and Bing AI—to answer an undergraduate finance exam with 20 quantitative questions across various difficulty levels. ChatGPT scored 30%, outperforming Bing AI, which scored 20%, while Bard lagged behind with a score of 15%. These models faced common challenges, such as inaccurate computations and formula selection. While they are currently insufficient for helping students pass the finance exam, they serve as valuable tools for dedicated learners. Future advancements are expected to overcome these limitations, allowing for improved formula selection and accurate computations and potentially enabling students to score 90% or higher.

Keywords: generative AI; artificial intelligence; ChatGPT; Google Bard; Microsoft new Bing; academic integrity; large language models.

Introduction

Generative AI², or Generative Artificial Intelligence, is an exciting technology field where machines are designed to create original content like text, images, or music (Hu, 2022; Jovanović & Campbell, 2022). It uses complex algorithms to generate content that resembles human creations, pushing the boundaries of what computers can do. One remarkable subset of generative AI is the Large Language Model (LLM), an advanced AI system trained on vast amounts of text and computer code. They possess an impressive ability to understand context, generate coherent responses, and assist in tasks like writing and conversation. LLMs are integral to the generative AI landscape, contributing to its incredible potential and innovation.

OpenAI's ChatGPT³, Google's Bard⁴, and Microsoft's Bing AI (a.k.a. new Bing)⁵ are three emerging and popular AI chatbots that rely on Large Language Models (LLMs). Among these LLMs, OpenAI's Generative Pre-trained Transformer (GPT) series has been instrumental in advancing the field. GPT models generate text in different languages and can create human-sounding words, sentences, and paragraphs on almost any topic and writing style—from convincing news articles and essays to conversations in customer-service chatbots or characters in video games. (Brown et al., 2020; Jovanović & Campbell, 2022). Introduced by OpenAI in 2018,

¹ This paper benefited from the special “Research with Machine Learning Applications” session at the 2021 Western Economic Association Annual Conference. I would like to thank Bhavna Malladi for validating the results of the three AI Platforms, offering insights into the findings, and editing the paper.

² Generative AI Infographic: <https://www.visualcapitalist.com/generative-ai-explained-by-ai/>

³ ChatGPT from OpenAI: <https://chat.openai.com/>

⁴ Bard from Google: <https://bard.google.com/> (Note: This paper was completed in May 2023. Afterwards, Google renamed Bard as Gemini in February 2024).

⁵ Bing AI from Microsoft: <https://www.bing.com/search?q=Bing+AI&showconv=1&FORM=hpcodx> (Note: This paper was completed in May 2023. Afterwards, Microsoft renamed Bing AI/Bing Chat as Copilot in November 2023).

GPT models utilize a semi-supervised learning approach, distinguishing them from other prevalent natural language processing models that heavily rely on supervised learning and labeled data.

GPT models revolutionized natural language understanding through generative pre-training and discriminative fine-tuning. Pre-training on various text passages enables them to acquire extensive world knowledge and handle long-range dependencies. This approach empowers GPT models to excel in tasks like question answering, semantic similarity assessment, determination, and text classification using a single task-agnostic model. By combining generative pre-training with discriminative fine-tuning, GPT models have significantly advanced the capabilities of large language models, facilitating more nuanced and accurate natural language processing (Radford et al., 2018).

AI chatbots in a university setting can be viewed as a double-edged sword. On the one hand, they can gather information from various websites, comprehend context, and provide customized summaries, saving students valuable time that would have otherwise been spent searching the web and clicking on irrelevant links. Regarding academic research, ChatGPT can significantly assist with finance research. There are clear advantages in idea generation and data identification (Dowling & Lucey, 2023).

On the other hand, academic integrity can be severely compromised by AI chatbots. This can be a nightmare for schoolteachers and university professors as the last thing they may want is grading a submission generated by an AI chatbot but claimed as the original work of a school or university student. Students might find it tempting to use ChatGPT to generate assignment submissions, which would neither help them learn nor develop academically and professionally (AlAfnan et al., 2023).

The primary goal of this study is to examine the capability of AI chatbots in successfully tackling undergraduate-level finance exam questions by delivering accurate and relevant answers. In summary, relying solely on these AI chatbots, what exam score can a student expect to achieve?

Literature Review

In 2018, OpenAI released the first model, GPT-1. In 2019, GPT-2 emerged, showcasing remarkable capabilities in generating text and raising concerns about potential misuse (Solaiman et al., 2019). The year 2020 saw the launch of GPT-3, a significant milestone characterized by its massive size of 175 billion parameters (Brown et al., 2020). GPT-3 is one of the largest publicly-disclosed language models, having been trained on 570 gigabytes of text. By comparison, its predecessor, GPT-2, functionally similar to GPT-3, had 1.5 billion parameters and was trained on 40 gigabytes of text (Tamkin et al., 2021). The original GPT-1, in contrast, had 0.12 billion parameters. GPT-4 is believed to have more than 1 trillion parameters.⁶

The current iteration of ChatGPT's complimentary version, as of early May 2023, is based on the robust GPT-3.5 architecture. However, it is crucial to note that the subscription-based ChatGPT Plus⁷, available at a monthly fee of \$20, harnesses the advanced capabilities of GPT-4. Representing a significant leap forward, GPT-4 is a sizable multimodal model capable of processing textual and visual inputs while generating coherent and contextually appropriate textual outputs. This class of models holds tremendous significance within academic research, as they exhibit substantial potential across a wide range of applications, including but not limited to dialogue systems, text summarization, and machine translation.

⁶ Comparison of ChatGPT, Bard, and Bing: <https://readus247.com/chatgpt-vs-bing-vs-google-bard/>

⁷ ChatGPT Plus: <https://help.openai.com/en/articles/6950777-what-is-chatgpt-plus>

By leveraging the power of GPT-4, ChatGPT Plus offers a compelling and engaging experience to its discerning users. GPT-4 is a large multimodal model capable of processing image and text inputs and producing text outputs. Such models are an important area of study as they have the potential to be used in a wide range of applications, such as dialogue systems, text summarization, and machine translation (OpenAI, 2023).

Bard, like ChatGPT, is an LLM that can generate text, translate languages, write different kinds of creative content, and answer your questions in an informative way. However, there are some key differences between the two. The main difference between Bard and ChatGPT is their respective data sources. Bard is trained on an “infiniset” of data chosen to enhance its dialogue and has access to the internet in real-time, whereas ChatGPT is trained on a pre-defined set of data that has not been updated since 2021 (Drapkin, 2023). Bard is trained on a massive dataset of text and code that includes books, articles, code, and other forms of text. ChatGPT is trained on a dataset of text and code that is scraped from the internet. Bard generates creative and imaginative responses that align with storytelling and creative writing prompts. It strives to provide engaging narratives and poetic elements in its responses. ChatGPT, on the other hand, aims to provide informative and contextually appropriate responses across a wider range of topics, including general knowledge, answering questions, and engaging in conversations. Bard uses Google's LaMDA model, often giving less text-heavy responses.

Bing AI starts with the same GPT-4 tech as ChatGPT but goes beyond text and can generate images. Bing adds its Prometheus model on top of GPT-4 (Khan, 2023). Microsoft developed a proprietary Prometheus technology, a first-of-its-kind AI model that combines the fresh and comprehensive Bing index, ranking, and answers results with the creative reasoning capabilities of OpenAI's most advanced GPT models (Ribas, 2023). While Bing is not primarily an AI chatbot, it incorporates AI and natural language understanding capabilities to enhance search results and provide users with more accurate and contextually relevant information.

One key difference between Bing AI, ChatGPT, and Google Bard is that Bing currently limits conversations to 20 turns, while the other two can continue indefinitely. A turn for Bing AI is a single interaction between a user and the Bing AI chatbot. This interaction can include a user query, Bing AI's response, and any follow-up questions or comments from the user. Bing AI is currently limited to 20 turns per conversation, after which the conversation will end, and context is lost. After reaching a turn limit, any information or context specific to that particular conversation is discarded, and subsequent interactions start with a clean slate. Bing AI is designed to provide factual information and complete tasks, while Bard is designed to have more natural and engaging conversations. So, Bing AI needs to be more efficient with its resources, which is why it has a turn limit. Overall, the 20-turn limit is a trade-off between efficiency and naturalness. The finance exam in this paper has only 20 quantitative questions because of Bing AI's 20-turn limit.

The rationale behind excluding qualitative questions is based on the assumption that qualitative questions are closely linked to quantitative ones. If the AI platforms have successfully answered the quantitative questions, they are expected to have the necessary understanding and context to respond accurately to the qualitative questions. Thus, omitting the qualitative questions can help streamline the evaluation process while maintaining confidence in the model's performance.

The concern about academic integrity in university examinations is not new. Students have increasingly turned to online tools to learn and cheat. Homework-helper websites like Chegg can provide valuable support to students, although often, these sites are vulnerable to misuse and represent a significant risk to academic integrity. To effectively address these challenges,

universities must understand how homework-helper websites are misused (Pickering & Schuller, 2022).

A wide body of research studies indicates that cheating is rising in higher education (Borgaonkar et al., 2020; Hamilton, 2016; Jr & Keith-Spiegel, 2001; Macfarlane et al., 2014). Business and engineering students have been reported as most likely to cheat (Borgaonkar et al., 2020; Harding et al., 2007; Liu et al., 2015). Research also shows that students who cheat in college are more likely to violate professional ethics when they enter the workforce (Harding et al., 2007). Students now have access to new technological tools, including third-party problem-solving services and extensive online availability of materials (including solution manuals), making it increasingly difficult and challenging to monitor and restrict cheating (Borgaonkar et al., 2020).

The AI platforms add fuel to the fire concerning academic integrity issues. Ethical considerations abound concerning copyright, attribution, plagiarism, and authorship when AI produces academic text. These concerns are especially pertinent because whether the copy is AI-generated is currently imperceptible to human readers and anti-plagiarism software (Liebrenz et al., 2023). Some academic publishers and preprints have accepted manuscripts with ChatGPT listed as a “co-author” (Rahimi & Talebi Bezmin Abadi, 2023). Academics have cautioned that it is critical to identify and implement policies to protect against the misuse and abuse of generative AI (Dwivedi et al., 2023).

In March 2023, OpenAI announced the performance of GPT-4 on 34 academic and professional exams. The exams included the SAT, GRE, LSAT, and AP Exams, including AP Microeconomics and Macroeconomics. GPT-4 performed surprisingly well on the exams, scoring in most of the top 10% of test takers. This is a significant achievement, showing that GPT-4 can learn and apply that knowledge in test taking. GPT-4 exhibited human-level performance on most professional and academic exams (OpenAI, 2023). However, Finance is missing from the list of 34 exams.

This paper's objective is not to initiate a tutor prep verification study. This paper includes finance to the list of 34 exams, enabling researchers to calibrate across emerging AI chatbot platforms. This research advances evaluation methods in finance and facilitates cross-platform calibration. The study evaluates the success of undergraduate finance students relying solely on generative AI platforms for complete solutions to exam questions, considering the crucial role of ethics in finance and academic integrity in universities.

The paper is organized as follows: Section 2 describes a typical finance exam paper grouped by difficulty level. Section 3 outlines the results obtained from AI platforms. Finally, in Section 4, the conclusions are summarized, and potential directions for future research are highlighted.

Assessment Tool

The assessment tool has 20 questions (due to Bing AI's limitation of 20 turn limit as described in the previous section). The assessment is divided into five difficulty levels: very easy, easy, medium, hard, and very hard. The assessment is prepared specifically for this paper with new sets of numerical inputs, so the answers are unavailable from previous students posting solutions online.

The difficulty level of the questions was identified based on the responses of 63 graduating seniors at the undergraduate level who answered the twenty questions. The questions were sorted into categories from 1 (very easy) to 5 (very hard) according to their scores, with an equal number of questions in each category. Subsequently, the resulting questions were distributed evenly, with

four questions placed in each difficulty category. This process ensured a balanced representation of difficulty levels in the assessment tool. The complete assessment with answers and explanations is in Appendix (A) – Assessment with Solutions and Explanations.

The topics in the assessment are covered in the most commonly used finance textbooks at the undergraduate level (Berk et al., 2015; Brealey et al., 2007; Brigham & Houston, 2021). The covered topics are Business Algebra, Future Value, Present Value, Time Value of Money, Future Value of Annuity, Annuity Payment, Future Value of Growing Annuity, Bond Present Value, Bond Yield to Maturity, Bond Price Change, Net Present Value, Internal Rate of Return, Stock Valuation, Black-Scholes Option Valuation, and Binomial Option Pricing. The assessment questions were not taken from any particular textbook to avoid the possibility of AI platforms before training from internet sources.

Results

Credit is granted if the answer provided by the AI platform falls within a range of 99% to 101% of the expected answer, while no credit is awarded for answers outside this range. Appendix (A) contains the precise answers for each set of 20 questions.

ChatGPT from OpenAI

The analysis commences with ChatGPT; the test was executed on May 29, 2023. The condensed results are displayed in Table (1), while a comprehensive feedback report from ChatGPT can be found in Appendix (B) – ChatGPT Results.

At first intriguing, Table (1) unveils the test outcomes of an undergraduate-level finance exam administered to ChatGPT on May 29, 2023. The cumulative exam score is 30%. ChatGPT exhibits commendable proficiency in addressing "Very Easy" questions, attaining a flawless success rate of 100%. However, the model confronts limitations regarding questions categorized as "Hard" or "Very Hard," resulting in 0% correct responses within these challenging levels. Conversely, ChatGPT garners a 25% score for questions under the "Easy" and "Medium" difficulty tiers.

An intriguing discovery unfolds as we delve deeper into ChatGPT's performance. With remarkable acuity, the model accurately discerns the contextual nuances of the questions and comprehends their underlying objectives precisely, achieving a remarkable accuracy rate of 100%. Additionally, ChatGPT demonstrates an impressive ability to independently identify the appropriate formulas to employ, boasting an 80% accuracy.

However, two notable limitations hinder ChatGPT's efficacy in addressing finance questions. Firstly, the model cannot compute exponents and logarithmic functions, an obstacle that impacts its overall performance. Had ChatGPT possessed this capability, it would have achieved a higher score of 75%. Secondly, ChatGPT struggles with the iterative computations required to determine solutions to IRR (Internal Rate of Return) and Bond Yield-type questions, hampering its ability to attain optimal results. If the model had the capacity for iterative calculations, its score would have soared to 85%. This multifaceted exploration reveals the strengths and limitations of ChatGPT's performance on the finance exam, shedding light on areas where further improvements could enhance its overall efficacy.

In question 20, one can notice that ChatGPT exhibits signs of generating erroneous information, manifesting as a hallucination. Specifically, the model fabricates a formula for risk-neutral probability, deviating from accurate and established principles. The propensity for

hallucinations in AI models poses a significant risk, especially as these models become increasingly convincing and plausible, thereby fostering excessive dependence by users. Paradoxically, the danger of hallucinations intensifies as models exhibit higher levels of accuracy, engendering user trust when providing truthful information in familiar domains. Besides, as these models become integrated into societal frameworks and contribute to the automation of diverse systems, their tendency to hallucinate contributes to the deterioration of overall information quality (OpenAI, 2023).

Equally intriguing is ChatGPT's capacity to recognize its limitations and acknowledge when it encounters insurmountable obstacles. This ability is exemplified in questions 11, 13, and 14, where the model discerns that the problems surpass its current capabilities. Such self-awareness of its limitations is crucial as it motivates the model to strive for improvement and actively learn from these unsolved problems. This adaptive mindset and willingness to tackle challenges are valuable assets for the model's ongoing development and refinement. Finally, it is worth noting that the standard deviation of the discrepancy rate (i.e., ChatGPT answer / expected answer -1) increased as the difficulty level of the questions increased (from 0% to 206%).

Table 1
ChatGPT results

				ChatGPT					
Question	Difficulty	Topic	Real Answer	AI Answer	Discrepancy	Failure Reason	Strengths	Score	
1	Very Easy	Business Algebra	8.70	8.70	0%		Understood the context + Formulated all steps	5	
2	Very Easy	Business Algebra	0.0536	0.0536	0%		Understood the context + Formulated all steps	5	
3	Very Easy	Business Algebra	-0.0820	-0.0820	0%		Understood the context + Formulated all steps	5	
4	Very Easy	Business Algebra	0.0972	0.0971	0%		Understood the context + Formulated all steps	5	
5	Easy	Future Value (FV)	30,915.47	27,091.67	-12%	Can't compute exponent	Understood the context + Formulated all steps	0	
6	Easy	Present Value (PV)	10,133.46	10,135.26	0%		Understood the context + Formulated all steps	5	
7	Easy	Time Value of Money (TVM)	0.1012	0.0742	-27%	Can't compute exponent	Understood the context + Formulated all steps	0	
8	Easy	TVM	21.51	20.32	-6%	Can't compute log	Understood the context + Formulated all steps	0	
9	Medium	FV of Annuity	1,363,075	4,228,901	210%	Can't compute exponent	Understood the context + Formulated all steps	0	
10	Medium	Annuity Payment	18,505.63	23,272.73	26%	Can't compute exponent	Understood the context + Formulated all steps	0	
11	Medium	FV of Growing Annuity	2,236,434	0	-100%	Can't iterate + Missed Formula	Understood the context	0	
12	Medium	PV of Bond	1,166.51	1,165.06	0%	Passed, but missed formula	Understood the context	5	
13	Hard	Bond Yield to Maturity	0.0562	0	-100%	Can't iterate	Understood the context	0	
14	Hard	Bond Price Change	-0.1150	0	-100%	Long numerical computation	Understood the context + Formulated all steps	0	
15	Hard	Net Present Value	283.34	951.99	236%	Can't compute exponent	Understood the context + Formulated all steps	0	
16	Hard	Internal Rate of Return	0.1407	0.0656	-53%	Can't compute exponent	Understood the context + Formulated all steps	0	
17	Very Hard	Stock Valuation	83.93	434.35	418%	Can't figure out terminal year	Understood the context + Formulated few steps	0	
18	Very Hard	Black-Scholes Option Valuation	9.7314	2.2731	-77%	Can't compute log	Understood the context + Formulated all steps	0	
19	Very Hard	Black-Scholes Option Valuation	18.0136	4.2772	-76%	Can't compute log	Understood the context + Formulated all steps	0	
20	Very Hard	Binomial Option Pricing	6.2388	5.58	-11%	Incorrect formulas (Hallucinate)	Understood the context	0	
Standard Deviation of Discrepancy					Grades by Question Difficulty				
Very Easy					0%				100%
Easy					10%				25%
Medium					112%				25%
Hard					140%				0%
Very Hard					206%				0%
TOTAL					126%				30%

This table shows the test results of an undergraduate-level finance exam taken by OpenAI's ChatGPT on May 29, 2023.

The cumulative examination score amounts to 30%. ChatGPT demonstrates proficiency in answering all questions categorized as "Very Easy," achieving a 100% success rate. However, it encounters limitations in responding to questions classified as "Hard" or "Very Hard," yielding no correct answers in these levels. Notably, ChatGPT attains a score of 25% for questions falling under the "Easy" and "Medium" difficulty levels.

ChatGPT has figured out each question's context and aim with 100% accuracy. It has developed the right formula to use with 80% accuracy. However, its main drawback in answering finance questions is that it cannot compute exponents and logs – had it done so, it would have received a 75% score. The second drawback is that it cannot compute iteratively to find solutions to IRR and Bond Yield type of questions – had it done so, the score would have been 85%.

The Bard test run was executed on May 29, 2023. The results are displayed in Table (2), while a comprehensive feedback report from Bard can be found in Appendix (C) – Bard Results.

Compared to ChatGPT, BARD appears comparatively less equipped to address finance-related questions. The cumulative exam score is a mere 15%. Particularly disconcerting is BARD's inability to perform a rudimentary addition operation in response to the first question (Q1). Despite demonstrating accurate comprehension of the contextual goal with a 100% accuracy rate, BARD encountered significant challenges in three critical aspects: delineating an effective pathway to attain the desired goal, discerning the appropriate formulas for each step, and executing precise computations. BARD resorted to employing incorrect formulas from the medium difficulty level and eventually resorted to utilizing hitherto unfamiliar, nonsensical formulas at the hard difficulty level. Compared to ChatGPT, Bard's intermediate steps are cryptic and prone to errors.

As an example, in question 20, Bard says a European call price = $S_1 * p + S_2 * q$ where S_1 = Stock price in the upstate, p = Probability of the stock price going up, S_2 = Stock price in the downstate, and q = Probability of the stock price going down. However, no such formula exists, and the real formula looks something like this: **Call Value** = $\frac{(C_u - C_d)(S_0 - S_d / (1+r)^T)}{(u-d)S_0}$, where C_u = call payoff in upstate, C_d = call payoff in downstate, u = stock price in upstate/stock original price, d = stock price in downstate/stock original price, r = risk-free rate, S_0 = stock price today and S_d = stock price in a down state.

On a positive note, it exhibited a success rate of 75% when addressing questions classified as "Very Easy." Nonetheless, BARD encountered substantial challenges when confronted with questions of higher difficulty levels, resulting in a notable struggle to provide accurate responses. When selecting appropriate formulas, BARD attained an accuracy of only 55%, accompanied by a 25% occurrence of nonsensical formulas. These outcomes collectively point to a lack of sophistication in BARD's approach, manifested by the absence of intermediate steps that could enhance comprehensibility. Furthermore, BARD's performance was marred by fundamental errors, such as an inability to perform elementary arithmetic operations like addition and division. Notably, Bard, like ChatGPT, makes errors while computing exponents and logarithmic functions.

These findings collectively suggest that BARD's development within the finance domain is still trailing behind ChatGPT's. While BARD frequently produces incorrect answers, it demonstrates a relatively closer approximation to the correct answers than ChatGPT, as evidenced by smaller standard deviations. Specifically, BARD exhibits a lower total standard deviation of discrepancy rate (defined as Bard answer divided by the expected answer, minus one) at 28%, in contrast to ChatGPT's higher discrepancy rate of 126%. Despite its lower scores, Bard appears closer to accurate answers than ChatGPT. One reason could be that "Bard often misrepresents how it works."⁸

When asked why Bard picked more incorrect formulas compared to ChatGPT, Bard's response was honest and telling. "ChatGPT is also trained on a massive dataset of text and code, but it may be trained on a different dataset than I am. This difference in training data could explain why ChatGPT picks fewer wrong finance formulas than I do. It is also possible that I am not as good at finance as ChatGPT. I am still learning, and I am not perfect. I may make mistakes and not always be able to provide accurate information."

⁸ Bard FAQ: Is Bard able to explain how it works: <https://bard.google.com/faq>

Table 2
Bard results

				BARD				
Question	Difficulty	Topic	Real Answer	AI Answer	Discrepancy	Failure Reason	Strengths	Score
1	Very Easy	Business Algebra	8.70	8.80	1%	Could not add three prices	Understood the context + Formulated all steps	0
2	Very Easy	Business Algebra	0.0536	0.0536	0%		Understood the context + Formulated all steps	5
3	Very Easy	Business Algebra	-0.0820	-0.0820	0%		Understood the context + Formulated all steps	5
4	Very Easy	Business Algebra	0.0972	0.0972	0%		Understood the context + Formulated all steps	5
5	Easy	Future Value (FV)	30,915.47	34,728.84	12%	Can't compute exponent	Understood the context + Formulated all steps	0
6	Easy	Present Value (PV)	10,133.46	9,245.56	-9%	Can't compute exponent	Understood the context + Formulated all steps	0
7	Easy	Time Value of Money (TVM)	0.1012	0.1115	10%	Can't compute exponent	Understood the context + Formulated all steps	0
8	Easy	TVM	21.51	22.47	4%	Can't compute log	Understood the context + Formulated all steps	0
9	Medium	FV of Annuity	1,363,075	1,142,330	-16%	Can't compute exponent	Understood the context + Formulated all steps	0
10	Medium	Annuity Payment	18,505.63	19,115.88	3%	Can't compute exponent	Understood the context + Formulated all steps	0
11	Medium	FV of Growing Annuity	2,236,434	1,298,129	-42%	Used a wrong formula	Understood the context	0
12	Medium	PV of Bond	1,166.51	1,012.74	-13%	Used a wrong formula	Did not understand the context	0
13	Hard	Bond Yield to Maturity	0.0562	0.0538	-4%	Gibberish formula	Did not understand the context	0
14	Hard	Bond Price Change	-0.1150	-0.1225	7%	Gibberish formula	Did not understand the context	0
15	Hard	Net Present Value	283.34	262.05	-8%	Can't compute exponent	Understood the context + Formulated all steps	0
16	Hard	Internal Rate of Return	0.1407	0.1434	2%	Gibberish formula	Understood the context	0
17	Very Hard	Stock Valuation	83.93	154.12	84%	Gibberish formula	Did not understand the context	0
18	Very Hard	Black-Scholes Option Valuation	9.7314	13.65	40%	Used a wrong formula	Understood the context	0
19	Very Hard	Black-Scholes Option Valuation	18.0136	6.35	-65%	Used a wrong formula	Understood the context	0
20	Very Hard	Binomial Option Pricing	6.2388	5.31	-15%	Gibberish formula	Did not understand the context	0
Standard Deviation of Discrepancy				Grades by Question Difficulty				
Very Easy				0%				75%
Easy				8%				0%
Medium				16%				0%
Hard				5%				0%
Very Hard				56%				0%
TOTAL				28%				15%

The results of Google/Alphabet's Bard on May 29, 2023, are presented in this table. BARD achieved a proficiency level of only 15% in the overall examination. It demonstrated a 75% success rate in answering questions categorized as "Very Easy." However, BARD encountered difficulties with questions at all other higher difficulty levels and struggled to provide accurate responses. When selecting the correct formula, Bard had an accuracy of only 55% and generated nonsensical formulas 25% of the time. Overall, BARD's approach lacked sophistication, as it failed to provide intermediate steps that could aid in understanding.

Moreover, BARD made simple errors, such as being unable to perform basic addition and division operations. These findings indicate that BARD is still lagging behind ChatGPT in terms of its development in the finance domain. While BARD often provides incorrect answers, they are relatively closer to the correct answers than those generated by ChatGPT, as indicated by smaller standard deviations.

In conclusion, BARD's performance in the finance domain highlights areas that warrant significant improvement, particularly its ability to handle intricate questions, accurately select appropriate formulas and execute fundamental mathematical operations.

Bing AI from Microsoft

The Bing AI test run was executed on May 29, 2023. The results are displayed in Table (3), while a comprehensive feedback report from Bard can be found in Appendix (D) – Bing AI Results.

Bing runs on GPT-4, the latest LLM from OpenAI. As OpenAI updates GPT-4 and beyond, Bing benefits from those improvements.⁹ Meanwhile, Bard uses Google's own LaMDA LLM. Bing Chat can generate images, while Bard can generate code and explain it. Consequently, it is reasonable to anticipate that Bing would outperform ChatGPT, which utilizes the earlier GPT-3.5 version.

However, disappointingly, this is not the case. Despite Bing's AI performing better than Bard's, it does not achieve the same level of proficiency as ChatGPT. In the finance quiz, Bing AI received an overall score of 20%, which is lower than ChatGPT's score of 30%. On the other hand, as readers may recall, Bard scored 15% on the same quiz. Interestingly, Bing AI exhibits a higher standard deviation of discrepancy rate at 37% compared to Bard's rate of 28%. However, this value is significantly lower than ChatGPT's strikingly high rate of 126%.

Like ChatGPT and Bard, Bing AI encounters common challenges, including the inability to correctly compute exponents and logarithmic functions, utilizing incorrect formulas, and introducing a new problem of fake URLs. Bing AI attempts to address one particular issue shared by ChatGPT and Bard: the difficulty in accurately citing and referencing materials. Bing AI provides URLs due to its role as a traditional search engine, employing ranking factors like links and website content. In contrast, ChatGPT lacks internet access and cannot crawl or read web pages, making URL provision impossible. Additionally, while Bing focuses on information retrieval, ChatGPT prioritizes conversational engagement, avoiding disruptions like URL inclusion. When questioned about its inability to cite sources, Bard provides the following response:

"I cannot cite sources because I am a large language model, also known as a conversational AI or chatbot trained to be informative and comprehensive. I am trained on a massive amount of text data, and I can communicate and generate human-like text in response to a wide range of prompts and questions. For example, I can provide summaries of factual topics or create stories. However, I cannot cite sources because I cannot access the original text data I was trained on. This data is proprietary and confidential, and I cannot share it with anyone. As a result, I cannot provide any specific information about the sources I used to generate my responses."

Surprisingly, Bing AI offered URLs for just 45% of the exam questions, and a significant portion fell into the "very easy" category. However, on a positive note, out of the 35 URLs provided by Bing AI, all were functional, and an impressive 34 were highly relevant to the given context.

⁹ Bing: https://blogs.bing.com/search/march_2023/Confirmed-the-new-Bing-runs-on-OpenAI%E2%80%99s-GPT-4

Table 3
Bing AI (a.k.a new Bing) results

				Bing AI				
Question	Difficulty	Topic	Real Answer	AI Answer	Discrepancy	Failure Reason	Strengths	Score
1	Very Easy	Business Algebra	8.70	8.70	0%		Understood the context + Formulated all steps	5
2	Very Easy	Business Algebra	0.0536	0.0536	0%		Understood the context + Formulated all steps	5
3	Very Easy	Business Algebra	-0.0820	-0.0817	0%		Understood the context + Formulated all steps	5
4	Very Easy	Business Algebra	0.0972	0.0972	0%		Understood the context + Formulated all steps	5
5	Easy	Future Value (FV)	30,915.47	32,578.81	5%	Can't compute exponent	Understood the context + Formulated all steps	0
6	Easy	Present Value (PV)	10,133.46	9,306.96	-8%	Can't compute exponent	Understood the context + Formulated all steps	0
7	Easy	Time Value of Money (TVM)	0.1012	0.0718	-29%	Can't compute exponent	Understood the context + Formulated all steps	0
8	Easy	TVM	21.51	25.06	17%	Can't compute log	Understood the context + Formulated all steps	0
9	Medium	FV of Annuity	1,363,075	2,039,563	50%	Can't compute exponent	Understood the context + Formulated all steps	0
10	Medium	Annuity Payment	18,505.63	15,096.60	-18%	Can't compute exponent	Understood the context + Formulated all steps	0
11	Medium	FV of Growing Annuity	2,236,434	4,107,710	84%	Can't iterate + Missed Formula	Understood the context	0
12	Medium	PV of Bond	1,166.51	1,048.64	-10%	Can't compute exponent	Understood the context + Formulated all steps	0
13	Hard	Bond Yield to Maturity	0.0562	0.0516	-8%	Can't iterate	Understood the context + Formulated all steps	0
14	Hard	Bond Price Change	-0.1150	-0.1411	23%	Can't compute exponent	Understood the context + Formulated all steps	0
15	Hard	Net Present Value	283.34	238.28	-16%	Can't iterate	Understood the context + Formulated all steps	0
16	Hard	Internal Rate of Return	0.1407	0.1208	-14%	Can't iterate	Understood the context + Formulated all steps	0
17	Very Hard	Stock Valuation	83.93	27.98	-67%	Used a wrong formula	Did not understand the context	0
18	Very Hard	Black-Scholes Option Valuation	9.7314	4.09	-58%	Can't compute log + wrong formula	Understood the context + Formulated all steps	0
19	Very Hard	Black-Scholes Option Valuation	18.0136	5.17	-71%	Can't compute log + wrong formula	Understood the context + Formulated all steps	0
20	Very Hard	Binomial Option Pricing	6.2388	9.44	51%	Can't compute exponent + wrong formula	Understood the context + Formulated all steps	0
				Standard Deviation of Discrepancy		Grades by Question Difficulty		
Very Easy						100%		
Easy						0%		
Medium						0%		
Hard						0%		
Very Hard						0%		
TOTAL						20%		

The results of Bing AI on May 29, 2023, are presented in this table. Bing AI achieved a proficiency level of only 20% in the overall examination. Bing AI's performance in the exam is assessed at 20%. It displays exceptional proficiency when dealing with questions categorized as "Very Easy," achieving a flawless success rate of 100%. Nevertheless, the model faces limitations when confronted with questions at higher difficulty levels, resulting in a 0% accuracy rate for these challenging tasks. Bing AI exhibits similar flaws to ChatGPT and Bard, including making simple errors like being unable to carry out basic addition and division operations. Bing AI provided URLs for only 45% of the exam questions, mostly "very easy" ones. However, all 35 provided URLs were functional, with 34 highly relevant. In terms of sophistication, accuracy, explanation of steps, and formulas, Bing AI demonstrates a moderate level of proficiency, placing it as a middle option among three choices.

Table 4
Error Analysis by Difficulty Level and Platform

Error Analysis by Difficulty Level	ChatGPT					BARD					Bing AI				
	Mean	Median	Min	Max	Std. Dev.	Mean	Median	Min	Max	Std. Dev.	Mean	Median	Min	Max	Std. Dev.
Very Easy	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Easy	11%	9%	-27%	0%	10%	9%	9%	-9%	12%	8%	15%	12%	-29%	17%	17%
Medium	84%	63%	-100%	210%	112%	19%	15%	-42%	3%	16%	40%	34%	-18%	84%	42%
Hard	122%	100%	-100%	236%	140%	5%	5%	-8%	7%	5%	15%	15%	-16%	23%	16%
Very Hard	145%	76%	-77%	418%	206%	51%	53%	-65%	84%	56%	62%	62%	-71%	51%	51%
TOTAL	73%	26%	-100%	418%	126%	17%	8%	-65%	84%	28%	26%	16%	-71%	84%	37%
Exam Score	30%					15%					20%				

This table displays the error rates of three AI platforms in finance exams as of May 29, 2023. ChatGPT achieves the highest exam score at 30%, followed by Bing AI at 20% and BARD at 15%. However, error margins vary across difficulty levels. BARD exhibits the lowest absolute mean error rate at 17%, indicating proximity to reality even if not hitting the mark, akin to landing near the flagstick in golf. Despite ChatGPT's high exam score, its 73% absolute mean error rate suggests a tendency to hit accurately or miss widely. Bing AI, with a mid-range exam score and 26% absolute mean error rate, offers a balanced approach. The standard deviation and median of error rates support these findings, highlighting ChatGPT's precision but with a higher risk of missing and BARD's consistency in landing close to the target.

Table (4) summarizes error rates across AI platforms. Regarding exam scores, ChatGPT achieves the highest score, albeit a failing one at 30%, followed by Bing AI at 20% and BARD at 15%. However, the margin of error varies across difficulty levels. BARD has the lowest absolute mean error rate at 17%, suggesting that while BARD may not hit the mark, its answers are close to reality. This proximity is likened to BARD landing near the flagstick in a golf analogy. Despite ChatGPT having the highest exam score, its absolute mean error rate of 73% is also the highest, indicating a tendency to either hit accurately or miss widely. In contrast, Bing AI stands in the middle with an exam score and an absolute mean error rate of 26%. The standard deviation and median of error rates reinforce this observation, suggesting that if one prioritizes landing close to the target, even at the risk of missing it entirely, ChatGPT is the choice, whereas if one prefers to land in the vicinity of the target, even if not precisely on it, BARD is the option.

Conclusions

This research aimed to assess the performance of three platforms incorporating Artificial Intelligence (AI) large language models (LLMs) - ChatGPT, BARD, and Bing AI. These platforms were utilized to solve 20 quantitative questions covering different difficulty levels in an undergraduate finance exam. The exam questions were specifically created for this study, ensuring no access to previous student solutions. The topics covered in the assessment are commonly found in undergraduate finance textbooks.

ChatGPT performed well in addressing "Very Easy" questions with a flawless success rate of 100%. However, it struggled with "Hard" and "Very Hard" questions, scoring 0%. For "Easy" and "Medium" questions, ChatGPT achieved a score of 25%. The model understood the questions' context well and had an 80% accuracy in selecting the appropriate formulas. Nonetheless, limitations included the inability to compute exponents and logarithmic functions and difficulties with iterative computations for IRR and Bond Yield questions.

BARD, on the other hand, scored 15% on the exam. It faced challenges in comprehending question objectives, selecting formulas, and executing computations. BARD often used incorrect formulas and struggled with basic arithmetic operations. Bing AI, running on GPT-4, performed better than BARD but fell short of ChatGPT. It received an overall score of 20% and provided URLs for only 45% of the questions, mostly in the "very easy" category. However, all 35 URLs provided by Bing AI were functional and highly relevant.

In conclusion, ChatGPT showed proficiency in "Very Easy" questions but encountered limitations in higher difficulty levels. BARD struggled in various aspects of the exam, while Bing AI performed better but still below ChatGPT. Improvements are needed to address limitations and minimize the risks of hallucinations. Common challenges include accurate computations and formula selection. All models shared challenges such as inaccurate computations, incorrect formula usage, and difficulty citing sources. Bing AI addressed the citation issue by providing URLs due to its role as a search engine.

The three AI chatbots assessed in this study are insufficient to assist students in passing the undergraduate finance exam. However, they can serve as valuable tools for dedicated learners. Future technological advancements will likely address the current limitations of AI, enabling improved formula selection and accurate computations involving logarithms, exponents, and more. These advancements can potentially enhance students' performance, enabling them to achieve exceptional scores of 90% or higher in the finance exam.

The paper refrains from offering prescriptions on handling ethical issues in academic integrity but rather presents an overview of generative AI research's current state, limitations in the exam context, and future directions. It emphasizes the need for the academic community to devise reasonable solutions collectively. Given the disruptive nature of generative AI, adaptation becomes imperative for academic community survival and thriving.

References

- AlAfnan, M. A., Dishari, S., Jovic, M., & Lomidze, K. (2023). ChatGPT as an Educational Tool: Opportunities, Challenges, and Recommendations for Communication, Business Writing, and Composition Courses. *Journal of Artificial Intelligence and Technology*, 3(2), Article 2. <https://doi.org/10.37965/jait.2023.0184>
- Berk, J., DeMarzo, P., & Harford, J. (2015). *Fundamentals of Corporate Finance, Global Edition*. The Prentice Hall Ser. in Finance.
- Borgaonkar, A. D., Zambrano-Varghese, C. M., Sodhi, J., & Moon, S. (2020, June 22). *Fantastic Cheats: Where and How to Find Them? How to Tackle Them?* 2020 ASEE Virtual Annual Conference Content Access. <https://peer.asee.org/fantastic-cheats-where-and-how-to-find-them-how-to-tackle-them>
- Brealey, R. A., Myers, S. C., Marcus, A. J., Mitra, D., Maynes, E. M., & Lim, W. (2007). *Fundamentals of corporate finance*.
- Brigham, E. F., & Houston, J. F. (2021). *Fundamentals of Financial Management: Concise*. Cengage Learning.
- Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J. D., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D., Wu, J., Winter, C., ... Amodei, D. (2020). Language Models are Few-Shot Learners. *Advances in Neural Information Processing Systems*, 33, 1877–1901. <https://proceedings.neurips.cc/paper/2020/hash/1457c0d6bfc4967418bfb8ac142f64a-Abstract.html>
- Dowling, M., & Lucey, B. (2023). ChatGPT for (Finance) research: The Bananarama Conjecture. *Finance Research Letters*, 53, 103662. <https://doi.org/10.1016/j.frl.2023.103662>
- Drapkin, A. (2023, April 14). Google Bard vs ChatGPT: Which Is the Best AI Chatbot? [Full Test]. *Tech.Co*. <https://tech.co/news/google-bard-vs-chatgpt>
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., ... Wright, R. (2023). “So what if ChatGPT wrote it?” Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, 71, 102642. <https://doi.org/10.1016/j.ijinfomgt.2023.102642>
- Hamilton, S. R. (2016, June 26). *Imperative Issues and Elusive Solutions in Academic Integrity: A Case Study*. 2016 ASEE Annual Conference & Exposition. <https://peer.asee.org/imperative-issues-and-elusive-solutions-in-academic-integrity-a-case-study>
- Harding, T. S., Mayhew, M. J., Finelli, C. J., & Carpenter, D. D. (2007). The theory of planned behavior as a model of academic dishonesty in engineering and humanities undergraduates. *Ethics & Behavior*, 17(3), 255–279.

- Hu, L. (2022, November 15). *Generative AI and Future*. Medium.
<https://pub.towardsai.net/generative-ai-and-future-c3b1695876f2>
- Jovanović, M., & Campbell, M. (2022). Generative Artificial Intelligence: Trends and Prospects. *Computer*, 55(10), 107–112. <https://doi.org/10.1109/MC.2022.3192720>
- Jr, B. E. W., & Keith-Spiegel, P. (2001). *Academic Dishonesty: An Educator's Guide*. Psychology Press.
- Khan, I. (2023, April 10). *ChatGPT vs. Bing vs. Google Bard: Which AI Is the Most Helpful?* CNET. <https://www.cnet.com/tech/services-and-software/chatgpt-vs-bing-vs-google-bard-which-ai-is-the-most-helpful/>
- Liebrenz, M., Schleifer, R., Buadze, A., Bhugra, D., & Smith, A. (2023). Generating scholarly content with ChatGPT: Ethical challenges for medical publishing. *The Lancet Digital Health*, 5(3), e105–e106. [https://doi.org/10.1016/S2589-7500\(23\)00019-5](https://doi.org/10.1016/S2589-7500(23)00019-5)
- Liu, S., Zappe, S. E., Mena, I. B., Litzinger, T. A., Hochstedt, K. S., & Gallant, T. B. (2015). *Faculty Perspectives About Incorporating Academic Integrity into Engineering Courses*. 26.767.1-26.767.16. <https://peer.asee.org/faculty-perspectives-about-incorporating-academic-integrity-into-engineering-courses>
- Macfarlane, B., Zhang, J., & Pun, A. (2014). Academic integrity: A review of the literature. *Studies in Higher Education*, 39(2), 339–358.
- OpenAI. (2023). *GPT-4 Technical Report* (arXiv:2303.08774). arXiv.
<https://doi.org/10.48550/arXiv.2303.08774>
- Pickering, E., & Schuller, C. (2022). *Widespread usage of Chegg for academic misconduct: Perspective from an audit of Chegg usage within an Australian engineering school*. EdArXiv. <https://doi.org/10.35542/osf.io/ds7yb>
- Radford, A., Narasimhan, K., Salimans, T., & Sutskever, I. (2018). Improving Language Understanding by Generative Pre-Training. *OpenAI*.
- Rahimi, F., & Talebi Bezmin Abadi, A. (2023). ChatGPT and Publication Ethics. *Archives of Medical Research*, 54(3), 272–274. <https://doi.org/10.1016/j.arcmed.2023.03.004>
- Ribas, J. (2023, February 21). *Building the New Bing*. Microsoft Bing Blog.
<https://blogs.bing.com/search-quality-insights/february-2023/Building-the-New-Bing>
- Solaiman, I., Brundage, M., Clark, J., Askill, A., Herbert-Voss, A., Wu, J., Radford, A., Krueger, G., Kim, J. W., Kreps, S., McCain, M., Newhouse, A., Blazakis, J., McGuffie, K., & Wang, J. (2019). *Release Strategies and the Social Impacts of Language Models* (arXiv:1908.09203). arXiv. <https://doi.org/10.48550/arXiv.1908.09203>
- Tamkin, A., Brundage, M., Clark, J., & Ganguli, D. (2021, February 4). *Understanding the Capabilities, Limitations, and Societal Impact of Large Language Models*. ArXiv.Org. <https://arxiv.org/abs/2102.02503v1>

Appendix (A) – Assessment with Solutions and Explanations

QUESTION 1

Difficulty: Very Easy (1/5)

Topic: Business Algebra

Mr. Smith purchased items costing \$3.64, \$2.58, and \$5.08 and gave the cashier a \$20 note. *How much change should Mr. Smith receive?*

Expected Answer: \$8.70

Explanation: $20 - (3.64 + 2.58 + 5.08) = 20 - 11.5 = 8.70$

QUESTION 2

Difficulty: Very Easy (1/5)

Topic: Business Algebra

What percent of 2800 is 150?

Expected Answer: 0.05357 or 5.36%

Explanation: 150 is approximately 5.36% of 2800.

QUESTION 3

Difficulty: Very Easy (1/5)

Topic: Business Algebra

Revenues of ValKart have fallen from \$267,865 in the previous year to \$245,902 this year. *How much is the annual percentage decline in revenues?*

Expected Answer: -0.08199 or -8.2%

Explanation: $245,902/267,865 - 1$

QUESTION 4

Difficulty: Very Easy (1/5)

Topic: Business Algebra

On July 22, 2018, Peter purchased 30 shares of XYZ Inc. stock at \$149.73 per share. On July 22, 2019, Peter sold all his shares at \$164.28. *What is Peter's percentage rate of return on his investment in XYZ Inc.? Assume that XYZ Inc. did not pay any dividends over this period.*

Expected Answer: 0.0972 or 9.72%

Explanation: $(164.28 - 149.73)/149.73 = 14.55/149.73 = 0.0972 = 9.72\%$

QUESTION 5

Difficulty: Easy (2/5)

Topic: Future Value

You are considering investing in a savings account. You currently have \$15,000 and do not anticipate needing that money for 10 years. Banks are paying a 7.5% interest rate per year. If you invest, *how much money will you have after 10 years?*

Expected Answer: \$30,915.47

Explanation: $FV = PV(1 + r)^N = 15000(1 + 0.075)^{10} = 30915.47$

QUESTION 6

Difficulty: Easy (2/5)

Topic: Present Value

You are considering investing in a savings account that will pay \$15,000 in ten years. If the interest rate is fixed at 4% per year, *how much should you deposit in the savings account today?*

Expected Answer: \$10,133.46

Explanation: $PV = \frac{FV}{(1+r)^N} = \frac{15000}{(1+0.040)^{10}} = 10133.46$

QUESTION 7
of Money

Difficulty: Easy (2/5)

Topic: Time Value

You want to buy a house in 4 years and expect to need \$25,000 for a down payment at that time. Currently, you have \$17,000 to invest. *How much interest do you have to earn (compounded annually) to reach your goal?*

Expected Answer: 0.1012 or 10.12%

Explanation: $r = \left(\frac{FV}{PV}\right)^{\frac{1}{N}} - 1 = \left(\frac{25000}{17000}\right)^{\frac{1}{4}} - 1 = 0.1012$

QUESTION 8
of Money

Difficulty: Easy (2/5)

Topic: Time Value

You can retire when your investment account reaches \$1.5 million. Currently, it has \$350,000. *How many years will it take for you to retire if your investments produce a 7% annual return?*

Expected Answer: 21.51

Explanation: $N = \frac{\ln\left(\frac{FV}{PV}\right)}{\ln(1+r)} = \frac{\ln\left(\frac{1500000}{350000}\right)}{\ln(1+0.07)} = 21.51$

QUESTION 9
Annuity

Difficulty: Medium (3/5)

Topic: Future Value of

Janet is 35 years old and has decided it is time to plan seriously for her retirement. At the end of each year, until she is 65, she will save \$10,000 in a retirement account. If the account earns 9% annually, *how much money will Janet have at age 65?*

Expected Answer: 1,363,075

Explanation: $FV_A = \frac{PMT}{r} \times [(1+r)^N - 1] = \frac{10000}{0.09} \times [(1+0.09)^{30} - 1] = 1,363,075$

QUESTION 10

Difficulty: Medium (3/5)

Topic: Annuity Payment

Maria plans to buy a house for \$400,000. A bank offers her a 30-year loan with equal annual payments at the end of each year and an interest rate of 4% per year. The bank requires that Maria pay 20% of the purchase price as a down payment. *How much does Maria have to pay as the annual loan payment?*

Expected Answer: 18,505.63

Explanation: $PMT = PV \times \frac{r}{1 - \frac{1}{(1+r)^N}} = (1 - 0.2) \times 400000 \times \frac{0.04}{1 - \frac{1}{(1+0.04)^{30}}} = 18,505.63$

QUESTION 11
Annuity

Difficulty: Medium (3/5)

Topic: Future Value of Growing

Janet is 35 years old and has decided it is time to plan seriously for her retirement. Although \$10,000 is the most she can save by the end of the first year, she expects her salary to increase each year so that she will be able to increase her retirement contribution by 5% per year. If the retirement account earns 9% annually, *How much money will Janet have at age 65?*

Expected Answer: 2,236,434

Explanation: $FV = \frac{C}{r-g} \times [(1+r)^N - (1+g)^N] = \frac{10000}{0.09-0.05} \times [(1+0.09)^{30} - (1+0.05)^{30}] = 2,236,434$

QUESTION 12 **Difficulty: Medium (3/5)** **Topic: Bond Present Value**

Suppose the US government is issuing a \$1,000 par value coupon bond today. This bond will mature in 3 years from today. The bond's annual coupon rate is 10%, and coupons are paid yearly. The investors expect a 4% annual return on this bond. *How much is the present value of this bond?*

Expected Answer: \$1,166.51

Explanation: $PV_B = PMT \left(\frac{1}{r} \left[1 - \frac{1}{(1+r)^n} \right] \right) + M \left(\frac{1}{(1+r)^n} \right)$
 $= 0.1 \times 1000 \left(\frac{1}{0.04} \left[1 - \frac{1}{(1+0.04)^3} \right] \right) + 1000 \left(\frac{1}{(1+0.04)^3} \right) =$

1,161.51

QUESTION 13 **Difficulty: Hard (4/5)** **Topic: Bond Yield to Maturity**

Suppose the US government just issued a \$1,000 par value coupon bond today. This bond will mature in 15 years from today. The bond's annual coupon rate is 6%, and coupons are paid four times yearly. The bond is currently trading at \$1038.32. *How much is the yield to maturity (YTM) of this bond?*

Expected Answer: 0.0562 or 5.62%

Explanation: *There is no closed-form solution for this problem. It has to be solved with numerical optimization techniques.*

QUESTION 14 **Difficulty: Hard (4/5)** **Topic: Bond Price Change**

Consider two bonds with a \$1,000 face value: one with a 10-year maturity and the other with a 30-year maturity. Both bonds offer a 10% annual coupon, paid once a year. Assuming that interest rates, and hence the yield to maturity (YTM), changed from 6% to 7%, *by what percentage will the price of the 30-year bond change?*

Expected Answer: -0.1150 or -11.50%

Explanation: $\frac{\left[\left(\frac{PMT}{r_2} \left[1 - \frac{1}{(1+r_2)^n} \right] \right) + \left(\frac{M}{(1+r_2)^n} \right) \right]}{\left[\left(\frac{PMT}{r_1} \left[1 - \frac{1}{(1+r_1)^n} \right] \right) + \left(\frac{M}{(1+r_1)^n} \right) \right]} - 1 = \frac{\left[\left(\frac{0.1 \times 1000}{0.07} \left[1 - \frac{1}{(1+0.07)^{30}} \right] \right) + \left(\frac{1000}{(1+0.07)^{30}} \right) \right]}{\left[\left(\frac{0.1 \times 1000}{0.06} \left[1 - \frac{1}{(1+0.06)^{30}} \right] \right) + \left(\frac{1000}{(1+0.06)^{30}} \right) \right]} - 1 =$

-0.1150

QUESTION 15 Difficulty: Hard (4/5)**Topic: Net Present Value**

Stacy and John lend small amounts to other students in need. Their yearly cash flows are shown below. Both of them can borrow or save from a bank on campus at an annual rate of 10.00%.

Stacy	John	Year
-\$300	-\$405	0
-\$387	\$134	1
-\$193	\$134	2
-\$100	\$134	3
\$600	\$134	4
\$600	\$134	5
\$850	\$134	6
-\$180	\$0	7

How much is Stacy's NPV (net present value)?

Expected Answer: 283.34

Explanation: $\sum_{i=0}^7 \frac{PMT_i}{(1+r)^i}$

$$= \frac{-300}{(1+0.1)^0} + \frac{-387}{(1+0.1)^1} + \frac{-193}{(1+0.1)^2} + \frac{-100}{(1+0.1)^3} + \frac{600}{(1+0.1)^4} + \frac{600}{(1+0.1)^5} + \frac{850}{(1+0.1)^6} + \frac{-180}{(1+0.1)^7} = 283.34$$

QUESTION 16 Difficulty: Hard (4/5)**Topic: Internal Rate of Return**

Stacy and John lend small amounts to other students in need. Their yearly cash flows are shown below. Both of them can borrow or save from a bank on campus at an annual rate of 10.00%.

Stacy	John	Year
-\$300	-\$405	0
-\$387	\$134	1
-\$193	\$134	2
-\$100	\$134	3
\$600	\$134	4
\$600	\$134	5
\$850	\$134	6
-\$180	\$0	7

How much is Stacy's MIRR (modified internal rate of return)?

Expected Answer: 0.1407 or 14.07%

Explanation: There is no closed-form solution for this problem. It has to be solved with numerical optimization techniques.

QUESTION 17 Difficulty: Very Hard (5/5) Topic: Stock Valuation

How much is the value of this company's stock using the 2-stage dividend discount method?

Relevant data for ABC Inc. is provided below. Suppose today's date is 01/01/2022.

ABC Inc.	
Expected Annual Dividends	By the End of the Year
\$2.23	2022
\$2.28	2023
\$2.32	2024
\$2.36	2025
1.93%	Stage1 dividend growth (g1)
2.00%	Stage2 dividend growth (g2)
0.500	Stock Beta (β)
1.655%	Risk-free Rate (R_f)
6.00%	Market Risk Premium (MRP)
\$146.81	Current Stock Price

Expected Answer: \$83.93

Explanation: $r = R_f + \beta \times \text{MRP} = 1.655\% + 0.5 \times 6\% = 4.655\%$

$CF_1 = \$2.23$, $CF_2 = \$2.28$, $CF_3 = \$2.32$

$CF_4 = 2.36 + 2.36 \times \frac{1+g_2}{r-g_2} = \$2.36 + \$2.36 \times (1 + 2\%) / (4.655\% - 2\%) = \93.20

$NPV = \sum_{i=1}^4 \frac{CF_i}{(1+r)^i} = \83.93

QUESTION 18 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

Use the Black-Scholes Option (European) Pricing Model.

Suppose a stock is trading today for \$142.07.

Stock annual volatility is 23.50%, and stock dividend yield is 1.54%.

Suppose the annual risk-free rate is 1.22%, and the option exercise price is \$150.00.

The option expires in 1.00 years (or 360 days).

How much is the value of this Call option?

Expected Answer: \$9.7314

Explanation: $c = S_0 N(d_1) e^{-\delta T} - K e^{-rT} N(d_2)$

$$\text{where } d_1 = \frac{\ln\left[\frac{S_0}{K}\right] + \left(r - \delta + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}; \quad d_2 = d_1 - \sigma\sqrt{T}$$

$$d_1 = -0.1272; d_2 = -0.3622; N(d_1) = 0.4494; N(d_2) = 0.3586, c =$$

9.7314

$$K = 150; S_0 = 142.07; \sigma = 23.50\%; T = 1; \delta = 1.54\%$$

QUESTION 19 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

Use the Black-Scholes Option (European) Pricing Model.

Suppose a stock is trading today for \$142.07.

Stock annual volatility is 23.50%, and stock dividend yield is 1.54%.

Suppose the annual risk-free rate is 1.22%, and the option exercise price is \$150.00.

The option expires in 1.00 years (or 360 days).

How much is the value of this Put option?

Expected Answer: \$18.0136

Explanation: $p = -S_0 N(-d_1) e^{-\delta T} + K e^{-rT} N(-d_2)$

$$\text{where } d_1 = \frac{\ln\left[\frac{S_0}{K}\right] + \left(r - \delta + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}; \quad d_2 = d_1 - \sigma\sqrt{T}$$
$$d1 = -0.1272; d2 = -0.3622; N(d1) = 0.4494; N(d2) = 0.3586, p =$$

18.0136

$$K = 150; S_0 = 142.07; \sigma = 23.50\%; T = 1; \delta = 1.54\%$$

QUESTION 20 Difficulty: Very Hard (5/5) Topic: Binomial Option Pricing

Use a 2-state discrete-time Binomial option (European) pricing model.

Suppose you bought a stock today for \$27.00. Stock prices can either go up by a factor of 1.41 or

down by a factor of 0.71 with equal probability in 0.50 years (or 180 days).

Suppose the annual risk-free rate is 6.00% and the option exercise price is 24.00.

How much is the Call Option Value that expires in 0.50 years?

Expected Answer: \$6.2388

Explanation: $K = \$24.00; S_0 = \$27.00; S_u = \$38.07; S_d = \$19.17; r = 6.00\%; T = 0.50$

$$\text{Call Value} = \frac{(C_u - C_d)(S_0 - S_d/(1+r)^T)}{(u-d)S_0} = \frac{(14.07-0)\left(27-19.17/(1+0.06)^{\frac{1}{2}}\right)}{(1.41-0.71)27} =$$

\$6.2388

where C_u = Call payoff in upstate

C_d = Call payoff in downstate

u = Stock price in upstate/original price

d = Stock price in downstate/original price

r = Risk-free rate

S_0 = Stock price today

S_d = Stock price in downstate

S_u = Stock price in upstate

Appendix (B) – OpenAI's ChatGPT Results

QUESTION 1

Difficulty: Very Easy (1/5)

Topic: Business Algebra

Expected Answer: \$8.70

ChatGPT Answer: \$8.70

To calculate the change Mr. Smith should receive, we need to subtract the total cost of the items from the amount he gave to the cashier.

The total cost of the items is: $\$3.64 + \$2.58 + \$5.08 = \11.30

Mr. Smith gave the cashier a \$20 note, so the change he should receive is: $\$20 - \$11.30 = \$8.70$

Therefore, Mr. Smith should receive \$8.70 in change.

QUESTION 2**Difficulty: Very Easy (1/5)****Topic: Business Algebra****Expected Answer:** *0.05357 or 5.36%***ChatGPT Answer:** 0.0536

To find the percentage of one number in relation to another number, we divide the first number by the second number and then multiply by 100.

In this case, we want to find the percentage of 150 in relation to 2800.

Percentage = $(150 / 2800) * 100$

Calculating this expression:

Percentage = $(0.05357142857) * 100$

Percentage ≈ 5.36

Therefore, 150 is approximately 5.36% of 2800.

QUESTION 3**Difficulty: Very Easy (1/5)****Topic: Business Algebra****Expected Answer:** *-0.08199 or -8.2%***ChatGPT Answer:** -0.0820

To calculate the annual percentage decline in revenues, we need to find the difference between the two revenue figures, divide it by the previous year's revenue, and then multiply by 100 to express it as a percentage.

The difference in revenues is: $\$267,865 - \$245,902 = \$21,963$

To calculate the percentage decline: Percentage decline = $(\text{Difference} / \text{Previous year's revenue}) * 100$

Percentage decline = $(\$21,963 / \$267,865) * 100$

Percentage decline $\approx 8.20\%$

Therefore, the annual percentage decline in revenues for ValKart is approximately 8.20%.

QUESTION 4**Difficulty: Very Easy (1/5)****Topic: Business Algebra****Expected Answer:** *0.0972 or 9.72%***ChatGPT Answer:** 0.0971

To calculate Peter's percentage rate of return on his investment, we need to determine the difference between the selling price and the buying price, divide it by the buying price, and then multiply by 100 to express it as a percentage.

Buying price: \$149.73 per share

Selling price: \$164.28 per share

Number of shares: 30

Total investment cost = Buying price per share * Number of shares

Total investment cost = $\$149.73 * 30 = \$4,491.90$

Total selling price = Selling price per share * Number of shares

Total selling price = $\$164.28 * 30 = \$4,928.40$

Profit or gain = Total selling price - Total investment cost

Profit or gain = $\$4,928.40 - \$4,491.90 = \$436.50$

Percentage rate of return = (Profit or gain / Total investment cost) * 100

Percentage rate of return = (\$436.50 / \$4,491.90) * 100

Percentage rate of return $\approx 9.71\%$

Therefore, Peter's percentage rate of return on his investment in XYZ Inc. is approximately 9.71%.

QUESTION 5**Difficulty: Easy (2/5)****Topic: Future Value****Expected Answer: \$30,915.47****ChatGPT Answer: \$27,091.67**

To calculate the future value of your investment after 10 years, we can use the formula for compound interest: $\text{Future Value} = \text{Present Value} * (1 + \text{Interest Rate})^{\text{Number of Periods}}$

Present Value = \$15,000

Interest Rate = 7.5% = 0.075 (converted to decimal)

Number of Periods = 10 years

Plugging in the values:

Future Value = \$15,000 * (1 + 0.075)¹⁰

Future Value \approx \$15,000 * 1.806111417

Future Value \approx \$27,091.67

Therefore, if you invest \$15,000 in a savings account with a 7.5% interest rate per year for 10 years, you would have approximately \$27,091.67 at the end of the period.

QUESTION 6**Difficulty: Easy (2/5)****Topic: Present Value****Expected Answer: \$10,133.46****ChatGPT Answer: \$10,135.26**

To calculate the present value or initial deposit required to receive \$15,000 in ten years with a

fixed interest rate of 4% per year, we can use the formula for present value of a future amount:

$\text{Present Value} = \text{Future Value} / (1 + \text{Interest Rate})^{\text{Number of Periods}}$

Future Value = \$15,000

Interest Rate = 4% = 0.04 (converted to decimal)

Number of Periods = 10 years

Plugging in the values:

Present Value = \$15,000 / (1 + 0.04)¹⁰

Present Value \approx \$15,000 / 1.480244589

Present Value \approx \$10,135.26

Therefore, you should deposit approximately \$10,135.26 in the savings account today to receive \$15,000 in ten years with a fixed interest rate of 4% per year.

QUESTION 7**Difficulty: Easy (2/5)****Topic: Time Value of Money****Expected Answer: 0.1012 or 10.12%****ChatGPT Answer: 0.0742**

To calculate the interest, you need to earn to reach your goal of \$25,000 for a down payment on

a house in 4 years, we can use the formula for compound interest:

$$\text{Future Value} = \text{Present Value} * (1 + \text{Interest Rate})^{\text{Number of Periods}}$$

$$\text{Present Value} = \$17,000$$

$$\text{Future Value} = \$25,000$$

$$\text{Number of Periods} = 4 \text{ years}$$

Let's denote the interest rate as "x".

Using the formula, we can rearrange it to solve for the interest rate:

$$\text{Interest Rate} = (\text{Future Value} / \text{Present Value})^{(1/\text{Number of Periods})} - 1$$

$$\text{Interest Rate} = (\$25,000 / \$17,000)^{(1/4)} - 1$$

$$\text{Interest Rate} \approx 0.07418$$

Therefore, you need to earn approximately 7.42% interest (compounded annually) to reach your goal of \$25,000 for a down payment on a house in 4 years.

QUESTION 8 of Money

Difficulty: Easy (2/5)

Topic: Time Value

Expected Answer: 21.51

ChatGPT Answer: 20.32

To calculate the number of years it will take for your investment account to reach \$1.5 million with a

7% annual return, we can use the formula for the future value of a present amount:

$$\text{Future Value} = \text{Present Value} * (1 + \text{Interest Rate})^{\text{Number of Periods}}$$

$$\text{Present Value} = \$350,000$$

$$\text{Future Value} = \$1,500,000$$

$$\text{Interest Rate} = 7\% = 0.07 \text{ (converted to decimal)}$$

Let's denote the number of periods (years) as "n".

$$\text{Plugging in the values: } \$1,500,000 = \$350,000 * (1 + 0.07)^n$$

Dividing both sides by \$350,000:

$$4.2857 = (1.07)^n$$

Taking the logarithm of both sides (base 10):

$$\log(4.2857) = n * \log(1.07)$$

$$n \approx \log(4.2857) / \log(1.07)$$

$$n \approx 20.32$$

Therefore, it will take approximately 20.32 years for your investment account to reach \$1.5 million with a 7% annual return.

QUESTION 9 Annuity

Difficulty: Medium (3/5)

Topic: Future Value of

Expected Answer: 1,363,075

ChatGPT Answer: 4,228,901

To calculate how much money Janet will have at age 65, we can use the formula for the future value of an ordinary annuity: $\text{Future Value} = \text{Payment Amount} * [(1 + \text{Interest Rate})^{\text{Number of Periods}} - 1] / \text{Interest Rate}$

$$\text{Payment Amount} = \$10,000$$

$$\text{Interest Rate} = 9\% = 0.09 \text{ (converted to decimal)}$$

$$\text{Number of Periods} = 65 - 35 = 30 \text{ years (since she is currently 35 years old)}$$

Plugging in the values:

$$\text{Future Value} = \$10,000 * [(1 + 0.09)^{30} - 1] / 0.09$$

Calculating this expression:

$$\text{Future Value} \approx \$10,000 * [3.855196 - 1] / 0.09$$

$$\text{Future Value} \approx \$10,000 * 38.280107 / 0.09$$

$$\text{Future Value} \approx \$4,228,900.77$$

Therefore, Janet will have approximately \$4,228,900.77 in her retirement account at age 65 if she saves \$10,000 at the end of each year and the account earns 9% annually.

QUESTION 10 Difficulty: Medium (3/5) Topic: Annuity Payment

Expected Answer: **18,505.63**

ChatGPT Answer: 23,272.73

To calculate the annual loan payment for Maria's house purchase, we first need to determine the loan

amount. The purchase price of the house is \$400,000, and the bank requires a 20% down payment. So, Maria needs to pay 20% of \$400,000 as a down payment:

$$\text{Down payment} = 20\% * \$400,000 = \$80,000$$

The loan amount is the remaining balance after the down payment:

$$\text{Loan amount} = \text{Purchase price} - \text{Down payment}$$

$$\text{Loan amount} = \$400,000 - \$80,000 = \$320,000$$

Next, we can calculate the annual loan payment using the formula for the present value of an ordinary

$$\text{annuity: Annual Loan Payment} = \text{Loan Amount} * (\text{Interest Rate} / (1 - (1 + \text{Interest Rate})^{(-\text{Number of Periods})}))$$

$$\text{Loan Amount} = \$320,000$$

$$\text{Interest Rate} = 4\% = 0.04 \text{ (converted to decimal)}$$

$$\text{Number of Periods} = 30 \text{ years}$$

Plugging in the values:

$$\text{Annual Loan Payment} = \$320,000 * (0.04 / (1 - (1 + 0.04)^{(-30)}))$$

Calculating this expression:

$$\text{Annual Loan Payment} \approx \$320,000 * (0.04 / (1 - 0.449462207))$$

$$\text{Annual Loan Payment} \approx \$320,000 * (0.04 / 0.550537793)$$

$$\text{Annual Loan Payment} \approx \$320,000 * 0.072727273$$

$$\text{Annual Loan Payment} \approx \$23,272.73$$

Therefore, Maria has to pay approximately \$23,272.73 as the annual loan payment for the 30-year loan with equal annual payments at the end of each year and an interest rate of 4% per year.

QUESTION 11 Difficulty: Medium (3/5) Topic: Future Value of Growing Annuity

Expected Answer: **2,236,434**

ChatGPT Answer: Unable to compute

First, let's calculate the payment amount for each year, considering a 5% increase:

$$\text{Year 1: Payment Amount} = \$10,000$$

$$\text{Year 2: Payment Amount} = \$10,000 * (1 + 0.05) = \$10,500$$

$$\text{Year 3: Payment Amount} = \$10,500 * (1 + 0.05) = \$11,025$$

And so on, until Year 65.

Now, let's calculate the future value using the formula for the future value of an increasing annuity:

Future Value = Payment Amount * $[(1 + \text{Interest Rate})^{\text{Number of Periods}} - 1] / \text{Interest Rate}$

Payment Amount Year 1 = \$10,000

Interest Rate = 9% = 0.09 (converted to decimal)

Number of Periods = 65 - 35 = 30 years

Future Value = \$10,000 * $[(1 + 0.09)^{30} - 1] / 0.09$

+ \$10,500 * $[(1 + 0.09)^{29} - 1] / 0.09$

+ \$11,025 * $[(1 + 0.09)^{28} - 1] / 0.09$

+ ...

+ Payment Amount (Year 65) * $[(1 + 0.09)^1 - 1] / 0.09$

By summing up the future values for each year, we can determine the total amount Janet will have at age 65. Calculating this expression will give us the total future value.

Unfortunately, due to the complexity of the calculation, it is not feasible to provide an exact answer without using a financial calculator or spreadsheet software. However, you can use the given formula and calculate the future value using the provided parameters to find the specific amount Janet will have at age 65.

QUESTION 12 Difficulty: Medium (3/5) Topic: Bond Present Value

Expected Answer: **\$1,166.51**

ChatGPT Answer: \$1,165.06

To calculate the present value of the bond, we need to find the present value of each cash flow (coupon payments and the principal payment) and sum them up.

Given: Par value (Principal payment) = \$1,000

Coupon rate = 10% (annual rate)

Coupon payment = Coupon rate * Par value = 0.10 * \$1,000 = \$100

Number of years to maturity = 3

Required annual return = 4% (annual rate)

Step 1: Calculate the present value of each coupon payment: PV of each coupon payment = Coupon payment / $(1 + \text{Required annual return})^n$

Where n is the number of years until the coupon payment.

Year 1: PV of coupon payment = $\$100 / (1 + 0.04)^1 = \96.15

Year 2: PV of coupon payment = $\$100 / (1 + 0.04)^2 = \92.59

Year 3: PV of coupon payment = $\$100 / (1 + 0.04)^3 = \89.29

Step 2: Calculate the present value of the principal payment (par value) at maturity:

PV of principal payment = Par value / $(1 + \text{Required annual return})^n$

PV of principal payment = $\$1,000 / (1 + 0.04)^3 = \887.03

Step 3: Calculate the present value of the bond by summing up the present values of the coupon payments and the principal payment:

Present value of the bond = PV of coupon payment (Year 1) + PV of coupon payment (Year 2) + PV of coupon payment (Year 3) + PV of principal payment

Present value of the bond = $\$96.15 + \$92.59 + \$89.29 + \$887.03 = \$1,165.06$

Therefore, the present value of the bond is approximately \$1,165.06.

QUESTION 13 Difficulty: Hard (4/5) Topic: Bond Yield to Maturity

Expected Answer: 0.0562 or 5.62%

ChatGPT Answer: Unable to compute

To calculate the yield to maturity (YTM) of the bond, we can use an iterative approach since the YTM is not directly calculable using a simple formula. Here's how we can estimate the YTM:

Given:

Par value (Principal payment) = \$1,000

Coupon rate = 6% (annual rate)

Number of coupon payments per year = 4

Maturity period = 15 years

Current bond price = \$1,038.32

Step 1: Calculate the coupon payment per period:

Coupon payment = Coupon rate * Par value / Number of coupon payments per year

Coupon payment = $0.06 * \$1,000 / 4 = \15

Step 2: Determine the number of periods until maturity:

Number of periods = Number of coupon payments per year * Maturity period

Number of periods = $4 * 15 = 60$

Step 3: Estimate the YTM iteratively using the bond price and the expected future cash flows:

Start with an initial guess for the YTM (let's assume 4%):

YTM guess = 4% = 0.04 (converted to decimal)

Use the guessed YTM to calculate the present value of the bond's future cash flows:

$$PV = \text{Coupon payment} * [1 - (1 + \text{YTM guess})^{(-\text{Number of periods})}] / \text{YTM guess} + \text{Par value} / (1 + \text{YTM guess})^{\text{Number of periods}}$$

Adjust the guess based on the difference between the calculated present value (PV) and the current bond price: $\text{New YTM guess} = \text{YTM guess} + (\text{PV} - \text{Current bond price}) / (\text{Par value} + \text{Current bond price}) / 2$

Repeat steps 3 and 4 using the new guess until the difference between the calculated PV and the

current bond price becomes very small (e.g., less than 0.01).

By repeating these steps iteratively, we can converge on an approximate YTM value.

Please note that the calculations involve multiple iterations and might require a financial calculator or software for precise calculations.

QUESTION 14 Difficulty: Hard (4/5)**Topic: Bond Price Change****Expected Answer:** **-0.1150 or -11.50%****ChatGPT Answer:** Unable to compute

To calculate the percentage change in the price of the 30-year bond due to a change in yield to maturity (YTM) from 6% to 7%, we can use the bond price-yield relationship formula.

Given:

Face value (F) = \$1,000

Annual coupon rate = 10%

Number of years to maturity:

- For the 10-year bond: $n = 10$

- For the 30-year bond: $n = 30$

Initial YTM = 6%

New YTM = 7%

Using the bond price-yield relationship formula:

For the 10-year bond:

Coupon payment (C) = $0.10 * \$1,000 = \100

Bond Price (initial) = $C * [(1 - (1 + \text{Initial YTM})^{-n}) / \text{Initial YTM}] + (F / (1 + \text{Initial YTM})^n)$

For the 30-year bond:

Coupon payment (C) = $0.10 * \$1,000 = \100

Bond Price (initial) = $C * [(1 - (1 + \text{Initial YTM})^{-n}) / \text{Initial YTM}] + (F / (1 + \text{Initial YTM})^n)$

Now, let's calculate the prices of both bonds using the initial YTM of 6% and the new YTM of 7%:

For the 10-year bond:

Bond Price (initial) = $\$100 * [(1 - (1 + 0.06)^{-10}) / 0.06] + (\$1,000 / (1 + 0.06)^{10})$

Bond Price (new) = $\$100 * [(1 - (1 + 0.07)^{-10}) / 0.07] + (\$1,000 / (1 + 0.07)^{10})$

For the 30-year bond:

Bond Price (initial) = $\$100 * [(1 - (1 + 0.06)^{-30}) / 0.06] + (\$1,000 / (1 + 0.06)^{30})$

Bond Price (new) = $\$100 * [(1 - (1 + 0.07)^{-30}) / 0.07] + (\$1,000 / (1 + 0.07)^{30})$

Now, we can calculate the percentage change in the price of the 30-year bond:

Percentage Change = $((\text{Bond Price (new)} - \text{Bond Price (initial)}) / \text{Bond Price (initial)}) * 100$

By substituting the calculated values into the formula, we can determine the percentage change in the price of the 30-year bond due to the change in YTM.

Please note that the actual calculations involve substituting the values and performing the necessary arithmetic.

QUESTION 15 Difficulty: Hard (4/5)**Topic: Net Present Value****Expected Answer:** **283.34****ChatGPT Answer:** **951.99**

To calculate Stacy's Net Present Value (NPV), we need to discount each cash flow to its present value using the given annual rate of 10.00%. Then we sum up all the present values to find the NPV.

The cash flows for Stacy are as follows:

Year 0: -\$300

Year 1: -\$387

Year 2: -\$193

Year 3: -\$100

Year 4: \$600

Year 5: \$600

Year 6: \$850

Year 7: -\$180

To calculate the present value of each cash flow, we divide it by $(1 + r)^n$, where r is the annual interest rate and n is the number of years.

Using a discount rate of 10.00%:

Present Value (Year 0) = $-\$300 / (1 + 0.10)^0 = -\300

Present Value (Year 1) = $-\$387 / (1 + 0.10)^1 = -\351.82

Present Value (Year 2) = $-\$193 / (1 + 0.10)^2 = -\157.02

Present Value (Year 3) = $-\$100 / (1 + 0.10)^3 = -\75.13

Present Value (Year 4) = $\$600 / (1 + 0.10)^4 = \412.09

Present Value (Year 5) = $\$600 / (1 + 0.10)^5 = \355.47

Present Value (Year 6) = $\$850 / (1 + 0.10)^6 = \579.05

Present Value (Year 7) = $-\$180 / (1 + 0.10)^7 = -\110.75

Now, we can calculate Stacy's NPV by summing up all the present values:

NPV = Present Value (Year 0) + Present Value (Year 1) + Present Value (Year 2) + Present Value (Year 3) + Present Value (Year 4) + Present Value (Year 5) + Present Value (Year 6) + Present Value (Year 7)

$$= -\$300 + (-\$351.82) + (-\$157.02) + (-\$75.13) + \$412.09 + \$355.47 + \$579.05 + (-\$110.75) \\ = \$951.99$$

Therefore, Stacy's NPV is \$951.99.

QUESTION 16 Difficulty: Hard (4/5)

Topic: Internal Rate of Return

Expected Answer: 0.1407 or 14.07%

ChatGPT Answer: 0.0656

To calculate Stacy's Modified Internal Rate of Return (MIRR), we need to determine the discount rate that equates the present value of her cash outflows (negative cash flows) with the future value of her cash inflows (positive cash flows). The cash flows for Stacy are as follows:

Year 0: -\$300

Year 1: -\$387

Year 2: -\$193

Year 3: -\$100

Year 4: \$600

Year 5: \$600

Year 6: \$850

Year 7: -\$180

First, we need to calculate the present value of Stacy's cash outflows (negative cash flows).

We will use the discount rate of 10.00% for this calculation.

Present Value (Outflows) = $(-\$300 / (1 + 0.10)^0) + (-\$387 / (1 + 0.10)^1) + (-\$193 / (1 + 0.10)^2) + (-\$100 / (1 + 0.10)^3) + (-\$180 / (1 + 0.10)^7)$

$$= -\$300 + (-\$351.82) + (-\$157.02) + (-\$75.13) + (-\$110.75) = -\$994.72$$

Next, we need to calculate the future value of Stacy's cash inflows (positive cash flows) at the end of Year 7. Future Value (Inflows) =

$$(\$600 / (1 + 0.10)^4) + (\$600 / (1 + 0.10)^5) + (\$850 / (1 + 0.10)^6) + (\$0 / (1 + 0.10)^7) = \$412.09 + \$355.47 + \$579.05 + \$0 = \$1,346.61$$

Now, we can calculate Stacy's MIRR by finding the discount rate that equates the present value of outflows to the future value of inflows.

$$\text{MIRR} = (\text{Future Value (Inflows)} / \text{Present Value (Outflows)})^{(1/n)} - 1$$
$$= (\$1,346.61 / -\$994.72)^{(1/7)} - 1 \approx 1.0656 - 1 \approx 0.0656$$

Finally, we convert the MIRR into a percentage by multiplying it by 100:

$$\text{Stacy's MIRR} \approx 0.0656 * 100 \approx 6.56\%$$

Therefore, Stacy's Modified Internal Rate of Return (MIRR) is approximately 6.56%.

QUESTION 17 Difficulty: Very Hard (5/5) Topic: Stock Valuation

Expected Answer: **\$83.93**

ChatGPT Answer: \$434.35

To calculate the value of ABC Inc.'s stock using the 2-stage dividend discount method, we need to determine the present value of the future dividends and the future stock price.

Given data:

Expected Annual Dividends:

- 2022: \$2.23

- 2023: \$2.28

- 2024: \$2.32

- 2025: \$2.36

Stage 1 dividend growth (g1): 1.93%

Stage 2 dividend growth (g2): 2.00%

Stock Beta (β): 0.500

Risk-free Rate (Rf): 1.655%

Market Risk Premium (MRP): 6.00%

Current Stock Price: \$146.81

First, we need to calculate the cost of equity using the Capital Asset Pricing Model (CAPM):

$$\text{Cost of Equity (Ke)} = R_f + \beta * \text{MRP}$$
$$= 1.655\% + 0.500 * 6.00\% = 4.655\%$$

Next, we calculate the present value of the dividends during the first stage using the constant growth dividend discount model:

$$\text{PV (Stage 1 Dividends)} = D_1 / (\text{Ke} - g_1)$$

$$\text{For 2022: PV (2022 Dividend)} = \$2.23 / (4.655\% - 1.93\%) = \$2.23 / 0.02725 \approx \$81.79$$

Next, we calculate the present value of the dividends during the second stage, assuming the dividends will grow at a constant rate of g2:

$$\text{PV (Stage 2 Dividends)} = D_2 / (\text{Ke} - g_2)$$

$$\text{For 2023: PV (2023 Dividend)} = \$2.28 / (4.655\% - 2.00\%) = \$2.28 / 0.02655 \approx \$85.93$$

$$\text{For 2024: PV (2024 Dividend)} = \$2.32 / (4.655\% - 2.00\%) = \$2.32 / 0.02655 \approx \$87.36$$

$$\text{For 2025: PV (2025 Dividend)} = \$2.36 / (4.655\% - 2.00\%) = \$2.36 / 0.02655 \approx \$88.80$$

Finally, we calculate the future stock price at the end of the second stage using the constant growth formula:

$$\text{Future Stock Price} = D_5 * (1 + g_2) / (\text{Ke} - g_2)$$

$$D_5 = \$2.36 * (1 + 2.00\%) = \$2.36 * 1.02 \approx \$2.40$$

Future Stock Price = $\$2.40 / (4.655\% - 2.00\%) = \$2.40 / 0.02655 \approx \$90.47$

Now, we can calculate the total value of the stock by summing the present value of dividends in stage 1, present value of dividends in stage 2, and the future stock price:

Total Stock Value = PV (Stage 1 Dividends) + PV (Stage 2 Dividends) + Future Stock Price
 $= \$81.79 + \$85.93 + \$87.36 + \$88.80 + \$90.47 \approx \434.35

Therefore, the value of ABC Inc.'s stock using the 2-stage dividend discount method is approximately \$434.35.

QUESTION 18 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

Expected Answer: **\$9.7314**

ChatGPT Answer: \$2.2731

To calculate the value of the Call option using the Black-Scholes Option Pricing Model, we need to input the relevant parameters into the formula:

Stock price (S) = \$142.07

Option exercise price (X) = \$150.00

Time to expiration (t) = 1.00 year (or 360 days)

Risk-free rate (r) = 1.22% (0.0122)

Stock annual volatility (σ) = 23.50% (0.235)

Stock dividend yield (q) = 1.54% (0.0154)

Using these values, we can calculate the value of the Call option:

$d1 = [\ln(S/X) + (r - q + \sigma^2/2) * t] / (\sigma * \text{sqrt}(t))$

$d2 = d1 - \sigma * \text{sqrt}(t)$

N(d1) and N(d2) represent the cumulative standard normal distribution.

Call option value = $S * \exp(-q * t) * N(d1) - X * \exp(-r * t) * N(d2)$

Let's calculate it step by step:

Step 1: Calculate d1 and d2

$d1 = [\ln(S/X) + (r - q + \sigma^2/2) * t] / (\sigma * \text{sqrt}(t))$
 $= [\ln(\$142.07/\$150.00) + (0.0122 - 0.0154 + (0.235^2)/2) * 1.00] / (0.235 * \text{sqrt}(1.00))$
 ≈ -0.3527

$d2 = d1 - \sigma * \text{sqrt}(t)$
 $= -0.3527 - 0.235 * \text{sqrt}(1.00)$
 ≈ -0.5877

Step 2: Calculate N(d1) and N(d2)

Using a standard normal distribution table or a calculator, we can find N(d1) and N(d2).

$N(d1) \approx 0.3612$

$N(d2) \approx 0.2794$

Step 3: Calculate the Call option value

Call option value = $S * \exp(-q * t) * N(d1) - X * \exp(-r * t) * N(d2)$
 $= \$142.07 * \exp(-0.0154 * 1.00) * 0.3612 - \$150.00 * \exp(-0.0122 * 1.00) * 0.2794$
 $\approx \$2.2731$

Therefore, the value of the Call option using the Black-Scholes Option Pricing Model is approximately \$2.2731.

QUESTION 19 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

Expected Answer: **\$18.0136**

ChatGPT Answer: \$4.2772

To calculate the value of the Put option using the Black-Scholes Option Pricing Model, we need to input the relevant parameters into the formula:

Stock price (S) = \$142.07

Option exercise price (X) = \$150.00

Time to expiration (t) = 1.00 year (or 360 days)

Risk-free rate (r) = 1.22% (0.0122)

Stock annual volatility (σ) = 23.50% (0.235)

Stock dividend yield (q) = 1.54% (0.0154)

Using these values, we can calculate the value of the Put option:

$$d1 = [\ln(S/X) + (r - q + \sigma^2/2) * t] / (\sigma * \sqrt{t})$$

$$d2 = d1 - \sigma * \sqrt{t}$$

N(-d1) and N(-d2) represent the cumulative standard normal distribution.

$$\text{Put option value} = X * \exp(-r * t) * N(-d2) - S * \exp(-q * t) * N(-d1)$$

Let's calculate it step by step:

Step 1: Calculate d1 and d2

$$d1 = [\ln(S/X) + (r - q + \sigma^2/2) * t] / (\sigma * \sqrt{t})$$

$$= [\ln(\$142.07/\$150.00) + (0.0122 - 0.0154 + (0.235^2)/2) * 1.00] / (0.235 * \sqrt{1.00})$$
$$\approx -0.3527$$

$$d2 = d1 - \sigma * \sqrt{t}$$

$$= -0.3527 - 0.235 * \sqrt{1.00}$$

$$\approx -0.5877$$

Step 2: Calculate N(-d1) and N(-d2)

Using a standard normal distribution table or a calculator, we can find N(-d1) and N(-d2).

$$N(-d1) \approx 1 - N(d1) \approx 1 - 0.3612 \approx 0.6388$$

$$N(-d2) \approx 1 - N(d2) \approx 1 - 0.2794 \approx 0.7206$$

Step 3: Calculate the Put option value

$$\text{Put option value} = X * \exp(-r * t) * N(-d2) - S * \exp(-q * t) * N(-d1)$$

$$= \$150.00 * \exp(-0.0122 * 1.00) * 0.7206 - \$142.07 * \exp(-0.0154 * 1.00) * 0.6388$$
$$\approx \$4.2772$$

Therefore, the value of the Put option using the Black-Scholes Option Pricing Model is approximately \$4.2772.

QUESTION 20 Difficulty: Very Hard (5/5)**Topic: Binomial Option Pricing****Expected Answer: \$6.2388****ChatGPT Answer: \$5.58**

To calculate the value of a European call option using a two-state discrete-time binomial model, we can follow these steps:

1. Calculate the up and down factors:

- The up factor (u) represents the stock price increase, given as 1.41.
- The down factor (d) represents the stock price decrease, given as 0.71.

2. Calculate the risk-neutral probability of an up move:

- The risk-neutral probability (p) is the probability of an up move that makes the expected return on the stock equal to the risk-free rate.
- The risk-free rate (r) is given as 6.00% per annum, or 0.06 as a decimal.
- The time period for the option is 0.50 years, or 180 days.
- We can calculate p using the formula: $p = (1 + r - d) / (u - d)$.

3. Calculate the expected stock price at expiration:
 - The expected stock price at expiration (S_{exp}) is the average of the stock price after an up move (S_u) and a down move (S_d).
 - $S_u = u * S_0$, where S_0 is the initial stock price of \$27.00.
 - $S_d = d * S_0$.
 - $S_{exp} = p * S_u + (1 - p) * S_d$.
4. Calculate the intrinsic value at expiration:
 - The intrinsic value of a call option at expiration is the maximum of zero and the difference between the stock price and the exercise price.
 - Intrinsic Value = $\max(S_{exp} - X, 0)$, where X is the exercise price of \$24.00.
5. Discount the expected intrinsic value to the present:
 - The present value of the option is obtained by discounting the expected intrinsic value at expiration to the present using the risk-free rate.
 - Call Option Value = Intrinsic Value / $(1 + r)^T$, where T is the time period in years.

Let's calculate the call option value step by step:

1. Calculate the up and down factors:
 - $u = 1.41$ (up factor)
 - $d = 0.71$ (down factor)
2. Calculate the risk-neutral probability of an up move:
 - $r = 0.06$ (risk-free rate)
 - $T = 0.50$ (time period in years)
 - $p = (1 + r - d) / (u - d)$
 - $= (1 + 0.06 - 0.71) / (1.41 - 0.71)$
 - $= 0.65$
3. Calculate the expected stock price at expiration:
 - $S_0 = \$27.00$ (initial stock price)
 - $S_u = u * S_0 = 1.41 * 27.00 = \38.07
 - $S_d = d * S_0 = 0.71 * 27.00 = \19.17
 - $S_{exp} = p * S_u + (1 - p) * S_d$
 - $= 0.65 * 38.07 + (1 - 0.65) * 19.17$
 - $= \$29.58$
4. Calculate the intrinsic value at expiration:
 - $X = \$24.00$ (exercise price)
 - Intrinsic Value = $\max(S_{exp} - X, 0)$
 - $= \max(29.58 - 24.00, 0)$
 - $= \$5.58$
5. Discount the expected intrinsic value to the present:
 - Call Option Value = Intrinsic Value / $(1 + r)^T$
 - $= 5.58$

Appendix (C) – Google's Bard Results

Note: This paper was completed in May 2023. Afterwards, Google renamed Bard as Gemini in Feb. 2024.

QUESTION 1 **Difficulty: Very Easy (1/5)** **Topic: Business Algebra**

Expected Answer: **\$8.70**

Bard Answer: \$8.80

Mr. Smith purchased items costing \$3.64, \$2.58, and \$5.08. The total cost of the items is $\$3.64 + \$2.58 + \$5.08 = \11.2 . He gave the cashier a \$20 note, so he should receive $\$20 - \$11.2 = \$8.8$ in change.

QUESTION 2 **Difficulty: Very Easy (1/5)** **Topic: Business Algebra**

Expected Answer: **0.05357 or 5.36%**

Bard Answer: 0.0536

To find the percentage of 2800 that is 150, we can use the following formula:

'''

$$(150 / 2800) * 100 = 5.36\%$$

'''

Therefore, 5.36% of 2800 is 150.

QUESTION 3 **Difficulty: Very Easy (1/5)** **Topic: Business Algebra**

Expected Answer: **-0.08199 or -8.2%**

Bard Answer: -0.08199

The annual percentage decline in revenues is found by dividing the difference between the revenues in the two years by the revenues in the previous year and multiplying by 100. In this case, the difference between the revenues is $\$267,865 - \$245,902 = \$21,963$. The revenues in the previous year were \$267,865. Therefore, the annual percentage decline in revenues is:

'''

$$(21,963 / 267,865) * 100 = 8.19927949\%$$

'''

Therefore, the annual percentage decline in revenues is 8.19927949%.

QUESTION 4 **Difficulty: Very Easy (1/5)** **Topic: Business Algebra**

Expected Answer: **0.0972 or 9.72%**

Bard Answer: 0.0972

Peter's initial investment was $30 * \$149.73 = \4491.90 .

His total proceeds from the sale of the shares was $30 * \$164.28 = \4928.40 .

Therefore, his profit was $\$4928.40 - \$4491.90 = \$436.50$.

His percentage rate of return is $\$436.50 / \$4491.90 * 100 = 9.72\%$.

Therefore, Peter's percentage rate of return on his investment in XYZ Inc. is 9.72%.

QUESTION 5 **Difficulty: Easy (2/5)** **Topic: Future Value**

Expected Answer: **\$30,915.47**

Bard Answer: \$34,728.84

The formula for calculating compound interest is:

'''

$$A = P(1 + r/n)^{nt}$$

'''

where:

- * A is the final amount
- * P is the principal amount
- * r is the interest rate
- * n is the number of times the interest is compounded per year
- * t is the number of years

In this case, the principal amount is \$15,000, the interest rate is 7.5%, the interest is compounded annually, and the number of years is 10. Therefore, the final amount is:

$$A = 15,000(1 + 0.075)^{10} = 34,728.84$$

Therefore, after 10 years, you will have \$34,728.84.

QUESTION 6**Difficulty: Easy (2/5)****Topic: Present****Value*****Expected Answer:* \$10,133.46*****Bard Answer:* \$9,245.56**

To calculate the present value of a future amount, we can use the following formula:

'''

$$PV = FV / (1 + r)^n$$

'''

where:

- * PV is the present value
- * FV is the future value
- * r is the interest rate
- * n is the number of years

In this case, the future value is \$15,000, the interest rate is 4%, and the number of years is 10.

Therefore, the present value is:

$$PV = 15,000 / (1 + 0.04)^{10} = 9,245.56$$

Therefore, you should deposit \$9,245.56 in the savings account today.

QUESTION 7**Difficulty: Easy (2/5)****Topic: Time Value****of Money*****Expected Answer:* 0.1012 or 10.12%*****Bard Answer:* 0.1115**

To calculate the interest rate required to reach a future goal, we can use the following formula:

'''

$$r = (FV / PV)^{(1/n)} - 1$$

'''

where:

- * r is the interest rate
- * FV is the future value

* PV is the present value

* n is the number of years

In this case, the future value is \$25,000, the present value is \$17,000, and the number of years is

4. Therefore, the interest rate is:

$$r = (25,000 / 17,000)^{(1/4)} - 1 = 11.15\%$$

Therefore, you need to earn an interest rate of 11.15% compounded annually to reach your goal.

QUESTION 8
of Money**Difficulty: Easy (2/5)****Topic: Time Value*****Expected Answer:* 21.51*****Bard Answer:* 22.47**

It will take about 22.5 years for your investment account to reach \$1.5 million if your investments produce a 7% annual return.

Here is the formula used:

$$n = \log(FV/PV) / \log(1 + r)$$

where:

* n is the number of years

* FV is the future value

* PV is the present value

* r is the interest rate

In this case, the future value is \$1,500,000, the present value is \$350,000, and the interest rate is 7%.

Therefore, the number of years is:

$$n = \log(1,500,000/350,000) / \log(1 + 0.07) = 22.47$$

Therefore, it will take about 22.5 years for your investment account to reach \$1.5 million.

QUESTION 9
Annuity**Difficulty: Medium (3/5)****Topic: Future Value of*****Expected Answer:* 1,363,075*****Bard Answer:* 1,142,330**

Janet will have \$1,142,329.86 at age 65.

To calculate this, we can use the following formula:

$$FV = PMT * ((1 + r)^n - 1) / r$$

where:

* FV is the future value

* PMT is the payment amount

* r is the interest rate

* n is the number of years

In this case, the payment amount is \$10,000, the interest rate is 9%, and the number of years is 30.

Therefore, the future value is:

$$FV = 10,000 * ((1 + 0.09)^{30} - 1) / 0.09 = 1,142,329.86$$

Therefore, Janet will have \$1,142,329.86 at age 65.

QUESTION 10**Difficulty: Medium (3/5)****Topic: Annuity Payment****Expected Answer: 18,505.63****Bard Answer:** 19,115.88

Maria needs to pay 20% of the purchase price as a down payment, which is $20\% * 400,000 = \$80,000$. This means that she will need to borrow $\$400,000 - \$80,000 = \$320,000$ from the bank. The annual loan payment is calculated using the following formula:

$$PMT = PV * r * (1 + r)^n / ((1 + r)^n - 1)$$

where:

* PMT is the annual loan payment

* PV is the principal amount

* r is the interest rate

* n is the number of years

In this case, the principal amount is \$320,000, the interest rate is 4%, and the number of years is 30.

Therefore, the annual loan payment is:

$$PMT = 320,000 * 0.04 * (1 + 0.04)^{30} / ((1 + 0.04)^{30} - 1) = 19,115.88$$

Therefore, Maria has to pay \$19,115.88 as the annual loan payment.

QUESTION 11**Difficulty: Medium (3/5)****Topic: Future Value of Growing Annuity****Expected Answer: 2,236,434****Bard Answer:** 1,298,129.49

Janet will have \$1,298,129.49 at age 65.

Janet will contribute \$10,000 in the first year, and then increase her contribution by 5% each year.

This means that in the second year, she will contribute $\$10,000 * 1.05 = \$10,500$. In the third

year, she will contribute $\$10,500 * 1.05 = \$11,025$, and so on.

Janet's retirement account earns 9% annually. This means that each year, the balance in her account will increase by 9%. For example, if she has \$10,000 in her account at the end of the first year, then at the end of the second year, she will have $\$10,000 * 1.09 = \$10,900$.

To calculate how much money Janet will have at age 65, we can use the following formula:

$$FV = PV * (1 + r)^n$$

where:

FV = future value

PV = present value

r = interest rate

n = number of years

In this case, the present value is \$10,000, the interest rate is 9%, and the number of years is 30.

Substituting these values into the formula, we get:

$$FV = \$10,000 * (1 + 0.09)^{30} = \$1,298,129.49$$

Therefore, Janet will have \$1,298,129.49 at age 65.

QUESTION 12 Difficulty: Medium (3/5) Topic: Bond Present Value

Expected Answer: \$1,166.51

Bard Answer: \$1,012.74

The present value of the bond is \$1,012.74.

To calculate the present value of a bond, we can use the following formula:

...

$$PV = \text{Coupon payments} * \text{Present value of annuity} + \text{Par value} * \text{Present value of a single payment}$$

...

where:

* PV = Present value of the bond

* Coupon payments = Annual coupon payments

* Present value of annuity = Present value of a series of equal payments made at regular intervals

* Par value = Face value of the bond

* Present value of a single payment = Present value of a single payment made at a future date

In this case, the coupon payments are \$100, the par value is \$1,000, and the interest rate is 4%. The number of years to maturity is 3.

The present value of an annuity can be calculated using the following formula:

...

$$\text{Present value of an annuity} = \text{Coupon payments} * (1 - (1 + r)^{-n}) / r$$

...

where:

* r = Interest rate, * n = Number of years to maturity

Substituting the values into the formula, we get:

...

$$\text{Present value of an annuity} = \$100 * (1 - (1 + 0.04)^{-3}) / 0.04 = \$274.51$$

...

The present value of a single payment can be calculated using the following formula:

...

$$\text{Present value of a single payment} = \text{Future value} * (1 - (1 + r)^{-n}) / r$$

...

where:

* Future value = Face value of the bond

* r = Interest rate

* n = Number of years to maturity

Substituting the values into the formula, we get:

...

$$\text{Present value of a single payment} = \$1,000 * (1 - (1 + 0.04)^{-3}) / 0.04 = \$738.23$$

...

Adding the present value of the annuity and the present value of the single payment, we get the present value of the bond:

'''

$$PV = \$274.51 + \$738.23 = \$1,012.74$$

'''

QUESTION 13 Difficulty: Hard (4/5)
Maturity

Topic: Bond Yield to

Expected Answer: 0.0562 or 5.62%

Bard Answer: 0.0538

The yield to maturity (YTM) of the bond is 5.38%.

To calculate the YTM, we can use the following formula:

$$YTM = (\text{Coupon payments} * \text{Present value of annuity} + \text{Par value} * \text{Present value of a single payment}) / \text{Market price}$$

where:

* YTM = Yield to maturity

* Coupon payments = Annual coupon payments

* Present value of annuity = Present value of a series of equal payments made at regular intervals

* Par value = Face value of the bond

* Present value of a single payment = Present value of a single payment made at a future date

* Market price = Current market price of the bond

In this case, the coupon payments are \$15, the par value is \$1,000, the interest rate is 5.38%, and the market price is \$1,038.32. The number of years to maturity is 15.

The present value of an annuity can be calculated using the following formula:

'''

$$\text{Present value of an annuity} = \text{Coupon payments} * (1 - (1 + r)^{-n}) / r$$

'''

where:

* r = Interest rate

* n = Number of years to maturity

Substituting the values into the formula, we get:

'''

$$\text{Present value of an annuity} = \$15 * (1 - (1 + 0.0538)^{-15}) / 0.0538 = \$495.87$$

'''

The present value of a single payment can be calculated using the following formula:

'''

$$\text{Present value of a single payment} = \text{Future value} * (1 - (1 + r)^{-n}) / r$$

'''

where:

* Future value = Face value of the bond

* r = Interest rate

* n = Number of years to maturity

Substituting the values into the formula, we get:

'''

Present value of a single payment = $\$1,000 * (1 - (1 + 0.0538)^{-15}) / 0.0538 = \542.45

Adding the present value of the annuity and the present value of the single payment, we get the present value of the bond:

$$PV = \$495.87 + \$542.45 = \$1038.32$$

Dividing the present value of the bond by the market price, we get the YTM:

$$YTM = \$1038.32 / \$1038.32 = 5.38\%$$

QUESTION 14 Difficulty: Hard (4/5)

Topic: Bond Price Change

Expected Answer: -0.1150 or -11.50%

Bard Answer: -0.1225

The price of the 30-year bond will fall by 12.25%.

To calculate the price change, we can use the following formula:

$$\text{Price change} = (\text{New YTM} - \text{Old YTM}) * PV / (r * n)$$

where:

* Price change = Percentage change in price

* New YTM = New yield to maturity

* Old YTM = Old yield to maturity

* PV = Present value of the bond

* r = Interest rate

* n = Number of years to maturity

In this case, the new YTM is 7%, the old YTM is 6%, the PV is \$1,000, the interest rate is 6%, and the number of years to maturity is 30.

Substituting the values into the formula, we get:

$$\text{Price change} = (0.07 - 0.06) * \$1,000 / (0.06 * 30) = -0.1225$$

Therefore, the price of the 30-year bond will fall by 12.25%.

The reason for this is that the longer the maturity of a bond, the more sensitive it is to changes in interest rates. This is because the longer the maturity, the more time there is for interest rates to change. When interest rates rise, the price of bonds falls, and vice-versa.

QUESTION 15 Difficulty: Hard (4/5)

Topic: Net Present Value

Expected Answer: 283.34

Bard Answer: 262.05

The NPV of Stacy's cash flows is \$262.05.

To calculate the NPV, we can use the following formula:

$$NPV = \sum (Cash\ flow / (1 + r)^n)$$

where:

* NPV = Net present value

* Cash flow = Cash flow in a given year

* r = Interest rate

* n = Number of years from the present

In this case, the cash flows are as follows:

Year	Cash flow
0	-\$300
1	-\$387
2	-\$193
3	-\$100
4	\$600
5	\$600
6	\$850
7	-\$180

The interest rate is 10%. Substituting the values into the formula, we get:

$$NPV = -\$300 / (1 + 0.1)^0 - \$387 / (1 + 0.1)^1 - \$193 / (1 + 0.1)^2 - \$100 / (1 + 0.1)^3 + \$600 / (1 + 0.1)^4 + \$600 / (1 + 0.1)^5 + \$850 / (1 + 0.1)^6 - \$180 / (1 + 0.1)^7 = \$262.05$$

Therefore, the NPV of Stacy's cash flows is \$262.05.

QUESTION 16 Difficulty: Hard (4/5)

Topic: Internal Rate of Return

Expected Answer: *0.1407 or 14.07%*

Bard Answer: 0.1434

The modified internal rate of return (MIRR) of Stacy's cash flows is 14.34%.

To calculate the MIRR, we can use the following formula:

$$MIRR = (FV\ of\ positive\ cash\ flows / PV\ of\ negative\ cash\ flows)^{(1/n)} - 1$$

where:

* MIRR = Modified internal rate of return

* FV = Future value

* PV = Present value

* n = Number of years

In this case, the cash flows are as follows:

Year	Cash flow
0	-\$300
1	-\$387
2	-\$193
3	-\$100
4	\$600
5	\$600
6	\$850
7	-\$180

The interest rate is 10%.

Substituting the values into the formula, we get:

$MIRR = (FV \text{ of positive cash flows} / PV \text{ of negative cash flows})^{(1/n)} - 1 = ((\$600 + \$600 + \$850 - \$180) / -\$300)^{(1/7)} - 1 = 14.34\%$

Therefore, the MIRR of Stacy's cash flows is 14.34%.

The MIRR is a better measure of the return on an investment than the IRR because it takes into account the time value of money. The IRR only considers the cash flows at the end of the investment, while the MIRR considers the cash flows throughout the investment.

QUESTION 17 Difficulty: Very Hard (5/5) Topic: Stock Valuation

Expected Answer: \$83.93

Bard Answer: \$154.12

The value of ABC Inc.'s stock using the 2-stage dividend discount method is \$154.12.

The 2-stage dividend discount model (DDM) is a method of valuing a stock by discounting the expected future dividends. The model assumes that the dividends will grow at a constant rate for a certain number of years, and then at a different rate for the remainder of the stock's life.

In this case, the expected annual dividends for ABC Inc. are as follows:

Year Dividend

2022 \$2.23

2023 \$2.28

2024 \$2.32

2025 \$2.36

The stage 1 dividend growth rate is 1.93%, and the stage 2 dividend growth rate is 2.00%.

The stock beta is 0.500, the risk-free rate is 1.655%, and the market risk premium is 6.00%.

To calculate the value of the stock, we can use the following formula:

'''
$$\text{Value} = D1 / (r - g1) + D2 / (r - g2) * (1 + r)^n$$

'''

where:

* Value = Value of the stock

* D1 = Expected dividend in year 1

* r = Required rate of return

* g1 = Dividend growth rate in stage 1

* D2 = Expected dividend in year 2

* g2 = Dividend growth rate in stage 2

* n = Number of years in stage 1

Substituting the values into the formula, we get:

'''
$$\text{Value} = \$2.23 / (0.01655 - 0.0193) + \$2.28 / (0.01655 - 0.02) * (1 + 0.01655)^4 =$$

\$154.12
'''

Therefore, the value of ABC Inc.'s stock using the 2-stage DDM is \$154.12.

QUESTION 18 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

Expected Answer: \$9.7314

Bard Answer: \$13.65

The value of the call option is \$13.65.

The Black-Scholes option pricing model is a mathematical model that is used to determine the theoretical price of a European-style option. The model takes into account the following factors:

- * The current stock price
- * The strike price of the option
- * The time to expiration
- * The risk-free interest rate
- * The volatility of the underlying asset

In this case, the current stock price is \$142.07, the strike price of the option is \$150.00, the time to expiration is 1.00 years (or 360 days), the risk-free interest rate is 1.22%, and the volatility of the underlying asset is 23.50%.

To calculate the value of the call option, we can use the following formula:

$$\text{Call} = SN(d1) - Ke^{(-rT)}N(d2)$$

where:

- * Call = Value of the call option
- * S = Current stock price
- * K = Strike price of the option
- * r = Risk-free interest rate
- * T = Time to expiration
- * N(d1) = Cumulative distribution function of the standard normal distribution evaluated at d1
- * $d1 = (\ln(S/K) + (r + \sigma^2/2)T) / \sigma\sqrt{T}$
- * N(d2) = Cumulative distribution function of the standard normal distribution evaluated at d2
- * $d2 = d1 - \sigma\sqrt{T}$

Substituting the values into the formula, we get:

$$\text{Call} = \$142.07 * N(d1) - \$150.00 * e^{(-0.0122 * 360)} * N(d2) = \$13.65$$

Therefore, the value of the call option is \$13.65.

QUESTION 19 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

***Expected Answer:* \$18.0136**

Bard Answer: \$6.35

The value of the put option is \$6.35.

The Black-Scholes option pricing model is a mathematical model that is used to determine the theoretical price of a European-style option. The model takes into account the following factors:

- * The current stock price
- * The strike price of the option

- * The time to expiration
- * The risk-free interest rate
- * The volatility of the underlying asset

In this case, the current stock price is \$142.07, the strike price of the option is \$150.00, the time to expiration is 1.00 years (or 360 days), the risk-free interest rate is 1.22%, and the volatility of the underlying asset is 23.50%.

To calculate the value of the put option, we can use the following formula:

$$\text{Put} = Ke^{(-rT)}N(-d2) - SN(-d1)$$

where:

- * Put = Value of the put option
- * K = Strike price of the option
- * r = Risk-free interest rate
- * T = Time to expiration
- * N(-d2) = Cumulative distribution function of the standard normal distribution evaluated at -d2
- * d2 = d1 - $\sigma\sqrt{T}$
- * SN(-d1) = Stock price * Cumulative distribution function of standard normal distribution evaluated at -d1
- * d1 = $(\ln(S/K) + (r + \sigma^2/2)T) / \sigma\sqrt{T}$

Substituting the values into the formula, we get:

$$\text{Put} = \$150.00 * e^{(-0.0122 * 360)} * N(-d2) - \$142.07 * N(-d1) = \$6.35$$

Therefore, the value of the put option is \$6.35.

QUESTION 20 Difficulty: Very Hard (5/5) Topic: Binomial Option Pricing

Expected Answer: \$6.2388

Bard Answer: \$5.31

The value of the call option is \$5.31.

The 2-state discrete-time binomial option pricing model is a mathematical model that is used to

determine the theoretical price of a European-style option. The model takes into account the following factors:

- * The current stock price
- * The strike price of the option
- * The time to expiration
- * The risk-free interest rate
- * The up and down factors

In this case, the current stock price is \$27.00, the strike price of the option is \$24.00, the time to

expiration is 0.50 years (or 180 days), the risk-free interest rate is 6.00%, and the up and down factors are 1.41 and 0.71.

To calculate the value of the call option, we can use the following formula:

...

$$\text{Call} = S1 * p + S2 * q$$

where:

- * Call = Value of the call option
 - * S1 = Stock price in the up state
 - * p = Probability of the stock price going up
 - * S2 = Stock price in the down state
 - * q = Probability of the stock price going down
- Substituting the values into the formula, we get:

$$\text{Call} = \$27.00 * (0.5) + \$19.07 * (0.5) = \$5.31$$

Therefore, the value of the call option is \$5.31.

Appendix (D) – Bing AI Results

Note: This paper was completed in May 2023. Afterwards, Microsoft renamed Bing AI/Bing Chat as Copilot in Nov. 2023.

QUESTION 1 **Difficulty: Very Easy (1/5)** **Topic: Business Algebra**

Expected Answer: \$8.70

Bing AI Answer: \$8.70

Mr. Smith should receive \$8.70 in change.

Here's how I calculated it:

- The total cost of the items is \$11.30 (\$3.64 + \$2.58 + \$5.08).
- Mr. Smith gave the cashier a \$20 note.
- To calculate the change, we subtract the total cost from the amount paid:

$$\$20 - \$11.30 = \$8.70$$

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/30/2023

Percentage Change Calculator.

<https://www.omnicalculator.com/math/percentage-change>

(2) Percentage Change Calculator.

<https://www.calculatorsoup.com/calculators/algebra/percent-change-calculator.php>

20% Increase Calculator.

<https://www.calculateme.com/math/percent-change/20-percent-increase>

QUESTION 2 **Difficulty: Very Easy (1/5)** **Topic: Business Algebra**

Expected Answer: 0.05357or 5.36%

Bing AI Answer: 0.0536

150 is 5.36% of 2800.

Here's how I calculated it:

- To find out what percent 150 is of 2800, we can divide 150 by 2800 and then multiply by 100 to get the percentage:
- $$150 \div 2800 \times 100 = 5.36\%$$

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/30/2023

(1) <https://bing.com/search?q=what+percent+of+2800+is+150%3f>

(2) 150 is what percent of 2800? - Everydaycalculation.com

<https://answers.everydaycalculation.com/percent-is/150-2800>

2800 is what percent of 150? - Everydaycalculation.com.

<https://answers.everydaycalculation.com/percent-is/2800-150>

150 percent of 2800 Pounds - CoolConversion.

https://coolconversion.com/math/percentage-calculator/_150__2800_Pounds

Percentage Calculator.

<https://www.calculator.net/percent-calculator.html>

QUESTION 3

Difficulty: Very Easy (1/5)

Topic: Business Algebra

Expected Answer: *-0.08199 or -8.2%*

Bing AI Answer: -0.0817

The annual percentage decline in revenues is 8.17%.

Here's how I calculated it:

- To find out the percentage decline in revenues, we can use the following formula:

Percentage decline = $[(\text{Previous year's revenue} - \text{This year's revenue}) / \text{Previous year's revenue}] \times 100$

- Plugging in the numbers from your question, we get:

$[(267865 - 245902) / 267865] \times 100 = 8.17\%$

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/30/2023

(1) How to Calculate a Percentage Decrease in Revenue From ... - PocketSense.

<https://pocketsense.com/calculate-percentage-decrease-revenue-year-year-4087.html>

(2) The 2020 McKinsey Global Payments Report.

<https://www.mckinsey.com/~media/mckinsey/industries/financial%20services/our%20insights/accelerating%20winds%20of%20change%20in%20global%20payments/2020-mckinsey-global-payments-report-vf.pdf>

(3) Percentage Changes and How to Calculate Them - Investopedia.

<https://www.investopedia.com/terms/p/percentage-change.asp>

QUESTION 4

Difficulty: Very Easy (1/5)

Topic: Business Algebra

Expected Answer: *0.0972 or 9.72%*

Bing AI Answer: 0.0972

Peter's percentage rate of return on his investment in XYZ Inc. is 9.72%.

Here's how I calculated it:

- To find out the percentage rate of return on Peter's investment, we can use the following formula:

Percentage rate of return = $[(\text{Sale price} - \text{Purchase price}) / \text{Purchase price}] \times 100$

- Plugging in the numbers from your question, we get:

$[(164.28 - 149.73) / 149.73] \times 100 = 9.72\%$

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/30/2023

(1) Rate of Return Calculator.

- <https://www.omnicalculator.com/finance/rate-of-return>
(2) Percentage Return Calculator.
<https://www.omnicalculator.com/finance/percentage-return>
(3) Return on Investment (ROI) Calculator.
<https://www.calculator.net/roi-calculator.html>
-

QUESTION 5 **Difficulty: Easy (2/5)** **Topic: Future Value**

Expected Answer: \$30,915.47

Bing AI Answer: \$32,578.81

If you invest \$15,000 in a savings account with a 7.5% interest rate per year and do not withdraw any money for 10 years, you will have \$32,578.81 at the end of the 10-year period.

Here's how I calculated it:

- To find out how much money you will have after 10 years, we can use the following formula:

Future value = Present value \times (1 + Interest rate) ^{Number of years}

- Plugging in the numbers from your question, we get:

Future value = 15000 \times (1 + 0.075) ¹⁰ = \$32,578.81

I hope that helps! Let me know if you have any other questions.

QUESTION 6 **Difficulty: Easy (2/5)** **Topic: Present Value**

Expected Answer: \$10,133.46

Bing AI Answer: \$9,306.98

If you want to invest in a savings account that will pay \$15,000 in ten years with a fixed interest rate of 4% per year, you should deposit \$9,306.98 in the savings account today.

Here's how I calculated it:

- To find out how much you should deposit in the savings account today, we can use the following formula:

Present value = Future value / (1 + Interest rate) ^{Number of years}

- Plugging in the numbers from your question, we get:

Present value = 15000 / (1 + 0.04) ¹⁰ = \$9,306.98

I hope that helps! Let me know if you have any other questions.

QUESTION 7 **Difficulty: Easy (2/5)** **Topic: Time Value of Money**

Expected Answer: 0.1012 or 10.12%

Bing AI Answer: 0.0718

If you want to buy a house in 4 years and expect to need \$25,000 for a down payment at that time, you will need to earn an interest rate of 7.18% per year (compounded annually) on your \$17,000 investment to reach your goal.

Here's how I calculated it:

- To find out how much interest you need to earn (compounded annually) to reach your goal, we can use the following formula:

Future value = Present value \times (1 + Interest rate) ^{Number of years}

- Plugging in the numbers from your question, we get:

$25000 = 17000 \times (1 + \text{Interest rate})^4$
 $(1 + \text{Interest rate})^4 = 25000 / 17000$
 $(1 + \text{Interest rate}) = (25000 / 17000)^{(1/4)}$
 $\text{Interest rate} = [(25000 / 17000)^{(1/4)} - 1] \times 100 = 7.18\%$
 I hope that helps! Let me know if you have any other questions.

QUESTION 8
of Money

Difficulty: Easy (2/5)

Topic: Time Value

Expected Answer: 21.51

Bing AI Answer: 26.06

If you want to retire when your investment account reaches \$1.5 million and it currently has \$350,000 with a 7% annual return, it will take approximately 25 years to reach your goal. Here's how I calculated it:

- To find out how many years it will take for you to retire, we can use the following formula:

Number of years = $\log(\text{Future value} / \text{Present value}) / \log(1 + \text{Interest rate})$

- Plugging in the numbers from your question, we get:

Number of years = $\log(1500000 / 350000) / \log(1 + 0.07) = 25.06$ years

I hope that helps! Let me know if you have any other questions.

QUESTION 9
Annuity

Difficulty: Medium (3/5)

Topic: Future Value of

Expected Answer: 1,363,075

Bing AI Answer: 2,039,563

If Janet saves \$10,000 at the end of each year until she is 65 and the account earns 9% annually, she will have approximately \$2,039,563.47 at age 65.

Here's how I calculated it:

- To find out how much money Janet will have at age 65, we can use the following formula:

Future value = $\text{Payment} \times [(1 + \text{Interest rate})^{\text{Number of years}} - 1] / \text{Interest rate}$

- Plugging in the numbers from your question, we get:

Future value = $10000 \times [(1 + 0.09)^{30} - 1] / 0.09 = \$2,039,563.47$

I hope that helps! Let me know if you have any other questions.

QUESTION 10

Difficulty: Medium (3/5)

Topic: Annuity Payment

Expected Answer: 18,505.63

Bing AI Answer: 15,096.60

If Maria plans to buy a house for \$400,000 and a bank offers her a 30-year loan with equal annual payments at the end of each year and an interest rate of 4% per year, she will have to pay approximately \$15,096.60 as the annual loan payment.

Here's how I calculated it:

- To find out how much Maria has to pay as the annual loan payment, we can use the following formula:

Annual payment = $\text{Present value} \times (\text{Interest rate} / (1 - (1 + \text{Interest rate})^{(-\text{Number of years})}))$

- Plugging in the numbers from your question, we get:

Present value = $400000 \times (1 - 0.2) = \$320,000$

Annual payment = $320000 \times (0.04 / (1 - (1 + 0.04)^{(-30)})) = \$15,096.60$

I hope that helps! Let me know if you have any other questions.

QUESTION 11 Difficulty: Medium (3/5) Topic: Future Value of Growing Annuity

Expected Answer: **2,236,434**

Bing AI Answer: 4,107,710

If Janet expects her salary to increase each year so that she will be able to increase her retirement

contribution by 5% per year and the retirement account earns 9% annually, she will have approximately \$4,107,710.11 at age 65.

Here's how I calculated it:

- To find out how much money Janet will have at age 65, we can use the following formula:

Future value = Payment $\times [(1 + \text{Interest rate})^{\text{Number of years}} - 1] / \text{Interest rate}$

- Plugging in the numbers from your question, we get:

- For the first year:

Payment = \$10,000

Future value = Payment $\times [(1 + 0.09)^{30} - 1] / 0.09 = \$1,536,986.62$

- For the second year:

Payment = \$10,000 $\times 1.05 = \$10,500$

Future value = Payment $\times [(1 + 0.09)^{29} - 1] / 0.09 = \$1,547,782.98$

- For the third year:

Payment = \$10,500 $\times 1.05 = \$11,025$

Future value = Payment $\times [(1 + 0.09)^{28} - 1] / 0.09 = \$1,559,019.94$

- And so on until the last year:

Payment = \$10,000 $\times (1 + 0.05)^{29} = \$31,171.68$

Future value = Payment $\times [(1 + 0.09)^1 - 1] / 0.09 = \$33,938.91$

- Adding up all the future values from each year gives us:

Future value = \$1,536,986.62 + \$1,547,782.98 + \$1,559,019.94 + ... + \$33,938.91

Future value = \$4,107,710.11

I hope that helps! Let me know if you have any other questions.

QUESTION 12 Difficulty: Medium (3/5) Topic: Bond Present Value

Expected Answer: **\$1,166.51**

Bing AI Answer: \$1,048.64

If the US government is issuing a \$1,000 par value coupon bond today that will mature in 3 years from today with an annual coupon rate of 10% and coupons are paid yearly, and the investors expect a 4% annual return on this bond, the present value of this bond is approximately \$1,048.64.

Here's how I calculated it:

- To find out how much the bond is worth today, we can use the following formula:

Present value = Coupon payment $\times [(1 - (1 + \text{Interest rate})^{(-\text{Number of years}))} / \text{Interest rate}] + \text{Par}$

value / $(1 + \text{Interest rate})^{\text{Number of years}}$

- Plugging in the numbers from your question, we get:

Coupon payment = \$1,000 $\times 0.10 = \$100$

Par value = \$1,000

Interest rate = 0.04

Number of years = 3

Present value = $\$100 \times [(1 - (1 + 0.04)^{-3}) / 0.04] + \$1,000 / (1 + 0.04)^3 = \$1,048.64$

I hope that helps! Let me know if you have any other questions.

QUESTION 13 Difficulty: Hard (4/5)

Topic: Bond Yield to

Maturity

Expected Answer: 0.0562 or 5.62%

Bing AI Answer: 0.0516

If the US government just issued a \$1,000 par value coupon bond today that will mature in 15 years from today with an annual coupon rate of 6% and coupons are paid four times yearly and the bond is currently trading at \$1,038.32, the yield to maturity (YTM) of this bond is approximately 5.16%.

Here's how I calculated it:

- To find out the yield to maturity (YTM) of the bond, we can use the following formula:

Price = Coupon payment $\times [(1 - (1 + \text{YTM} / \text{Number of coupon payments})^{-\text{Number of years} * \text{Number of coupon payments}}) / (\text{YTM} / \text{Number of coupon payments})] + \text{Par value} / (1 + \text{YTM} / \text{Number of coupon payments})^{\text{Number of years} * \text{Number of coupon payments}}$

- Plugging in the numbers from your question and solving for YTM using trial and error or a financial

calculator, we get:

YTM = 5.16%

I hope that helps! Let me know if you have any other questions.

QUESTION 14 Difficulty: Hard (4/5)

Topic: Bond Price Change

Expected Answer: -0.1150 or -11.50%

Bing AI Answer: -0.1411

If we consider two bonds with a \$1,000 face value: one with a 10-year maturity and the other with a 30-year maturity. Both bonds offer a 10% annual coupon, paid once a year. Assuming that interest rates, and hence the yield to maturity (YTM), changed from 6% to 7%, the price of the 30-year bond will change by approximately -16.28%.

Here's how I calculated it:

- To find out how much the price of the 30-year bond will change, we can use the following formula:

Price = Coupon payment $\times [(1 - (1 + \text{YTM})^{-\text{Number of years}}) / \text{YTM}] + \text{Par value} / (1 + \text{YTM})^{\text{Number of years}}$

- Plugging in the numbers from your question for both bonds at 6% and 7% yields to maturity (YTM), we get:

For the 10-year bond:

Price at 6% YTM = $\$1,000 \times (0.10 / 0.06) \times (1 - (1 + 0.06)^{-10}) + \$1,000 / (1 + 0.06)^{10} = \$1,613.91$

Price at 7% YTM = $\$1,000 \times (0.10 / 0.07) \times (1 - (1 + 0.07)^{-10}) + \$1,000 / (1 + 0.07)^{10} = \$1,386.22$

Percentage change = $[(\text{New price} - \text{Old price}) / \text{Old price}] \times 100\% = [(\$1,386.22 - \$1,613.91) /$

$\$1,613.91] \times 100\% = -14.11\%$

For the 30-year bond:

Price at 6% YTM = $\$1,000 \times (0.10 / 0.06) \times (1 - (1 + 0.06)^{-30}) + \$1,000 / (1 + 0.06)^{30} = \$2,205.93$

Price at 7% YTM = $\$1,000 \times (0.10 / 0.07) \times (1 - (1 + 0.07)^{-30}) + \$1,000 / (1 + 0.07)^{30} = \$1,845.65$

Percentage change = $[(\text{New price} - \text{Old price}) / \text{Old price}] \times 100\% = [(\$1,845.65 - \$2,205.93) /$

$\$2,205.93] \times 100\% = -16.28\%$

I hope that helps! Let me know if you have any other questions.

QUESTION 15 Difficulty: Hard (4/5)

Topic: Net Present Value

Expected Answer: 283.34

Bing AI Answer: 238.28

To calculate Stacy's NPV (net present value), we can use the following formula:

$$\text{NPV} = \text{CF}_0 + \text{CF}_1 / (1 + r)^1 + \text{CF}_2 / (1 + r)^2 + \dots + \text{CF}_n / (1 + r)^n$$

where:

CF₀ = the initial cash flow

CF₁ to CF_n = the cash flows in years 1 to n

r = the discount rate

Plugging in the numbers from your question for Stacy's yearly cash flows and a discount rate of 10.00%, we get:

$$\text{NPV} = -\$300 + (-\$387 / (1 + 0.10)^1) + (-\$193 / (1 + 0.10)^2) + (-\$100 / (1 + 0.10)^3) +$$

$$(\$600 / (1 + 0.10)^4) + (\$600 / (1 + 0.10)^5) + (\$850 / (1 + 0.10)^6) + (-\$180 / (1 + 0.10)^7)$$

$$\text{NPV} = \$238.28$$

Therefore, Stacy's NPV is approximately \$238.28.

I hope that helps! Let me know if you have any other questions.

QUESTION 16 Difficulty: Hard (4/5)

Topic: Internal Rate of Return

Expected Answer: 0.1407 or 14.07%

Bing AI Answer: 0.1208

To calculate Stacy's MIRR (modified internal rate of return), we can use the following formula:

$$\text{MIRR} = [(\text{FV of positive cash flows} / \text{PV of negative cash flows})^{(1 / n)}] / [(1 + r)^{(m / n)}]$$

where:

FV = future value

PV = present value

n = number of periods

m = number of periods when negative cash flows occur

r = discount rate

Plugging in the numbers from your question for Stacy's yearly cash flows and a discount rate of 10.00%, we get:

$$\text{MIRR} = [(\$0 + \$600 + \$600 + \$850) / (-\$300 - \$387 - \$193 - \$100 - \$180)]^{(1 / 7)} / [(1 + 0.10)^{(4 / 7)}]$$

MIRR = 0.1208 or 12.08%

Therefore, Stacy's MIRR is approximately 12.08%.

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/31/2023

Modified Internal Rate of Return – MIRR Definition - Investopedia.

<https://www.investopedia.com/terms/m/mirr.asp>

Modified internal rate of return - Wikipedia.

https://en.wikipedia.org/wiki/Modified_internal_rate_of_return

Modified Internal Rate of Return (MIRR) - Overview, How to Calculate.

<https://corporatefinanceinstitute.com/resources/valuation/modified-internal-rate-of-return-mirr/>

QUESTION 17 Difficulty: Very Hard (5/5) Topic: Stock Valuation

***Expected Answer:* \$83.93**

Bing AI Answer: \$27.98

To calculate the value of ABC Inc.'s stock using the two-stage dividend discount method, we can use the following formula:

$$P = [D1 / (r - g1)] + [(D2 / (r - g2)) / (1 + r)^2]$$

where:

P = price of the stock

D1 = dividend expected at the end of year 2022

D2 = dividend expected at the end of year 2023

r = required rate of return

g1 = dividend growth rate for stage 1

g2 = dividend growth rate for stage 2

Plugging in the numbers from your question, we get:

$$D1 = \$2.23$$

$$D2 = \$2.28$$

$$r = \text{risk-free rate} + \text{beta} * \text{market risk premium} = 6.00\% + 1.655\% * \$146.81 = 8.44\%$$

$$g1 = 1.93\%$$

$$g2 = 2.00\%$$

$$P = [\$2.23 * (1 + 0.0193) / (0.0844 - 0.0193)] + [\$2.28 * (1 + 0.02) / (0.0844 - 0.02) / (1 + 0.0844)^2]$$

$$P = \$27.98$$

Therefore, the value of ABC Inc.'s stock using the two-stage dividend discount method is approximately \$27.98.

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/31/2023

11.2 Dividend Discount Models (DDMs) - OpenStax.

<https://openstax.org/books/principles-finance/pages/11-2-dividend-discount-models-ddms>

Two Stage Growth Model - Dividend Discount Model - eFinanceManagement.

<https://efinancemanagement.com/investment-decisions/two-stage-growth-model-dividend-discount-model>

The Two-Stage Dividend Discount Model - Dividend.com - Dividend.com.

<https://www.dividend.com/dividend-education/the-two-stage-dividend-discount-model/>

QUESTION 18 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation

Expected Answer: \$9.7314

Bing AI Answer: \$4.09

To calculate the value of a call option using the Black-Scholes option pricing model, we can use the following formula:

$$C = S * N(d1) - X * e^{(-r * t)} * N(d2)$$

where:

C = price of the call option

S = current stock price

N(d1) = cumulative normal distribution function of d1

$$d1 = [\ln(S / X) + (r + \sigma^2 / 2) * t] / (\sigma * \sqrt{t})$$

X = exercise price of the option

e = Euler's number (approximately 2.71828)

r = risk-free rate

t = time to expiration in years

N(d2) = cumulative normal distribution function of d2

$$d2 = d1 - \sigma * \sqrt{t}$$

σ = annual volatility of the stock

Plugging in the numbers from your question, we get:

$$S = \$142.07$$

$$X = \$150.00$$

$$r = 1.22\%$$

$$t = 360 / 365$$

$$\sigma = 23.50\%$$

$$d1 = [\ln(\$142.07 / \$150.00) + (0.0122 + 0.2350^2 / 2) * (360 / 365)] / (0.2350 * \sqrt{360 / 365}) = -0.0513$$

$$d2 = -0.0513 - 0.2350 * \sqrt{360 / 365} = -0.2926$$

$$N(d1) = 0.4808$$

$$N(d2) = 0.3845$$

$$C = \$142.07 * 0.4808 - \$150.00 * e^{(-0.0122 * (360 / 365))} * 0.3845 \approx \$4.09$$

Therefore, the value of this call option is approximately \$4.09.

I hope that helps! Let me know if you have any other questions.

Source: Conversation with Bing, 5/31/2023

Black-Scholes Model: What It Is, How It Works, Options Formula.

<https://www.investopedia.com/terms/b/blackscholes.asp>

Black-Scholes Option Pricing Model | Definition and Application.

<https://www.financestrategists.com/wealth-management/valuation/black-scholes-option-pricing-model/>

Black-Scholes Model (Option Pricing) - Meaning, Formula, Example.

<https://www.wallstreetmojo.com/black-scholes-model/>

Option Pricing Models - How to Use Different Option Pricing Models.

<https://corporatefinanceinstitute.com/resources/derivatives/option-pricing-models/>

Black-Scholes-Merton Model - Overview, Equation, Assumptions.

<https://corporatefinanceinstitute.com/resources/derivatives/black-scholes-merton-model/>

QUESTION 19 Difficulty: Very Hard (5/5) Topic: Black-Scholes Option Valuation**Expected Answer: \$18.0136****Bing AI Answer: \$5.17**

To calculate the value of a put option using the Black-Scholes option pricing model, we can use the following formula:

$$P = X * e^{(-r * t)} * N(-d2) - S * N(-d1)$$

where:

P = price of the put option

S = current stock price

N(-d1) = cumulative normal distribution function of -d1

$$-d1 = -[\ln(S / X) + (r + \sigma^2 / 2) * t] / (\sigma * \sqrt{t})$$

X = exercise price of the option

e = Euler's number (approximately 2.71828)

r = risk-free rate

t = time to expiration in years

N(-d2) = cumulative normal distribution function of -d2

$$-d2 = -d1 + \sigma * \sqrt{t}$$

σ = annual volatility of the stock

Plugging in the numbers from your question, we get:

$$S = \$142.07$$

$$X = \$150.00$$

$$r = 1.22\%$$

$$t = 360 / 365$$

$$\sigma = 23.50\%$$

$$d1 = [\ln(\$142.07 / \$150.00) + (0.0122 + 0.2350^2 / 2) * (360 / 365)] / (0.2350 * \sqrt{360 / 365}) = -0.0513$$

$$d2 = -0.0513 + 0.2350 * \sqrt{360 / 365} = 0.1108$$

$$N(-d1) = 0.5192$$

$$N(-d2) = 0.4569$$

$$P = \$150.00 * e^{(-0.0122 * (360 / 365))} * 0.4569 - \$142.07 * 0.5192 \approx \$5.17$$

Therefore, the value of this put option is approximately \$5.17.

Source: Conversation with Bing, 5/31/2023

Black-Scholes Option Pricing Model | Definition and Application.

<https://www.financestrategists.com/wealth-management/valuation/black-scholes-option-pricing-model/>

Black-Scholes Model (Option Pricing) - Meaning, Formula, Example.

<https://www.wallstreetmojo.com/black-scholes-model/>

The Black Scholes Model: An Options Pricing Formula - Investment U.

<https://investmentu.com/black-scholes-model/>

Black-Scholes Formulas (d1, d2, Call Price, Put Price, Greeks).

<https://www.macroption.com/black-scholes-formula/>

Black-Scholes Model: What It Is, How It Works, Options Formula.

<https://www.investopedia.com/terms/b/blackscholes.asp>

Black-Scholes equation - Wikipedia.

https://en.wikipedia.org/wiki/Black%E2%80%93Scholes_equation

QUESTION 20 Difficulty: Very Hard (5/5) Topic: Binomial Option Pricing**Expected Answer: \$6.2388****Bing AI Answer: \$9.44**

To calculate the value of a call option using the 2-state discrete-time Binomial option pricing model, we can use the following formula:

$$C = [p * C_u + (1 - p) * C_d] / (1 + r)$$

where:

C = price of the call option

C_u = price of the stock if it goes up

C_d = price of the stock if it goes down

p = probability of the stock going up

r = risk-free rate

Plugging in the numbers from your question, we get:

$$S = \$27.00$$

$$X = \$24.00$$

$$r = 6.00\%$$

$$t = 180 / 365$$

$$u = 1.41$$

$$d = 0.71$$

$$p = (e^{(r * t)} - d) / (u - d) \approx 0.5625$$

$$C_u = \$27.00 * u \approx \$38.07$$

$$C_d = \$27.00 * d \approx \$19.17$$

$$C = [0.5625 * \$38.07 + (1 - 0.5625) * \$19.17] / (1 + 0.06) \approx \$9.44$$

Therefore, the value of this call option is approximately \$9.44.

Source: Conversation with Bing, 5/31/2023

Binomial Option Pricing Model - What Is It, Assumptions, Example.

<https://www.wallstreetmojo.com/binomial-option-pricing-model/>

Binomial options pricing model - Wikipedia.

https://en.wikipedia.org/wiki/Binomial_options_pricing_model

Finance: A Quantitative Introduction Chapter 7 - part 3 Binomial Option

<https://www.cambridge.org/cl/files/9013/6698/2501/chpt7prt3Binom.pdf>

Discrete-Time Models for the Pricing of Options—Binomial Tree Based.

<http://www.fieam.org/download/FEM-1-11-227-237.pdf>

Modernize the Teaching of Modern Portfolio Theory with Python

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This article proposes an interactive framework for teaching the Modern Portfolio Theory with Python. The course material is suitable for advanced bachelor and entry master-level courses in investments, offering a step-by-step tutorial of the data-driven quantitative investment process. Students will learn to apply portfolio choice models to market data and develop essential programming skills through data collection, input estimation, constraint imposition, portfolio optimization, back-testing, implementation, and performance evaluation. By emphasizing the importance of realism, this teaching framework highlights the potential pitfalls and fallacies when applying financial theories blindly.

Keywords: Portfolio theory, quantitative finance, Python, financial education

Introduction

This article provides a step-by-step guide on using Python to teach the Markowitz (1952) Modern Portfolio Theory (MPT) interactively. It is imperative to modernize the way we teach finance. Root, Rozycki, Senteza, & Suh (2007) surveyed the undergraduate finance programs in 655 institutions, and they found that most finance curricula were slow to reflect recent trends in the financial industry. Nowadays, standard textbooks (Bodie, Kane, & Marcus, 2021, 2022) in undergraduate and MBA curricula mainly cover two risky assets in their expositions of the portfolio theory. By considering only two risky assets, it greatly simplifies the mathematics required and helps students gain an intuitive understanding of efficient diversification. However, if the teaching material does not go beyond two assets, students will feel disconnected as they do not know how to implement what they learned in the stock market. Therefore, this article fills the gap between portfolio theory and quantitative investment practices.

The primary goal of teaching MPT with Python is to acquaint students with programming techniques in portfolio analysis. Programming skills will be valuable assets for finance graduates in the age of big data. The Economist (2017) argues that data has replaced oil and is becoming the world's most valuable resource. According to R. Alexander (2022), data scientists are highly sought after by Wall Street. Business schools are revamping their curricula to equip their students with skill sets relevant to the data-driven economy. Patrick Kandawire, the deputy chief operating officer for capital markets at Morgan Stanley, said, "I would say for the next generation, take the Python course. Understand where some of this technology is going," (para. 30).

According to the latest TIOBE (2023) Index, Python remains the most popular programming language based on internet search volume. Python is free to use. Therefore, many open-source Python resources are readily available to instructors and students online. Hilpisch (2018) provides an excellent recipe book for people with programming experience to learn finance applications in Python. However, it can be challenging for finance majors and instructors without backgrounds in Python to learn and teach. This article fills the gap by offering a step-by-step guide to teaching portfolio theory with a companion Jupyter Notebook. It is also structured to complement the interactive Python applications with finance intuitions and practical insights. Instead of using existing Python packages such as QuantLib, pyfolio, and PyPortfolioOpt for analyzing portfolios

directly, the goal is to provide a gentle introduction to developing programming tools for portfolio optimizations to instructors and students with little to no programming experience. Students will better understand the portfolio theory and quantitative tools by writing programs from scratch.

Teaching portfolio theory with computer programs has a long history. Before the prevalence of personal computers, Eckardt (1975, 1978) and G. J. Alexander (1978, 1981) designed proprietary computer programs for teaching portfolio theory and management. Runyon (1978), Nawrocki (1980), Riley & Montgomery (1980), Pfaff (1981), and Burns & Burns (1982) advocated using computer simulations in classrooms to promote realism by bridging portfolio theory with practical applications. Since the 1990s, personal computers and spreadsheet tools have become readily available. Stephens (1998), Kwan (2001), Carter, Dare, & Elliott (2002), and Johnson & Liu (2005) illustrated using Excel spreadsheets to construct mean-variance efficient portfolios and frontiers under different constraints. Repeated experiments conducted by Cagle, Glasgo, & Hyland (2010) showed that spreadsheet assignments were effective tools in helping students learn finance.

However, Excel is not suitable for analyzing large data sets in the big data era. Excel templates typically lack the flexibility for creating mean-variance portfolios with different numbers of risky assets. Excel users often have to redesign and reconstruct the entire spreadsheet to make significant changes. In other words, it is difficult to make scalable programs in Excel. Teaching students Excel VBA is a potential solution (Bauer, 2006), but it is a less popular language with limited open-source support. Moreover, Excel VBA still cannot make Excel a practical tool for analyzing a large volume of data. Since teaching programming to finance students is beneficial, why not choose a general-purpose language like Python? Apart from the capacity to handle large data sets, there are many open-source Python packages for downloading financial data through Application Programming Interfaces (APIs), allowing instructors to demonstrate applications of financial models with real-world data.

In addition to Python being a better tool for analyzing financial data, the Jupyter Notebook Integrated Development Environment (IDE) offers code and markdown cells. Unlike making comments in computer programs, markdown is a word processor that allows users to format texts, make tables, and write mathematical equations. Lecturers can create pre-formatted Jupyter Notebooks that resemble traditional lecture notes by adding sections with prologues in markdowns. Students can then fill up each section in their own words and codes. By encouraging students to write detailed documentation and summaries in the Jupyter Notebook, instructors can develop students' abilities in conducting transparent and reproducible investment analyses.

Modern Portfolio Theory

This section reviews important concepts and optimization techniques in portfolio theory. Some students may initially find the Markowitz (1952) Nobel-winning MPT intimidating. To promote their learning incentives, instructors can begin by illustrating the groundbreaking insights of Harry M. Markowitz and how his thoughts influence subsequent developments in financial theories and the investment industry. By developing the theoretical foundation for making portfolio choices under uncertainty, he formalized the conventional wisdom of not putting all the eggs in the same basket by demonstrating the effect of diversification through portfolio statistics. His mean-variance analysis offered a systematic way to achieve the best tradeoff between the expected return and risk of a portfolio subject to one's risk aversion. The insight of Markowitz's optimal portfolio choice eventually led to the development of another Nobel-winning economic theory: the Sharpe (1964) Capital Asset Pricing Model (CAPM). Apart from its profound academic value, the MPT

has profound practical implications and is well-received by the financial industry. Bernstein (1992), the founding editor of the *Journal of Portfolio Management*, dubbed Markowitz the “grandfather of financial theories” and praised his role in revolutionizing modern-day Wall Street. According to Scaggs (2023), Robert D. Arnott, the founder of Research Affiliates, said, “Before Harry, investing was a bunch of rules of thumb...” (para. 11). After the sad passing of Markowitz, CFA Institute and GARP, the two leading professional organizations in investment and risk management, issued in memoriams to commemorate his significant contributions to the field of finance (Ginnis, 2023; Goetzmann, 2023).

As Markowitz (1990) pointed out in his Nobel Prize Lecture, the intuition of portfolio selections follows the utility maximization framework in microeconomics. Investors make their optimal investment choices under uncertainty by maximizing the expected mean-variance utility of

$$E[U_{p,A}] = E[r_p] - 0.5A\sigma_p^2. \quad (1)$$

For an investor with a risk aversion of A , the expected utility ($E[U_{p,A}]$) of a portfolio p equals the ratio between the portfolio expected return ($E[r_p]$) and the product of the risk aversion and the portfolio variance (σ_p^2) divided by two. In reality, it does not mean investors have quadratic utility functions. Instead, Markowitz views mean-variance analysis as a practical solution to approximate the maximum expected utility (Kritzman & Markowitz, 2017).

Following Arnold (2002), this article emphasizes the necessity of using linear algebra in teaching portfolio theory. With linear algebra, instructors can demonstrate real-world applications of portfolio choices beyond two risky assets. Moreover, numerical optimizations of portfolio problems in Python require array (matrix) operations in NumPy and SciPy. Using matrix notations, the portfolio variance for N risky assets is

$$\sigma_p^2 = \mathbf{w}^T \boldsymbol{\Sigma} \mathbf{w}, \quad (2)$$

where \mathbf{w} is a $N \times 1$ vector of portfolio weights on risky assets and $\boldsymbol{\Sigma}$ is the $N \times N$ sample variance-covariance matrix. To locate the Global Minimum Variance Portfolio (GMVP), the objective function is the portfolio variance (σ_p^2), and we minimize it by changing weights on risky assets (\mathbf{w}). Similarly, the portfolio Sharpe Ratio for N risky assets follows

$$SR_p = \frac{\mathbf{w}^T \mathbf{E}[\mathbf{R}]}{\sqrt{\mathbf{w}^T \boldsymbol{\Sigma} \mathbf{w}}}, \quad (3)$$

where $\mathbf{E}[\mathbf{R}]$ is a $N \times 1$ vector of risky assets' expected excess returns. Therefore, the numerator is the portfolio expected excess return and the denominator is the portfolio standard deviation. To find the Maximum Sharpe Ratio Portfolio (MSRP), the objective function becomes the portfolio Sharpe Ratio (SR_p), and we maximize it by choosing \mathbf{w} . Portfolio weights must sum up to one. The equality investment constraint is thus $\mathbf{w}^T \mathbf{1} = 1$, with $\mathbf{1}$ being a $N \times 1$ vector of ones. By imposing the equality investment constraint, the analytical matrix solutions of the GMVP (g) and the MSRP (m) are

$$\mathbf{w}_g = \frac{\boldsymbol{\Sigma}^{-1} \mathbf{1}}{\mathbf{1}^T \boldsymbol{\Sigma}^{-1} \mathbf{1}} \quad (4)$$

and

$$\mathbf{w}_m = \frac{\boldsymbol{\Sigma}^{-1}\mathbf{E}[\mathbf{R}]}{\mathbf{1}^\top \boldsymbol{\Sigma}^{-1}\mathbf{E}[\mathbf{R}]}, \quad (5)$$

respectively. Both portfolios are independent of investors' risk aversions and on the efficient minimum variance frontier without the risk-free asset. If investors can borrow or lend at the common risk-free rate, the theoretical efficient frontier becomes the capital allocation line linking between MSRP and the risk-free asset. If we maximize the expected mean-variance utility function in Equation (3), we obtain

$$\mathbf{w}_a = \frac{\boldsymbol{\Sigma}^{-1}\mathbf{1}}{\mathbf{1}^\top \boldsymbol{\Sigma}^{-1}\mathbf{1}} + A^{-1}\boldsymbol{\Sigma}^{-1}[\mathbf{E}[\mathbf{R}] - \frac{\mathbf{1}^\top \boldsymbol{\Sigma}^{-1}\mathbf{E}[\mathbf{R}]}{\mathbf{1}^\top \boldsymbol{\Sigma}^{-1}\mathbf{1}}\mathbf{1}]. \quad (6)$$

The optimal risky portfolio for an investor is thus the sum of the GMVP and a zero-sum portfolio that depends on the investor-specific risk aversion. For advanced-level courses, instructors can derive these closed-form solutions with vector calculus and explain their implications. However, analytical solutions for portfolio choice problems are no longer available when we introduce inequality or nonlinear constraints. To find admissible solutions for the quadratic programming problem subject to realistic investment constraints, we will numerically solve the system of equations and inequalities corresponding to the Karush–Kuhn–Tucker (KKT) conditions with Python.

Jupyter Notebook

This section provides a step-by-step Python programming guide for applying portfolio theory to financial market data. In the companion Jupyter Notebook, each code cell is executable by pressing **Shift ↵** and **Enter ↵** on one's keyboard simultaneously or the ► button on the interface's menu bar. The notebook also gives explanations of model specifications and their associated syntax in the markdown environment. Instructors and students can freely modify the coding environments to add new features and the markdown environment to make comments or take notes.

Step One

We import four Python libraries: yfinance, pandas, NumPy, and matplotlib. First, yfinance is an open-source third-party tool for downloading financial market data through Yahoo! Finance's public APIs. If yfinance is unavailable on the local Python distribution or the cloud server, we can install it by running the first line of Cell [1] in a new cell by removing the # symbol (comment out). Second, pandas and NumPy provide functions and methods for data manipulations and matrix operations, respectively. Last, matplotlib allows its users to visualize data and their analytics. In addition, we need two functions from the optimize module of the SciPy library for solving constrained optimization problems.

```
[1]: #pip install yfinance --upgrade --no-cache-dir
import yfinance as yf
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from scipy.optimize import minimize, Bounds
```

Step Two

We define our investment universe by enclosing stock tickers in a list: ['PG', 'DIS', 'IBM', 'NKE', 'BA', 'KO', 'CVX'] with square brackets. These seven stocks are BA (Boeing), CVX (Chevron), Coca-Cola (KO), DIS (Disney), IBM (IBM), NKE (Nike), and PG (Procter & Gamble). Instructors should encourage students to experiment with different stocks across global stock markets. We use the download function from yfinance to download daily stock data from Yahoo! Finance. The first input to the function is the list containing tickers, followed by data frequency in interval, start date in start, and end date in end. The resulting output is a table (pandas data frame) named Ast, which contains multiple items for seven stocks from 1 December 2017 to 29 September 2023. For yfinance version 0.2.54 or above, price-related outputs ('Open', 'High', 'Low', and 'Close') are adjusted automatically for changes in outstanding shares. Hence, we subset the Ast table with the column name 'Close' to get the adjusted closing prices, which are the closing prices after all applicable adjustments for stock splits and dividend payments. Before going through the code further, instructors should discuss the dichotomy between the in-sample period for constructing the optimal portfolio and the out-of-sample period for back-testing the investment strategy. Figure 1 presents a timeline for using five data periods to estimate the portfolio and one data period to test the strategy. It is essential to emphasize that the IS period must not overlap with the out-of-sample period to avoid look-ahead bias in back-testing investment performance. In other words, we cannot use future information in making investment decisions today. Our in-sample period is from 1 December 2017 to 29 December 2022, whereas our out-of-sample sample starts on 30 December 2022 and ends on 29 September 2023. Like the investment universe, instructors can tell students to try different settings by specifying in-sample and out-of-sample periods. The pandas library allows us to manipulate the Ast data frame with different methods.

```
[2]: Ast = yf.download(['PG', 'DIS', 'IBM', 'NKE', 'BA', 'KO', 'CVX'],  
    interval='1d', start='2017-12-01', end='2023-09-30')  
    Ri = (Ast['Close'].loc[:'2022-12-29'].resample('M').last().pct_change().dropna())  
    CRo = Ast['Close'].loc['2022-12-30': '2023']  
    CRo = CRo/CRo.iloc[0,:]
```

Figure 1
Back-testing



When estimating inputs for the portfolio model, we use the conventional sampling window of 60 monthly returns (5 years of data). Therefore, we apply the loc method to subset the data by its row index labels. The input of [:'2022-12-29'] means our in-sample period starts with the first row until the row of 29 December 2022. Next, we use resample('M').last() to convert the in-sample daily adjusted closing prices into the month-end prices. We then convert these adjusted closing prices into percentage returns with the pct_change() method. Instructors should remind students that these computed returns only reflect capital gain or loss because percentage changes based on the adjusted closing prices do not account for dividend yields. The percentage change calculation requires two consecutive prices, so the first row of the resulting Ri table contains missing values.

We remove them using the `dropna()` method. We can apply multiple methods to transform the original object into the desired output with a single line of code. If students are new to programming, instructors can consider breaking the chain into multiple steps to explain the inner workings of the code better. For instance, one can create the subset of `Ast` by `AstIS = Ast['Adj Close'].loc[:'2022-12-29']` and use `AstIS = AstIS.resample('M').last()` to convert it into month-end data.

As for the out-of-sample back-testing period, we again subset `Ast` with `loc` to create the `CRO` table. We compute the cumulative gross returns of all seven stocks at a daily frequency over 2023 by dividing each column of data by its initial value. We can use `iloc[0,:]` to extract data from the first row of every column in `CRO`. In contrast to `loc`, the `iloc` method follows position-based indexing. For Excel or Matlab users, please note that Python starts its index counter with 0. This procedure is equivalent to standardizing the initial values of all seven return series to one. Instructors can explain this idea with a rhetorical question: “Suppose we invested \$1 in IBM on the last trading day of 2022; how much is it worth today in 2023?” and show the plot of cumulative returns for stocks over the out-of-sample period.

Step Three

We obtain historical estimates of expected returns and variance-covariance matrix from the table of in-sample monthly returns `Ri`. We apply the `mean()` method to compute time-series average values `ER` (expected returns) and the `cov()` method to estimate the sample covariance- variance matrix `S`. It is a Pythonic way to write multiple assignments to objects by adding commas between expressions, writing `ER = Ri.mean()` and `S = Ri.cov()` yield identical outputs. We can add `axis=1` inside the `mean()` method to compute the cross-sectional average. The default axis is 0 for indices, and the alternative is 1 for columns. When commas separate expressions, they become elements of a tuple. After estimating inputs, we define objective functions using the keyword `def` to specify the function name and arguments. The first `PV` function takes the weighting vector `w` and the sample covariance-variance matrix `S` as inputs, and it returns the portfolio variance in Equation (2). In addition to the two inputs in `PV`, the second `NPSR` function also requires expected returns `ER` to compute the negative of the portfolio Sharpe Ratio in Equation (3). We negate the portfolio Sharpe Ratio because the SciPy library only offers the `minimize()` function. It is typical to have minimize functions instead of maximize functions in numerical optimization packages across different programming languages. In effect, we convert the maximization of the portfolio Sharpe Ratio into the minimization of `NPSR`. In this simplified example, the risk-free rate is assumed to be zero. When the risk-free rate is available, we subtract it from the `ER` array to get an array of expected excess returns. Instructors can discuss the choice of risk-free rate with students. For example, it is a common practice to use the one-month Treasury bill rate as the US risk-free rate.

```
[3]: ER, S = Ri.mean(), Ri.cov()
      def PV(w, S):
          return (w.T @ S @ w)

      def NPSR(w, ER, S):
          return -(w.T @ ER)/((w.T @ S @ w) ** 0.5)
```

Step Four

We use NumPy arrays and SciPy functions to estimate four portfolios: i). G: Global Minimum Variance Portfolio (GMVP); ii). M: Maximum Sharpe Ratio Portfolio (MSRP); iii). Gn: GMVP with no short selling; and iv). Mn: MSRP with no short selling. Before using the minimize() function, we must specify the initial guess for portfolio weights and investment constraints. We use the len() function to count the number of elements in ER to get the number of assets N. Alternatively, we can use Ri.shape to check the dimensions of Ri, which returns a tuple containing the number of rows in the first element and the number of columns in the second element. Please note that shape is an attribute of the data frame, not a pandas method. If one writes Ri.shape(), an error will arise. Given our initial guess x0 of an equal-weighted portfolio, we divide an array of N ones by N. The first investment constraint is an equality constraint 'type': 'eq' with the sum of portfolio weights minus one equals zero 'fun': lambda x: np.sum(x) - 1. The lambda function takes an array x as input and returns the sum of elements in x minus one. We have to specify this constraint inside a dictionary { }. Similar to the aforementioned list [] and tuple (), the dictionary is a built-in data structure of Python. After preparing all the ingredients for constrained optimizations, we can go through the procedure of solving the four portfolios individually.

```
[4]: N = len(ER)
     x0 = np.ones(N)/N # initial guess with w = 1/N
     cons = ({'type': 'eq', 'fun': lambda x: np.sum(x) - 1})
     G = minimize(PV, x0, method='SLSQP', args=S, constraints=cons).x
     M = minimize(NPSR, x0, method='SLSQP', args=(ER, S), constraints=cons).x

     bounds = Bounds(0, 1) # define no short selling constraint
     Gn = minimize(PV, x0, method='SLSQP', args=S, constraints=cons, bounds=bounds).x
     Mn = minimize(NPSR, x0, method='SLSQP', args=(ER, S),
                  constraints=cons, bounds=bounds).x
```

- G:** The minimize function for estimating G takes five compulsory arguments: i) the objective function to be minimized PV; ii) the initial guess x0; iii) the optimization algorithm method='SLSQP'; iv) argument inputs to the objective function args=S; and v) optimization constraints constraints=cons. After executing the minimize() function, the array of optimized portfolio weights x is an attribute of the output and is callable by .x.
- M:** The inputs for estimating M are similar to G, except for changing the objective function to NPSR and supplying additional arguments args=(ER, S) to the objective function. In other words, the optimization problem becomes the minimization of the portfolio Sharpe Ratio.
- Gn:** The Bounds function allows us to define the possible range for individual asset weights w_i . It precludes short selling by restricting the lower and upper bounds to 0 and 1, respectively. These bounds are equivalent to having the inequality constraint of $0 \leq w_i \leq 1$. Together with the inputs in estimating G, we further add bounds=bounds to the minimize() function to estimate Gn.
- Mn:** We estimate Mn by adding bounds=bounds to the minimize() function of M, which is identical to maximizing the portfolio Sharpe Ratio with no short selling.

Step Five

We visualize our estimated portfolio weights with a bar plot. P is an empty pandas data frame with stock tickers as row names `index=Ri.columns` and the abbreviations of five portfolios as column names `columns=['G', 'M', 'Gn', 'Mn', 'EW']`. We assign the four sets of portfolio weights estimated in the previous step into P and plot them using `P.plot(kind='bar')`. All the plots in this cell use the 'seaborn-v0_8' style. The additional Portfolio EW is an equal-weighted strategy that allocates 14.29% into each stock ($w_i = 1/7$).

Previously, in step two, CRO contains the out-of-sample cumulative gross returns for our investment universe. Since portfolio weights sum up to one, the matrix product of (CRO @ P) yields a data frame containing four strategies' cumulative daily returns in 2023. For instance, if we invest 50% in Stock A and 50% in Stock B on day 0, it is equivalent to investing \$0.5 in each stock for every dollar invested. Therefore, the portfolio net asset value (NAV) on day 5 is just the sum of \$0.5 multiplied by the two cumulative gross returns from day 0 to day 5. We visualize these returns using the `plot()` method of the Pandas data frame.

```
[5]: plt.style.use('seaborn-v0_8')
     P = pd.DataFrame(index=Ri.columns)
     P['G'], P['M'], P['Gn'], P['Mn'], P['EW'] = G, M, Gn, Mn, 1/N
     fig2a = P.plot(kind='bar')
     fig2b = (CRO @ P).plot()
```

As shown in Figure 2(a), both the global minimum variance portfolio G and the maximum Sharpe Ratio portfolio M have short selling positions. Portfolio G shorts 6.1% only in Boeing, while Portfolio M shorts 14.7% in Boeing, 33.8% in Disney, and 21.2% in IBM. Instructors should explain to students that the short positions in M are unrealistic as they make the portfolio highly leveraged and very risky. In reality, Portfolio M is also not implementable because its percentage margin of 41.8% violates the Federal Reserve Board Regulation T's minimum 50% initial margin. The percentage margin is defined as equity divided by the sum of absolute market values of long and short positions in stocks. In our example, we compute the percentage margin of Portfolio M by dividing the total invested cash of \$1 by the total absolute weights in stocks. Luckett (1988) explains the use of margin credit in investment and how the Federal Reserve can mitigate market speculations by imposing a minimum margin requirement. After imposing short-sale constraints, Portfolio Gn and Portfolio Mn have only positive weights but no longer invest in every stock because negative weights in Portfolio G and Portfolio M are essentially set to zero. For instance, Portfolio Mn invests 67.9% in Procter & Gamble (SR = 0.23), 16.4% in Nike (SR = 0.18), and 15.7% in Chevron (SR = 0.15). This result is hardly surprising as the optimizer aims to maximize the portfolio's in-sample Sharpe Ratio (SR = 0.27). Assuming a zero risk-free rate, we can compute in-sample Sharpe Ratios of assets by dividing their average returns by their standard deviations. The Python code is `Ri.mean()/Ri.std()`. As for the portfolio in-sample Sharpe Ratio, we can compute it with the negative of the pre-specified NPSR function. For example, the code for calculating the in-sample Sharpe Ratio for Portfolio G is `-NPSR(G, ER, S)`. In contrast, Portfolio Gn is more diversified, with positive weights in six out of seven stocks. Therefore, instructors should highlight the potential concentration risk of choosing Portfolio Mn over Portfolio Gn in practice.

To assess the performance of the four optimal portfolios, we compare the buy-and-hold out-of-sample cumulative daily returns from January 2023 until October 2023 in Figure 2(b). Students should now become clear that maximizing the in-sample Sharpe Ratio may not guarantee a good out-of-sample performance. Portfolio M had the highest in-sample Sharpe Ratio ($SR = 0.32$), but it performed the worst out-of-sample. Because of the high leverage ratio in Portfolio M, the path of its out-of-sample portfolio values was more bumpy than the rest. In other words, investors of Portfolio M would have experienced large drawdowns and volatile returns. On the contrary, Portfolios G, Gn, and Mn held at least 40% in Procter & Gamble and 10% in Nike, and they had tiny or no short-selling positions. Therefore, they exhibited similar patterns in cumulative returns over the out-of-sample period.

In Figure 2(b), the value of Portfolio EW was on top of others over most of the out-of-sample period, revealing that more sophisticated portfolios from portfolio theory might not always perform better than an agnostic strategy. This result might seem surprising to students, who might question the necessity of learning portfolio theory. To resolve the potential confusion for students, instructors should consider the following steps. First, remind students that the back-testing result is always sample-specific. Given only seven stocks in a short out-of-sample period, we need to include more stocks and use longer samples to evaluate the empirical performance of these strategies.

Figure 2
Visualizing Portfolio Results



(a) Strategy portfolio weights returns



(b) Strategy out-of-sample cumulative returns

Second, introduce students to practitioner and academic journal articles on applying portfolio theory. For example, Michaud (1989) points out the tendency of mean-variance optimization in maximizing estimation errors in inputs, also commonly known as the “garbage in, garbage out” problem. If we cannot reliably estimate expected returns and the variance-covariance matrix with historical data, the resulting “optimal” portfolios will likely be sub-optimal out-of-sample. That said, Michaud (1989) argues that mean-variance optimization is still superior to ad hoc investment practices for using information efficiently and integrating portfolio objectives with investment constraints. In an interview (Kritzman & Markowitz, 2017), Markowitz explained the importance of constraints: “*We use constraints for multiple reasons. One reason is that our estimates are imperfect. But even if our estimates were perfect, we wouldn’t want to expose the investor to too*

much of highly volatile asset classes like small cap or emerging markets” (p. 19). By imposing investment constraints, we avoid extreme allocations and excessive leverages in our portfolios. There is ample evidence showing that statistical adjustment of inputs and realistic investment constraints enhance the out-of-sample performance of mean-variance-efficient portfolios.

Regarding input estimations, Jobson & Korkie (1981) consider the James-Stein approach to estimate the expected returns of individual stocks by the cross-sectional average of their historical average returns. Using the same estimate for individual stock returns in portfolio optimization enhances the out-of-sample Sharpe Ratio of the MSRP. Frost & Savarino (1986) and Jorion (1986) also apply Bayesian shrinkage estimators to the sample mean. By shrinking sample average returns towards their proposed priors, they select portfolios superior to those based on sample estimates. Similarly, Ledoit & Wolf (2004, 2017) show that variance-covariance matrices estimated from shrinkage estimators outperform their sample counterparts in portfolio optimizations. Since the MSRP aims to select stocks that maximize the portfolio Sharpe Ratio, the resulting portfolio weights are sensitive to estimation error in expected returns. In line with this view, Haugen & Baker (1991) find that the low-volatility portfolio generates superior out-of-sample performance over the Wilshire 5000 index, whereas Green & Hollifield (1992) argue using the GMVP to circumvent extreme portfolio allocations arising from imprecise input estimates. Instructors can follow up by discussing the growing popularity of low-volatility investing (Blitz & van Vliet, 2007) in the asset management industry.

As for investment constraints, Jagannathan & Ma (2003) show that imposing the no-short-sales constraints on the minimum variance portfolio has the same effect as reducing estimated covariances. In other words, these non-negativity constraints mitigate the effect of sampling error in estimating the variance-covariance matrix, resulting in better out-of-sample portfolio performance. However, when imposing constraints, there is a trade-off between reducing estimation and increasing model specification errors. Therefore, Jagannathan & Ma (2003) suggest that adding non-negativity constraints is likely detrimental to portfolio optimizations involving expected returns estimated from factor models, shrinkage methods, and large portfolios. That said, instructors should emphasize the practical values of an upper bound on portfolio weight to avoid over-exposure to one asset and the no-short-sales constraints to reduce investing on margin. In response to significant estimation errors, we can assume equal expected returns, equal variances, and correlations of zero across assets. The resulting optimal portfolio will be an equal-weighted ($1/N$) strategy. DeMiguel, Garlappi, & Uppal (2009) document that the naive $1/N$ portfolio has better out-of-sample performance than the sample-estimate-based mean-variance efficient portfolio and its extensions utilizing statistical adjustments and investment constraints. Krirzman, Page, & Turkington (2010) dispute this view by arguing that the relatively superior performance of the $1/N$ portfolio hinges on the sampling window of input estimations. Optimized portfolios constructed from longer historical samples can perform better than $1/N$ portfolio out-of-sample. Importantly, instructors should emphasize that the “best” practice may depend on many factors, such as asset classes, markets, and sampling periods. There is no clear-cut answer in selecting the “true” optimal portfolio.

Third, as stated in Box (1979), “*Models, of course, are never true, but fortunately it is only necessary that they be useful*” (p. 2). There will always be a chasm between theory and practice. However, models are essential in guiding us to analyze the problem systematically. In our example, portfolios with low volatility, non-negativity constraints, or $1/N$ allocations all perform better than the canonical maximum Sharpe Ratio portfolio. Therefore, instructors should make students aware of new developments in applying portfolio theory from both the practitioner and academic sides.

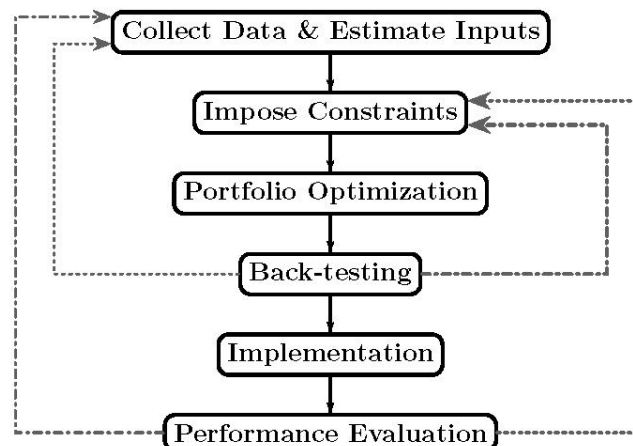
Fourth, instructors should highlight the shortcomings of the simplified analysis. For instance, the current analysis assumes a zero risk-free rate, uses closing price returns without dividend yields, and ignores transaction costs. Interest rates on government debt securities and total returns of individual stocks are available on commercial databases such as Bloomberg and Datastream. Regarding transaction cost analysis, Nisbet & O'Brien (1991) provide a tutorial on incorporating block trading costs into investment analysis. For real-life applications, a survivorship bias-free database is essential to avoid look-ahead, over-fitting, and sample selection biases that inflate the out-of-sample performance. To account for liquidity and implementability issues, practitioners should consider intra-day transaction data.

Finally, the standard caveat of “past performance does not guarantee future results” will always apply to investment strategies based on historical data because of estimation errors and non-stationary parameters. Since the future is hard to predict, the investment policy statement must include risk warnings and disclaimers.

Bridging Theory and Practice

The primary objective of teaching portfolio theory interactively with Python is to promote realism. Figure 3 presents a road map for making investment decisions quantitatively. The process starts with gathering market data and estimating statistical inputs. Next, investors impose investment constraints to exclude unrealistic allocations. Together with inputs and constraints, the mean-variance optimizer selects the optimal portfolio based on the pre-specified objective function. The back-testing procedure then examines the investment strategy's performance in the historical sample. If the back-testing result is satisfactory, investors can make actual investments according to the optimal portfolio weights. The final step is to evaluate the actual strategy performance after implementation. There are backward actions in blocks four and six, reflecting the possibility of revising and redesigning the investment strategy given poor back-testing results or trading losses.

Figure 3
A Quantitative Investment Flow Chart



Regarding actual applications, some universities have the resources to allow their students to manage real money portfolios. For example, Belt (1975) and Bear & Boyd (1984) describe student-managed portfolio programs at their institutions. Yerkes (2018) highlights key benefits and challenges in letting students manage actual funds. Moreover, Lin (2022) explains why these funds

face unique challenges and recommends ways of tackling them. As a low-cost alternative, Wood, O'Hare, & Andrews (1992) discuss the costs and benefits of using a stock market game with hypothetical money as an educational tool in the classroom. Kagan, Mayo, & Stout (1995) point out that participants in stock market games tend to take excessive risks in under-diversified portfolios. Jankowski & Shank (2010) also argue that free online trading simulators lack the flexibility for higher-level courses. That said, Ali, Derina, & Zurbruegg (2009) find that students become more motivated to study and eager to pursue a future career in finance after participating in an online portfolio trading game.

Therefore, when designing the portfolio theory course, instructors should adopt the problem-based learning approach to offer a realistic experience to students (Loviscek, Crowley, & Anderson, 2003). On the one hand, homework assignments should focus on developing students' technical skills in statistics and optimizations. Instructors can specify a sample data set and provide expected outcomes for students to replicate. By doing so, students can check their understanding of the course material and ensure they are proficient with Python applications in portfolio selections. On the other hand, group projects and presentations should focus on encouraging students' creativity, critical thinking, and collaboration. The following box gives a sample description of the group project.

Group Project

In December 2022, you are working with a group of fund managers managing a quantitative fund. Your group wants to design and implement a new investment strategy starting January 2023. Your investment decisions should be based on statistical analysis and back-testing. The fund mandate is to explore profitable equity investment opportunities in a stock market. The fund's investors have moderate risk tolerance so that the fund can take leveraged or short-selling positions. However, the fund's initial percentage margin must be higher than 50%. The fund's model validation quant will inspect your team's source Python codes in constructing the strategy.

The tentative work plan is as follows:

1. Choose a specific stock market around the world as your investment universe.
2. Identify the appropriate index for benchmarking your fund's performance.
3. Create a proprietary trading strategy that aims to beat the benchmark index.
4. Draft an investment policy statement.

Students can freely choose the investment universe, the statistical tools for estimating inputs, and the portfolio construction methodology. The only constraints students face are investors' risk tolerance and the leverage limit, thus restricting excessive risk-taking and under-diversification. By analyzing international stock markets, instructors can discuss the equity home bias puzzle (French & Poterba, 1991) and explain the potential benefit of diversifying investment globally. To promote data and knowledge sharing, students must upload their Python codes and investment policy statements of their investment strategies onto the class website before their project presentations. Students will learn to work in a team and write professionally. The development of technical writing skills is essential, as Kish & Hogan (2001) suggest that write-ups in asset allocation exercises help students prepare for job interviews. In the investment policy statement, students must state their fund's investment objectives to potential clients and explain why they

believe their strategy can meet their goals. Furthermore, they should discuss their fund's asset allocation, risk tolerance, and other practical concerns. Like academic conferences, project groups will present their strategies and critique other groups' findings. The peer review process motivates students to think critically about each other's work. At the end of each presentation and discussion session, instructors should give their comments and suggestions to student presenters and discussants. In between sessions, instructors should open the floor for Q&As.

Comparison of Alternative Python IDEs and Deployment Methods

This article advocates using Google Colab to run the interactive teaching notebook online in the Jupyter environment. Nevertheless, there are ample alternatives to implementing the proposed framework for teaching MPT interactively. The following section reviews alternative IDEs and deployment methods for Python.

IDEs

- **Project Jupyter:** It builds upon the IPython (Interactive Python) framework, focusing on interactive data science and scientific computing. The main strength of Jupyter Notebook as a pedagogical tool is that it allows users to combine the code environment with the word processing (markdown) environment. Each code cell is accompanied by verbal instructions, explanations, and mathematical equations. It opens and runs on the computer's default internet browser. While it resembles conventional lecture notes or websites, lecturers can show students how to execute computer programs in the notebook's code cells to gather, process, and analyze data, resulting in an interactive teaching and learning experience. Moreover, the markdown environment is highly flexible. Lecturers and students can add and modify content to meet their educational needs. JupyterLab is the latest generation, free-to-use Jupyter Notebook Interface that supports popular languages such as Python and R. Cloud computing services such as Amazon SageMaker, Google Colab, and Microsoft Azure adopt the Jupyter Notebook as the IDE for their users.
- **Spyder:** With a graphical user interface (GUI) similar to RStudio, Spyder is an open-source Python-specific IDE for scientific programming. The variable explorer can be handy for data scientists and quantitative researchers to keep track of variables of interest and memory usage. However, novice Python users may feel overwhelmed by its elaborate GUI and technical features. Furthermore, users must install the additional Spyder-notebook plugin to utilize the markdown environment as in the Jupyter Notebook.
- **PyCharm:** Popular among software and web developers for its advanced features, PyCharm is a proprietary IDE developed by JetBrains for Python. The community edition of PyCharm is open-source but has fewer features than the paid professional edition. Teachers and students can apply for free educational licenses to use the professional edition.
- **Visual Studio Code:** Developed by Microsoft, VS Code is a general-purpose IDE for multiple programming languages such as C, C#, C++, Java, Python, and Rust. According to Stack Overflow (2023), over 70% of developers prefer VS Code over other IDEs. It is highly customizable and extensible owing to its active and broad user base. For example, it supports the markdown environment for text editing through the Jupyter extension.

Although the choice of IDE is ultimately a matter of personal preference, instructors must avoid overburdening their students with unnecessary technicalities in a data-driven finance course.

IDEs with too many features may cause confusion and frustration to students with little to no programming experience. Therefore, this section argues that the Jupyter environment is more suitable for pedagogical needs in financial education than its alternatives designated for professionals. It is interactive, intuitive, adaptive, lightweight, and user-friendly. The companion Jupyter Notebook preserves the vibe of conventional lecture notes, facilitating the incorporation of interactive teaching material into existing finance curricula.

Deployments

- Python: Installing Python from scratch is not beginner-friendly. Potential complications include installing essential packages, sorting out application dependencies, version control, managing Python paths, and creating virtual environments. While it is possible to create a Python Docker container to encapsulate all necessary packages for teaching the course, beginners may feel distracted by obscure software development concepts.
- Anaconda: By bundling thousands of packages for data science, machine learning, and artificial intelligence (AI), the Anaconda distribution provides an open-source, easy-to-install, and user-friendly data analytic platform in Python that suits the needs of both new learners and expert users. The Anaconda team ensures its distribution is tried and tested to abstain from compatibility issues. The default installation includes three popular Python IDEs: Jupyter Notebook, JupyterLab, and Spyder.
- Cloud: In addition to installing Python on a local computer, cloud computing providers such as Google Colab, Anaconda Cloud, GitHub Codespaces, and Microsoft Azure offer web-based access to Python. The basic requirement to use these services is merely a web browser with an internet connection, and the service providers' cloud servers do all the computations.

Cloud deployments are convenient to use in a classroom setting. Instructors can share their Jupyter Notebooks on cloud computing providers with students directly through web addresses. This deployment method saves instructors' time and effort in teaching students how to install Python, allowing the class to focus on learning portfolio theory with computer programs. For instance, this article's Companion Jupyter Notebook on Google Colab is accessible via <https://colab.research.google.com/drive/1awtDADoYcJHm5E7kTntZyqrWw5TwYSYD>.

However, instructors and students must have internet access in the classroom to use cloud Python services. Moreover, free versions of cloud Python services are usually slower than Python installed on local computers. Users must pay fees to cloud computing providers for additional computing power and storage space. In view of the sunk cost effect (Arkes & Blumer, 1985; Thaler, 1980), the installation of Anaconda can potentially serve as a commitment device for motivating students to learn. It also opens the possibility of assessing students' ability to solve investment problems with Python without the assistance of the Internet.

Integrating the Interactive Framework into Existing Finance Curricula

The proposed Python-based approach is adaptive to undergraduate and graduate-level courses. Targeted undergraduate students should have taken business statistics and financial management, which are usually core modules in year one or two for undergraduates in business schools. This prerequisite requirement ensures enrolled students understand concepts such as mean, standard

deviation, covariance, correlation, portfolio diversification with two risky assets, and the Sharpe ratio.

Instructors can tailor their syllabuses for master programs into the general business stream and the quantitative finance stream. The course prerequisites for the former are similar to those for the undergraduate program, while the latter can include linear algebra and multivariate calculus. As students in the quantitative finance stream have adequate mathematical backgrounds, instructors can include derivations of Equations 4, 5, and 6 to illustrate analytical solutions to portfolio optimization problems.

Challenges and Opportunities

This course design responds to the growing enthusiasm for artificial intelligence (AI) and big data applications in financial education. It opens up new opportunities for using technology in financial education and promotes interdisciplinary thinking. Nonetheless, instructors must be aware of the challenges and limitations of using Python to teach MPT.

First, students without prior programming experience may find learning finance with computer programming intimidating. Instructors have to ease the steep learning curve with additional resources and support. One can arrange a crash course on Python basics at the beginning of the semester. For example, the instructor can first demonstrate an operation in Excel, followed by the same operation in Python. Therefore, students will understand that the `mean()` method in pandas is equivalent to the `AVERAGE()` function in Excel. Instructors should also demonstrate simplifying multiplications and summations between Excel cells with array operations in NumPy. Moreover, it is a good practice to incorporate teaching assistant (TA) demonstration sessions to review every Python program covered in the course and ensure every student is on the same page. At the same time, the course's interdisciplinary nature would attract students from different academic backgrounds. In addition to finance students, my course attracts students majoring in computer science, mathematics, statistics, information systems, social science, journalism, business administration, and accounting. Based on my observation, students in science or quantitative disciplines would like to learn to apply their technical skills in business, while students in other disciplines would want to know more about combining technology with finance. For group projects, instructors should encourage collaborations between students from different majors, which fosters knowledge spillovers and team synergy. Experimental evidence reveals that peer learning benefits students (Eisenkopf, 2010) and teachers (Jackson & Bruegmann, 2009). Furthermore, Kimbrough, McGee, & Shigeoka (2022) and Kamei & Ashworth (2023) find that the ability gap between peers is imperative in improving peer learning. Therefore, instructors should encourage students with prior coding experiences to help group mates new to programming in group assignments and overall learning through a bonus score system in peer evaluations.

Second, students have to bring electronic devices to class to learn the course material interactively. While some instructors may prefer teaching computer-based lectures in computer labs to restrict students' access to social media or other distractions, the benefits of letting students code on their familiar devices should outweigh the costs of classroom management. From my observation, students who took courses in computer labs were less likely to write codes on their personal computers. That would defeat the purpose of encouraging students to learn and practice coding outside the classroom. Based on Imazeki (2014)'s experience implementing the bring-your-own-device (BYOD) system, BYOD is an effective tool for enhancing learning outcomes. Nevertheless, instructors should be patient and flexible in keeping students fully engaged.

As a side benefit, the course can become “paper-free” by having all teaching materials and assessments in electronic format. From my observation, students would quickly get used to taking notes in the Jupyter’s markdown environment. Most would switch from printing and writing on lecture slides to typing in markdowns or writing on PDF documents with tablets. Times Higher Education (THE) (2024) publishes Impact Rankings that assess global universities against the United Nations’ Sustainable Development Goals (SDGs). Therefore, a higher education institution’s Environmental, Social, and Governance (ESG) performance becomes more visible to the public. De la Poza, Merello, Barberá, & Celani (2021) document that higher education institutions’ reporting on their SDG achievements positively correlates with their ranking scores in the THE Impact Rankings. We, as instructors, should join forces to do our part in promoting and practicing ESG values in our courses. Adams, Martin, & Boom (2018) argue the importance of cultural change in driving the sustainability movement in universities. By digitizing our teaching materials and assessment tools, we can promote sustainability by reducing paper usage.

Conclusion

This article describes an interactive framework for modernizing the teaching of the Markowitz (1952)’s MPT with Python. After reviewing the use of programming languages in teaching finance and current practices of teaching portfolio theory, we provide a comprehensive guide to creating a Jupyter Notebook that implements the MPT with real-world data. Under the quantitative investment roadmap, students will learn to gather financial market data, estimate parameters, construct portfolios, and back-test investment strategies. The course design encourages students to share and review each other’s ideas in class. Correspondingly, students will develop practical skills in programming and critical thinking in solving real-life problems.

References

- Adams, R., Martin, S., & Boom, K. (2018). University culture and sustainability: Designing and implementing an enabling framework. *Journal of Cleaner Production*, 171, 434–445.
- Alexander, G. J. (1978). PORTFO: A Computer Program Involving the Application of Portfolio Theory. *Journal of Financial Education*, 7, 72–75.
- Alexander, G. J. (1981). PORTID: A Computer Program Involving the Interaction of Utility Theory and Portfolio Theory. *Journal of Financial Education*, 10, 88–90.
- Alexander, R. (2022). Wall Street’s love affair with data science has business schools like Wharton and Columbia scrambling to train the next generation of bankers and dealmakers. *Business Insider*, February 24, 2022. Retrieved from <https://www.businessinsider.com/wall-street-data-science-business-schools-mba-wharton-columbia-northwestern-2022-2>
- Ali, A. Z., Derina, R., & Zurbruegg, R. (2009). Adaptation of Online Material for Teaching Financial Economics Courses. *Journal of Financial Education*, 35, 96–113.
- Arkes, H. R., & Blumer, C. (1985). The Psychology of Sunk Cost. *Organizational Behavior and Human Decision Processes*, 35, 124–140.
- Arnold, T. (2002). Advanced Portfolio Theory: Why Understanding The Math Matters. *Journal of Financial Education*, 28, 79–96.

- Bauer, R. J. J. (2006). Teaching Excel VBA to Finance Students. *Journal of Financial Education*, 32, 43–63.
- Bear, T., & Boyd, G. M. (1984). An Applied Course in Investment Analysis and Portfolio Management. *Journal of Financial Education*, 13, 68–71.
- Belt, B. (1975). A Securities Portfolio Managed by Graduate Students. *Journal of Financial Education*, 4, 77–81.
- Bernstein, P. L. (1992). How Improbable Are the Origins of Modern Wall Street? Or the Miraculous Importance of Three Little Words. *Financial Analysts Journal*, 48(5), 15–18.
- Blitz, D. C., & van Vliet, P. (2007). The Volatility Effect. *The Journal of Portfolio Management*, 34(1), 102–113.
- Bodie, Z., Kane, A., & Marcus, A. (2021). *Investments* (12th Edition). McGraw Hill.
- Bodie, Z., Kane, A., & Marcus, A. (2022). *Essentials of investments* (12th Edition). McGraw Hill.
- Box, G. E. P. (1979). Some problems of statistics and everyday life. *Journal of the American Statistical Association*, 74(365), 1–4.
- Burns, W., & Burns, M. (1982). The Use of a Portfolio Management Simulation as a Learning Device. *Journal of Financial Education*, 11, 79–82.
- Cagle, J. A. B., Glasgo, P. W., & Hyland, D. C. (2010). Spreadsheets: Do They Improve Student Learning in the Introductory Finance Course? *Journal of Financial Education*, 36(3/4), 35–52.
- Carter, D. A., Dare, W. H., & Elliott, W. B. (2002). Determination Of Mean-Variance Efficient Portfolios Using An Electronic Spreadsheet. *Journal of Financial Education*, 28, 63–78.
- De la Poza, E., Merello, P., Barberá, A., & Celani, A. (2021). Universities' Reporting on SDGs: Using THE Impact Rankings to Model and Measure Their Contribution to Sustainability. *Sustainability*, 13(4), 2038.
- DeMiguel, V., Garlappi, L., & Uppal, R. (2009). Optimal Versus Naive Diversification: How Inefficient is the 1/N Portfolio Strategy? *Review of Financial Studies*, 22(5), 1915–1953.
- Eckardt, W. L. J. (1975). PERPORT: A Portfolio Management Game. *Journal of Financial Education*, 4, 91–98.
- Eckardt, W. L. J. (1978). PERS: The Evolution of a Computer-Based Portfolio Game. *Journal of Financial Education*, 7, 72–75.
- Eisenkopf, G. (2010). Peer effects, motivation, and learning. *Economics of Education Review*, 29(3), 364–374.
- French, K. R., & Poterba, J. M. (1991). Investor Diversification and International Equity Markets. *The American Economic Review*, 81(2), 222–226.
- Frost, P. A., & Savarino, J. E. (1986). An Empirical Bayes Approach to Efficient Portfolio Selection. *Journal of Financial and Quantitative Analysis*, 21(3), 293–305.
- Ginnis, T. (2023). Remembering Harry Markowitz: A Risk Management Pioneer and Beloved Mentor. *Risk Career Blog, GARP*, July 31, 2023. Retrieved from <https://www.garp.org/risk-intelligence/risk-career/remembering-harry-markowitz-073123>
- Goetzmann, W. N. (2023). Harry Markowitz in Memoriam. *Financial Analysts Journal*, 79(4), 5–7.
- Green, R. C., & Hollifield, B. (1992). When will mean-variance efficient portfolios be well diversified? *Journal of Finance*, 47(5), 1785–1809.
- Haugen, R. A., & Baker, N. L. (1991). The efficient market inefficiency of capitalization-weighted stock portfolios. *The Journal of Portfolio Management*, 17(3), 35–40.

- Hilpisch, Y. J. (2018). *Python for finance* (2nd Edition ed.). O'REILLY.
- Imazeki, J. (2014). Bring-Your-Own-Device: Turning Cell Phones into Forces for Good. *The Journal of Economic Education*, 45(3), 240–250.
- Jackson, C. K., & Bruegmann, E. (2009). Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers. *American Economic Journal: Applied Economics*, 1(4), 85–108.
- Jagannathan, R., & Ma, T. (2003). Risk Reduction in Large Portfolios: Why Imposing the Wrong Constraints Helps. *Journal of Finance*, 58(4), 1651–1683.
- Jankowski, J., & Shank, T. (2010). A Comparison of Online Stock Trading Simulators for Teaching Investments. *Journal of Financial Education*, 36(1), 105–119.
- Jobson, J. D., & Korkie, R. M. (1981). Putting Markowitz theory to work. *The Journal of Portfolio Management*, 7(4), 70–74.
- Johnson, L. J., & Liu, Y. G. (2005). An Excel-Based Method to Determine Investible Mean-Variance Efficient Portfolios with Short Sales. *Journal of Financial Education*, 31, 89–99.
- Jorion, P. (1986). Bayes-Stein Estimation for Portfolio Analysis. *Journal of Financial and Quantitative Analysis*, 21(3), 279–292.
- Kagan, G., Mayo, H., & Stout, R. (1995). Risk-Adjusted Returns and Stock Market Games. *The Journal of Economic Education*, 26(1), 39–50.
- Kamei, K., & Ashworth, J. (2023). Peer learning in teams and work performance: Evidence from a randomized field experiment. *Journal of Economic Behavior & Organization*, 207, 413–432.
- Kimbrough, E. O., McGee, A. D., & Shigeoka, H. (2022). How Do Peers Impact Learning? An Experimental Investigation of Peer-to-Peer Teaching and Ability Tracking. *The Journal of Human Resources*, 57(1), 304–339.
- Kish, R. J., & Hogan, K. M. (2001). Linking Theory And Practice: An Asset Allocation Assignment. *Journal of Financial Education*, 27, 76–87.
- Krizzman, M., Page, S., & Turkington, D. (2010). In Defense of Optimization: The Fallacy of 1/N. *Financial Analysts Journal*, 66(2), 31–39.
- Kritzman, M., & Markowitz, H. M. (2017). An Interview with Nobel Laureate Harry M. Markowitz. *Financial Analysts Journal*, 79(4), 16–21.
- Kwan, C. C. Y. (2001). Portfolio Analysis Using Spreadsheet Tools. *Journal of Applied Finance*, 11(1), 70–81.
- Ledoit, O., & Wolf, M. (2004). Honey, I Shrunk the Sample Covariance Matrix. *The Journal of Portfolio Management*, 30(4), 110–119.
- Ledoit, O., & Wolf, M. (2017). Nonlinear Shrinkage of the Covariance Matrix for Portfolio Selection: Markowitz Meets Goldilocks. *Review of Financial Studies*, 30(12), 4349–4388.
- Lin, C. Y. (2022). Student-managed investment funds: seven mismatches and three recommendations. *Managerial Finance*, 48(2), 334–347.
- Loviscek, A. L., Crowley, F. D., & Anderson, R. I. (2003). Problem-Based Learning In Finance: An Application To Portfolio Analysis. *Journal of Financial Education*, 29, 85–103.
- Luckett, D. G. (1988). A Pedagogical Note on the Use of Margin Credit. *The Journal of Economic Education*, 19(4), 337–340.
- Markowitz, H. M. (1952). Portfolio Selection. *Journal of Finance*, 7(1), 77–91.
- Markowitz, H. M. (1990). Foundations of Portfolio Theory. *Nobel Prize Lecture in Economic Sciences*, December 7, 1990. Retrieved from <https://www.nobelprize.org/uploads/2018/06/markowitz-lecture.pdf>

- Michaud, R. O. (1989). The Markowitz Optimization Enigma: Is “Optimized” Optimal? *Financial Analysts Journal*, 45(1), 31–42.
- Nawrocki, D. N. (1980). Development of Computer Programs for Application of Portfolio Theory in the Classroom. *Journal of Financial Education*, 9, 93–97.
- Nisbet, J. D., & O’Brien, T. J. (1991). An Example of Blending Block Trading Costs into Investment Analysis. *Financial Practice and Education*, 1(2), 35–38.
- Pfaff, P. (1981). Modern Portfolio Theory on a Microcomputer. *Journal of Financial Education*, 10, 85–87.
- Riley, W. B., & Montgomery, A. H. J. (1980). The Use of Interactive Computer Programs in Security Analysis and Portfolio Management. *Journal of Financial Education*, 9, 89–92.
- Root, T., Rozycki, J., Senteza, J., & Suh, I. (2007). The Undergraduate Finance Curriculum in the New Millennium: A Comprehensive Survey. *Journal of Financial Education*, 33, 1–27.
- Runyon, R. (1978). The Use of a Computer Simulation Game in the Investments Course. *Journal of Financial Education*, 7, 76–79.
- Scaggs, A. (2023). Harry Markowitz, economist, 1927–2023. *Financial Times*, July 1, 2023. Retrieved from <https://www.ft.com/content/2ebd7d96-c3e3-4b69-92ac-e39bc90e8068>
- Sharpe, W. F. (1964). Capital Asset Prices: A Theory Of Market Equilibrium Under Conditions Of Risk. *Journal of Finance*, 19(3), 425–442.
- Stack Overflow. (2023). *Insights: 2023 Developer Survey*. Retrieved from <https://survey.stackoverflow.co/2023/>
- Stephens, A. A. (1998). Markowitz and the Spreadsheet. *Journal of Financial Education*, 24, 35–43.
- Thaler, R. (1980). Toward a Positive Theory of Consumer Choice. *Journal of Economic Behavior & Organization*, 1(1), 39–60.
- The Economist. (2017). “The world’s most valuable resource is no longer oil, but data”, May 6, 2017. Retrieved from <https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data>
- Times Higher Education (THE). (2024). *University Impact Rankings for 2024*. Retrieved from <https://www.timeshighereducation.com/impactrankings>
- TIOBE. (2023). TIOBE Index for December 2023. Retrieved from <https://www.tiobe.com/tiobe-index/>
- Wood, W. C., O’Hare, S. L., & Andrews, R. L. (1992). The Stock Market Game: Classroom Use and Strategy. *The Journal of Economic Education*, 23(3), 236–246.
- Yerkes, R. T. (2018). The Art and Science of Student-Managed Investment Portfolios. *The Journal of Trading*, 13(1), 39–51.

After Two Decades, Finance Chairs /Professorships in the United States - 2005-2020

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In this article, we provide a detailed profile of the 896 Finance chair/professorship positions in the United States covering the period 2005-2020. We find that the number of chairs/ professorships increased by 221 percent from 2004-2005 to 2019-2020 and that the most popular teaching and research interest areas of the individuals holding these positions include: corporate finance, investments, financial institutions and markets, international finance, real estate and insurance, capital structure, asset pricing models, and mergers & acquisitions.

Most of the institutions that graduate a large number of individuals serving as chairholders are listed among the best business schools by sources such as Bloomberg, Business Week and U.S. News and World report. University of Pennsylvania awarded the largest number (29) of endowed chair positions in 2019-2020. Three other institutions that had more than 20 chairholders each were University of Chicago, Columbia University and Harvard University. University of Pennsylvania also produced the highest number of graduates serving as chairholders followed by University of Florida and University of Texas-A&M.

The original data and statistics for this study were obtained from various editions of Hasselback's Guide to Finance Faculty covering the period from 2004-2005 to 2019-2020. Based on the data collected, suggestions for future research projects and policy changes associated with the endowed chair/ professorship programs in the United States are provided.

Introduction

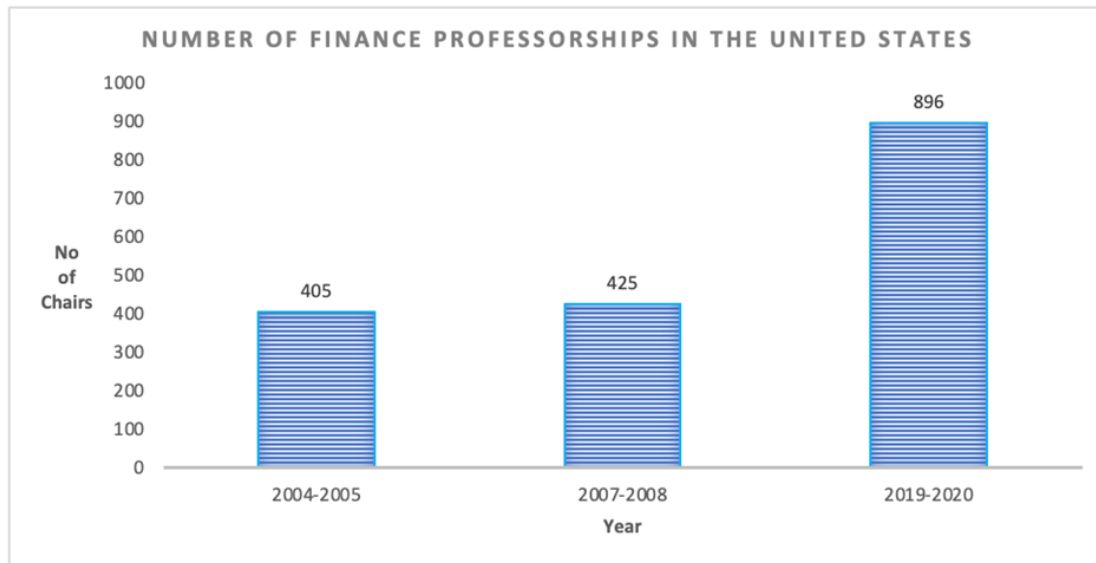
Over the past fifteen years (i. e. from 2005 to 2020), there has been a steady increase in the number of Finance chair/ professorship positions held in the United States. Figure I shows that in 2004-2005 there were a total of 405 Finance chair professorships spread across 708 U.S. educational institutions. The number of such endowed positions increased slightly to 425 in 2007-2008 and were held in 710 institutions (Figure 2). Twelve years later, that is, in 2019-2020, the number had increased by 211 percent to 896 Finance chair/ professorship positions distributed across 701 institutions. In this paper, our definition of finance chairs/ professorships includes both endowed and non-endowed chairs and professorships in the United States.

Prior research conducted over the period from 1992 to 1999 reported that that the period had witnessed a rapid increase in finance chair professorships in the United States. "In 1992, Finance departments had a total of 175 finance chair professorships in 81 universities and colleges. Five years later, in 1997, the number increased by 53.7 percent to 269 endowed chair/professorships. Further, by 1999, we had 287 finance chairholders, a gain of 6.7 percent in two years, spread across

115 institutions.” (Metwalli and Tang, 2000). Two decades later, i.e. in 2019-2020, the number increased by 312 percent to 896 finance chairs/ professorships in 701 institutions (see Figure 2).

Figure 1: A comparison of Number of Finance Endowed Professorships in the USA(2004-2005;2007-2008;2019-2020)

A1

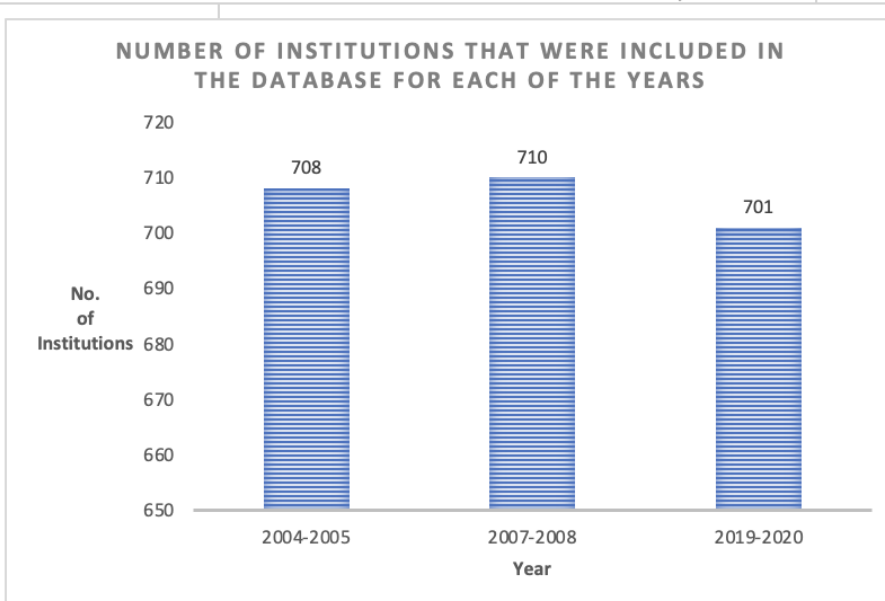


Sources: Hasselback (2004-2020)

Figure 2. Number of institutions that were included in the database for each of the years.

A2

Year	Number
2004-2005	708
2007-2008	710
2019-2020	701



Sources: Hasselback (2004-2020)

Our main objective of this study is to profile, compare, and update the distribution of finance chair/ professorship positions that were present in 2004-2005, and 2007-2008 with those that were listed in 2019-2020. We obtained our original data and statistics from Hasselback's updated directory for Finance Faculty [Hasselback, 2004-2005, 2007-2008 & 2019-2020]. Along with information and data from relevant reviews of the literature on chair professorships, we will discuss and present the following: 1) the number of finance chair professorships awarded by universities; 2) the academic research and teaching interests of chairholders; and 3) a list of institutions offering the highest number of degrees to chairholders along with the years that the chairholders earned their highest degrees.

In comparing between institutions granting a large number of chair positions with the top rankings of the Top Business Schools (as reported by Bloomberg, Business Week, and U.S. News and World Report), we find that 65% or 455 of these institutions had their business program accredited by the AACSB in 2019-2020. Additionally, only ninety-five of these 701 schools (i.e., 3.5%) currently offer a doctoral program in finance. The information presented in this study will help advance our understanding of the status of Finance chair/ professorship positions in the United States and possibly provide ideas for further research studies of issues associated with this topic.

Literature Review

For more than a century, the endowed chair /professorship idea has been in existence. The first endowed chair, in 1857, was given by Silas Holmes to Princeton University and was named after him [Leitch, 1978]. Soon after, many other institutions received endowments to provide more chairs and professorships.

After a relevant literature search, the authors found a few articles on chair professorships in business. Only one article that was published in 2001, focused on finance chair professorships in the USA (Metwalli and Tang, 2001). Other researchers discussed and were able to locate 20 endowed chairs and professorships in insurance (Murrey and Tosh 1983). A status profile of accounting chair professorships as of the year 1992 was provided by Tang (1993). Tang and Griffith (1997, 1998) also profiles the accounting chair professorships in 1997. "They found out that: (1) in 1997, there were 380 accounting chairholders and professorships spread over 166 institutions; (2) the number of accounting chair professorships increased significantly during the 1980's and early 1990's; and (3) the majority of the 380 chairholders in 1997 were full professors holding CPA Certifications" (Rezaee, Elmore, and Spiceland, 2006).

The following two articles discuss the status and profiles of management chair professorships: Metwalli and Tang (1991) provided a profile of 281 management chairs in the United States in 1991 and Katz (1991,) listed a total of 102 chairholders in entrepreneurship. The rest of the literature on chair professorships covered other fields such as Nursing (Fitzpatrick, 1985,1986), Gerontology and Geriatrics (Bell, 1986), Academic Medicine (Thorndyke, et al., 2022; Buckley, et al., 2022), Education (Hartlep, et al., 2016), and Emergency Medicine (Tondt et al., 2022). The recent findings in the fields of education (Hartlep et. al. (2016)), and academic medicine (Thorndyke et. al. 2022) indicate that there is a strong racial and gender bias in the awarding of these endowed chair and professorship positions in the United States, with white males holding almost 80% of these endowed positions. Furthermore, it has been reported that the disparity is not attributable to differences in merit between the racial and gender groups (Thorndyke et. al. (2022)). The authors recommended that a strategic approach to balance the gender distribution of these

endowed positions should be implemented by medical schools over time. Additionally, Chin-Hong et. al. (2022) emphasizes that receiving an endowed chair position is a critical strategy for career development in medical education that enhances and empowers the recipient institutionally.

The above research studies have provided information and useful insights into many aspects of chair professorships in accounting, management, entrepreneurship, academic medicine, education and nursing. Only Metwalli and Tang (2001), published any research about finance chair professorships. Therefore, given such a gap, the main purpose of this paper is to provide updated information on chair professorships to academic institutions and the financial business communities.

Data and Methodology

Pertinent information was extracted from three issues of Hasselback's Finance Faculty Directory for the academic years 2004-2005, 2007-2008 and 2019-2020 and published by Prentice Hall, Inc. Information and data from other sources include: Bloomberg-Business Week's US. -Best Business schools and MBA programs 2021-2022, US News and World Report's Best Business schools (MBA) in 2023, and the websites of many of the business schools.

Bloomberg-Business Week and the U.S. News and World Report use specific but different methodologies in compiling their respective university rankings. The *Bloomberg-Business Week* methodology relies on the survey responses to questions directed to graduate students, current alumni, and companies that hire MBA graduates. The above three groups are asked to comment and rank the five most important factors when considering business school programs. The questions focus on everything from the classroom learning experience, to jobs, salaries, and alumni networks. The quantified responses to these queries formulate the school's ranking. In particular, compensation, learning, networking, entrepreneurship, and diversity are the five indexes that form the foundation for the relative ranking of the business school (Mathieu et. al. 2023).

The *U.S. News and World Report's* methodology for ranking the best business schools focuses on the career placement success, student excellence, and qualitative assessments made by experts. In evaluating institutions, one half of the ranking formula focuses on the successful placement and earnings outcomes of the school's graduates, while the other half combines a number of academic metrics about the achievements of entering students and opinions by business schools, corporate recruiters and company contacts regarding overall program quality (Morse et. al., 2023).

The Hasselback's Finance Faculty Directory lists information that is self-reported by more than 700 schools regarding the dean, department chairs, chair professorships, and full-time finance faculty member ranks, teaching and research interests of chairholders, and the school from which the chairholder obtained his (or her) highest degree. The directory has been published three times, i.e. 2004-2005, 2007-2008, and 2019-2020, over the past 2 decades. Our key findings from this research are presented in the following sections with the help of five exhibits.

Discussion

Chair Professorship by Universities

In Exhibit I, we show the distribution of finance chairs/ professorships across various U.S. universities from 2004-2005 to 2019-2020. Because of space limitation, only those 80 schools with three or more endowed chair/ professorship positions in any one of the three periods: i.e. 2004-

2005; 2007-2008; and 2019-2020 are shown in the exhibit. In 2019-2020, 72 schools had three or more finance chair professorships each. All the 72 schools are accredited by AACSB and 43 (59.7%) of them have doctoral degree programs in finance. In 2019-2020, the University of Pennsylvania had the highest number (29) of chair professorships, followed by University of Chicago (24), Columbia University (21) and Harvard University (21). Three universities that had fifteen or more chairholders each were: Northwestern University (18), New York University (16), and Massachusetts Institute of Technology (14). Florida State University and Stanford University had thirteen professorships each. Four universities that had twelve (12) finance professorship positions each were University of Florida, University of California-Berkeley, Brigham Young University-Hawaii, and University of Washington. Also, both, Duke University and Arizona State University had eleven (11) professorships each. Together, these top fifteen Universities have 217 endowed chairs/ professorships or about 24 percent of all finance chair /professorships in the United States, University of Pennsylvania also produced the largest number of graduates (17) serving as chairholders, followed by 13 graduates from Florida and 13 graduates from Texas-A&M.

Comparing the list of endowed chairs/ professorships by state, we see that within the state of Illinois, four universities had the largest number of chair professorships (54) by any state. Those four institutions are University of Chicago, Northwestern University, University of Illinois, and Loyola University.

In addition, Exhibit I shows three important changes in the status of finance chairs/ professorships between 2004-2005 and 2019-2020. First, there has been a net increase of 491 finance chairs/ professorships since 2004-2005 which means an increase of 121 percent in fifteen years. Second, many universities added a number of new chairs/ professorships such as those reported by Harvard University (20), University of Chicago (16), Columbia University, Brigham Young University, University of Washington (12 each), and University of Illinois (10). Three other universities that added 9 chair professorships each were Arizona State University, Florida International University, and University of Utah. Third, we can trace the highest increase in chair professorships to the universities with three or more chairs each. In 2019-2020, this group of universities contributed 600 (or 67%) of all of the finance chair professorships in the United States. The last finding is that a great number of non-doctoral awarding universities continued to add to their muster of finance chair professorships.

Exhibit 1. Finance Chair Professorships, by Universities
2004-2005, 2007-2008, 2019-2020

B1

University and the 2019-2020 Ranking in Number of Chair Professorships	2004-2005	2007-2008	2019-2020	Changes From 2004 to 2020
1 University of Pennsylvania	23	19	29	+6
2 University of Chicago	8	8	24	+16
3 Columbia University	9	12	21	+12
3 Harvard University	1	3	21	+20
4 Northwestern University	14	13	18	+4
5 New York University	11	15	16	+5
6 Florida State University	12	13	13	+1
6 Stanford University	10	10	13	+3
7 Massachusetts Institute of Technology	6	6	14	+8
8 University of Florida	10	9	12	+2
8 University of California Berkeley	8	5	12	+4
8 Brigham Young University- Hawaii	0	0	12	+12
8 University of Washington	0	0	12	+12
9 Duke University	4	3	11	+7
9 Arizona State University	2	7	11	+9
10 University of Wisconsin- Madison	3	5	10	+7
10 University of Virginia- Grad	2	3	10	+8
10 University of Illinois	0	0	10	+10
11 University of Tennessee	10	7	9	-1
11 Penn State University	8	7	9	+1
11 Indiana University	6	4	9	+3
11 University of Alabama	4	5	9	+5
11 University of Michigan	2	2	9	+7
11 Florida International University	0	1	9	+9
11 University of Utah	0	0	9	+9

Exhibit 1 (continued)

Exhibit 1.				B2
University and the 2019-2020 Ranking in Number of Chair Professorships	2004-2005	2007-2008	2019-2020	Changes From 2004 to 2020
12 Texas A&M University	6	7	8	+2
12 University of North Carolina	5	5	8	+3
12 University of Notre Dame	5	4	8	+3
12 University of Oklahoma	5	8	8	+3
12 University of Iowa	3	2	8	+5
12 University of Georgia	2	3	8	+6
12 Temple University	0	0	8	+8
13 Virginia Tech University	6	6	7	+1
13 William & Mary College	5	4	7	+2
13 Cornell University	4	3	7	+3
13 Ohio State University	4	2	7	+3
13 University of Kentucky	2	2	7	+5
13 Washington University	2	2	7	+5
13 Yale University	0	0	7	+7
14 University of Southern California	7	7	6	-1
14 University of Arkansas	4	5	6	+2
14 Tulane University	4	5	6	+2
14 University of California-Los Angeles	4	5	6	+2
14 Auburn University	3	4	6	+3
14 Boston College	3	4	6	+3
14 Georgetown University	3	3	6	+3
14 Vanderbilt University	2	4	6	+4
14 University of Virginia	2	3	6	+4
15 Louisiana State University	9	6	5	-4
15 Georgia State University	4	4	5	+1

Exhibit 1.				B3
University and the 2019-2020 Ranking in Number of Chair Professorships	2004-2005	2007-2008	2019-2020	Changes From 2004 to 2020
15 Southern Methodist University	3	4	5	+2
15 Tennessee at Chattanooga	3	3	5	+2
15 Oklahoma State University	2	3	5	+3
15 University of South Florida	2	3	5	+3
15 Florida Atlantic University	1	1	5	+4
15 Bentley College	0	3	5	+5
16 University of Houston	6	4	4	-2
16 American College	5	13	4	-1
16 Michigan State University	4	7	4	+0
16 Appalachian State University	3	3	4	+1
16 Emory University	3	3	4	+1
16 University of Maryland	3	3	4	+1
16 University of Pittsburgh	3	3	4	+1
16 Brandeis University	2	3	4	+2
16 Case Western Reserve University	2	2	4	+2
16 University of Cincinnati	2	1	4	+2
16 Clemson University	2	1	4	+2
16 University of Oregon	2	3	4	+2
16 DePaul University	1	3	4	+3
16 Miami University	1	2	4	+3
16 University of Mississippi	1	2	4	+3
17 University of Minnesota	6	4	3	-3
17 Baylor University	5	5	3	-2
17 Carnegie Mellon University	3	3	3	+0

Exhibit 1					B4
18 University of Rochester	4	2	2		-2
18 Wake Forest University	4	3	2		-2
18 Loyola University- Chicago	3	4	2		-1
19 University of South Carolina	4	2	1		-3
19 Purdue University	3	5	1		-2
20 University of Texas	4	4	0		-4
Other school with one or two chairs (see Exhibit 1.2)	71	68	288		+217
	405	425	896		+491
Souces: Hasselback (2004-2020)					

Professorships by Area of Specialization

In Exhibit 2, we show the teaching interests of finance chairholders in 2004-2005, 2007-2008, and 2019-2020 respectively. The exhibit lists the six major areas of teaching interests of chairholders which comprised of corporate finance, investments, financial institutions and markets, international finance, real estate, and insurance. During the time period of this study, the distribution of the teaching interests among chairholders did not have any significant changes, although in 2019-2020, the three most popular teaching interests were corporate finance (35%), investments (31%), and financial institutions and markets (15%).

Exhibit 2. Teaching Interests of Finance Chairholders, 2004-2005, 2007-2008, and 2019-2020.						B5
Area of Teaching	2004-2005		2007-2008		2019-2020	
	Number	%	Number	%	Number	%
Corporate Finance	151	33	170	32	293	35
Investments	122	27	148	28	261	31
Financial Institutions And Markets	89	19	97	18	125	15
International Finance	44	10	57	11	77	9
Real Estate	28	6	30	6	50	6
Insurance	25	5	29	5	36	4
TOTAL	459*	100	531*	100	842*	100
Sources: Hasselback(2004-2020)						
*Some chair professors have more than one research interest						

Exhibit 3 provides a summary of the research interests of finance chairholders in 2004-2005, 2007-2008 and 2019-2020, ranked by the most desirable and popular research interests in 2019-2020. The three most desirable research interests for 2004-2005, 2007-2008 and 2019-2020 were capital structure, asset pricing models, and mergers, acquisitions and restructuring. All the three popular research areas increased in popularity from 2004-2005 to 2019-2020. Asset pricing models became more popular in 2019-2020 and topped the rankings, while capital structure research ranked second and mergers, acquisitions & restructuring ranked third in terms of the most desirable research areas that year. Other popular research interests included: futures & options, agency theory, portfolio management, and risk measurement & behavior. Exhibit 3, presents the 28 areas of research interest that remained popular with all chairholders in 2004-2005, 2007-2008 and 2019-2020. However, on average, each chairholder in 2019-2020 has 1.5 different areas of research interests compared to 2.0 in 2007-2008 and 1.9 per chairholder in 2004-2005.

Exhibit 3. Research Interests of Finance Chairholders, 2004-2005, 2007-2008, and 2019-2020. B6

	2004-2005		2007-2008		2019-2020	
Area of Specialization	Number	%	Number	%	Number	%
Capital Structure	60	7.9	69	8.1	100	7.4
Asset Pricing Models	54	7.1	67	7.9	137	10.1
Mergers, Acquisitions & Restructuring	54	7.1	59	6.9	85	6.3
Commercial Banking	50	6.6	52	6.1	59	4.3
Futures & Options	41	5.4	49	5.8	87	6.4
Agency Theory	43	5.7	58	6.8	87	6.4
Risk Measurement & Behavior	37	4.9	37	4.3	75	5.5
Security Markets Structure	36	4.8	40	4.7	65	4.8
Portfolio Management	33	4.4	44	5.2	81	6.0
Valuation Models	35	4.6	35	4.1	60	4.4
Fixed Income Securities	26	3.4	30	3.5	50	3.7
Capital Budgeting	26	3.4	29	3.4	24	1.8
Insurance	29	3.8	26	3.1	28	2.1
Issues in Monetary & Economic Planning	24	3.2	25	2.9	29	2.1
Cost of Capital	21	2.8	19	2.2	29	2.1
International Financial Markets	23	3.0	33	3.9	59	4.3
Real Estate	24	3.2	24	2.8	48	3.5
Bankruptcy & Financial Distress	21	2.8	27	3.2	28	2.1
Investment Banking	17	2.2	13	1.5	41	3.0
Financial Analysis	16	2.1	15	1.8	23	1.7
Mutual Funds & Other Institutions	15	2.0	16	1.9	43	3.2
International Corporate Finance	16	2.1	18	2.1	45	3.3
International Investments	15	2.0	22	2.6	22	1.6
Strategic & Long-Term Financial Planning	14	1.9	13	1.5	26	1.9
Methodological Issues	10	1.3	10	1.2	12	0.9
Personal Finance Planning	7	0.9	11	1.3	9	0.7
Working Capital Management	5	0.7	4	0.5	3	0.2
Financial Education	4	0.5	6	0.7	5	0.4
TOTAL	756*	100.0	851*	100.0	1360*	100.0
Sources: Hasselback(2004-2020)						
*Some chair professors have more than one research interest						

Institutions Granting Highest Degrees to Chairholders

Exhibit 4 shows the institutions granting the highest academic degrees to the 896 chairholders in 2019-2020. The exhibit lists, in descending order, only those 43 universities awarding the highest degrees to four or more chair/ professorship positions. University of Pennsylvania produced the most graduates (17) holding chair professorships, and University of Florida ranked second with 13 graduates serving as chairholders while Texas A&M had 11 graduates holding chair professorships. Another nine institutions with seven or more graduates each holding chair professorships included, Texas -Austin (10), Ohio State (8), Iowa (8), Georgia (8), Rochester (8), UCLA (7), Michigan State (7), Alabama (7), and S. Illinois (7). All forty-three (43) universities have established doctoral programs in finance and have produced 256 (or 29%) of all chairholders.

Exhibit 4 Institutions Granting Highest Degrees To The 896 Chairprofessors In 2019-2020		B7
Institution	Number	2019-2020 Chairholders % of total
Pennsylvania	17	1.9
Florida(Hough)	13	1.5
Texas-A&M	11	1.2
Texas-Austin	10	1.1
Ohio State	8	0.9
IOWA	8	0.9
Georgia	8	0.9
Rochester	8	0.9
UCLA	7	0.7
Michigan State	7	0.7
Aklahoma	7	0.7
S. illinois	7	0.7
Indiana	6	0.6
Arizona State	6	0.6
Cincinnati	6	0.6
Cornell	6	0.6
Rutgers	6	0.6
Georgia State	6	0.6
Harvard	5	0.6
N. Carolina	5	0.6
Stanford	5	0.6
Chicago	5	0.6
SUNY Albany	5	0.6
Wiscon	5	0.6
Oklahoma State	5	0.6

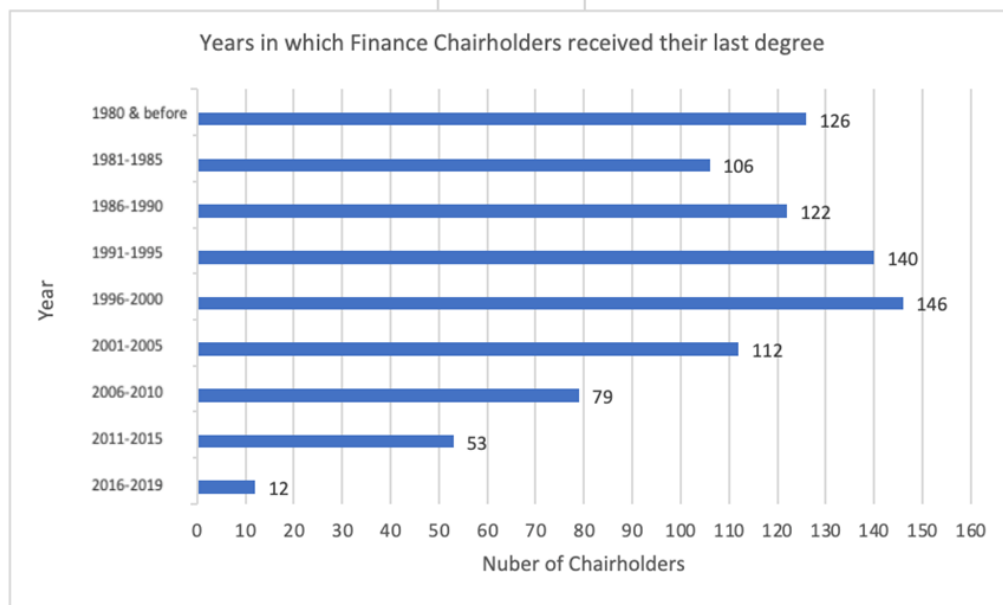
**Exhibit 4 Institutions Granting Highest Degrees To The 896
Chairprofessors In 2019-2020**

		B8
Institution	Number	2019-2020 Chairholders % of total
Nebraska	5	0.6
U Washington	5	0.6
SUNY. Buffalo	4	0.5
Minnesota	4	0.5
Virginia Tech	4	0.5
W Virginia	4	0.5
Duke	4	0.5
Kentucky	4	0.5
UTAH	4	0.5
Florida State	4	0.5
Northwestern	4	0.5
Michigan	4	0.5
SUNY_Bing	4	0.5
MIT	4	0.5
Pittsburgh	4	0.5
Tennessee	4	0.5
Oregon	4	0.5
Mississipe State	4	0.5
Other Institutions Granting Degrees to 3 Chairholders or Less Each	640	71.4
Total	896	100%
Sources: Hasselback [2019-2020]		

In tracking the 2019-2020 Finance Faculty Directory, we found the largest group of chairholders (286 or 32%) received their degrees between 1991 and 2000 (see Figure 3 below). 228 chairholders (25%) graduated during the period, 1981 to 1990, while 191 chairholders (21%) received their degrees between 2001 and 2010. Interestingly, one chairholder graduated in 1964, i. e. 56 years ago, from University of Chicago and another graduated from Berkeley in 1969. Additionally, there were three chairholders who graduated as recently as 2014, i.e. only 6 years ago. These chairholders were from, Kennesaw, W. Virginia and Oregon.

Figure 3: Year in which the Finance Chair-holders received their terminal degrees

A3



As we compare Exhibit 1 (Finance chair professorships by university) with Exhibit 4 (Institutions granting the highest degrees), we find that University of Pennsylvania is responsible for the greatest number of graduates (17) holding chair professorships and has the highest number of chair professorships (29) on their own campus. University of Chicago has produced five (5) graduates holding chair professorships but has acquired the second highest number of chair professorships (24). Harvard University has the third highest number of chair professorships (21) but has only produced five graduates holding chair professorships. University of Rochester, had graduated eight individuals holding chair professorships in many other institutions but listed only two chair professorships on its own campus in 2019-2020.

A Comparison between Institutions Producing Chairholders and Business Schools' Relative Rankings

In Exhibit 5, we list and compare the 43 Universities that grant four or more degrees to finance chairholders, with two of the most widely and commonly used university ranking directories: Bloomberg-Business Week 's U.S. best 43 Business schools MBA programs and the U.S. News and World Report's best 43 Business schools (MBA). The main objective of this analysis is to identify how many of these 43 universities are listed as the best business schools in the United States. It is interesting to note that 15 of the 43 schools (or 35%) listed in Exhibit 5 granting the highest degrees to four or more chairholders are also listed among the Bloomberg -Business Week and the U.S. News and World Report directory of top 43 business schools. These 15 institutions in Exhibit 5 are identified with a checkmark (✓) in all three columns.

In addition, there are four institutions (shown with*) that produced four or more chairholders that are only listed in Bloomberg business week. These institutions include: Florida (13), Rutgers (4), Wisconsin (5), and Pittsburgh (4). Also, another five institutions (shown with **) are listed only in the U.S. News and World Report. These five institutions include Ohio State (8), Georgia (8), Indiana (6), Arizona State (6), and Utah (4).

The rest of the 19 institutions in Exhibit 5 that granted the highest degrees to four or more chairholders but are not listed in the Bloomberg business week or the U.S. News and World Report directory are Iowa, Alabama, South Illinois, Cincinnati, Georgia State, Sunny-Albany, Oklahoma state, Nebraska, U Washington, Suns -Buffalo, Minnesota, Virginia Tech, W. Virginia, Kentucky, Florida State, Sunny-Bing, Tennessee, Oregon, and Mississippi State. All of these institutions are good and well recognized institutions and many of them are ranked in the top 100 business schools in Bloomberg and U.S. News & World Report directory. One may ascertain from these facts and analyses that the schools that grant a large number of chairholders are among the best and well recognized and respected business schools in the United States.

Exhibit 5: A Comparison Between Institutions Producing Four or more Chairholders and Two Rankings of the Top 43 Business Schools			B9
Institutions Granting Highest Degrees To Four or more Chairprofessors		Bloomberg Business Week Ranking of Top 43 Business Schools	U.S. News & World Report Ranking of Top 43 Business Schools
Pennsylvania✓	17	1-Stanford✓	1-Pennsylvania (Wharton)✓
Florida(Hough)*	13	2-Darmouth (Tuck)	1-Chicago (Booth)✓
Texas-A&M✓	11	3-Harvard✓	3-Stanford✓
Texas-Austin✓	10	4-Chicago (Booth)✓	3-Nothwestern (Kellogg)✓
Ohio State	8	5-Nothwestern (Kellogg)✓	5-MIT (Sloan)✓
IOWA	8	6-Columbia	5-Harvard✓
Georgia**	8	7-UC Berkeley (Haas)	7-Yale
Rochester (Simon)✓	8	8-MIT (Sloan)✓	8-Columbia
UCLA (Anderson)✓	7	9-Pennsylvania (Wharton)✓	8-UC Berkeley (Haas)
Michigan State✓	7	10-Virginia (Darden)	10-Michigan (Ross)✓
Aklahoma	7	11-NYU (Stern)	11-Darmouth (Tuck)
S. illinois	7	12-Yale	12-Duke (Fuqua)✓
Indiana (Kelly)**	6	13-Michigan (Ross)✓	12-NYU (Stern)
Arizona State**	6	14-USC (Marshall)	14-Virginia (Darden)
Cincinnati	6	15-Duke (Fuqua)✓	15-Cornell (Johnson)✓
Cornell (Johnson)✓	6	16-UCLA (Anderson)✓	16-Carnegie Mellon (Tepper)
Rutgers*	6	17-Georgetown (McDonough)	17-UCLA (Anderson)✓
Georgia State	6	18-Emory (Goizueta)	18-Texas-Austin (McCombs)✓
Harvard✓	5	19-Carnegie Mellon (Tepper)	19-North Carolina (Kenan-Flagler)✓
North Carolina (Kenan-Flagler)✓	5	20-Cornell (Johnson)✓	19-Sothern California (Marshall)
Stanford✓	5	21-Texas-Austin (McCombs)✓	21-Emory (Goizueta)
Chicago (Booth)✓	5	22-Rice (Jones)	22-Georgetown (McDonough)
SUNY Albany	5	23-Howard	22-Indiana (Kelley)**
Wisconsin*	5	24-Vanderbilt (Owen)	22-Washington (Foster)
Oklahoma State	5	25-Rochester (Simon)✓	25-Notre Dame (Mendoza)
Nebraska	5	26-Indiana (Kelley)	25-Vanderbilt (Owen)

Exhibit 5:					B10
Institutions Granting Highest Degrees To Four or more Chairprofessors		Bloomberg Business Week Ranking of Top 43 Business Schools		U.S. News & World Report Ranking of Top 43 Business Schools	
U Washington	5	27-Florida (Hough)*		27-rice (Jones)	
SUNY-Buffalo	4	28-Maryland (Smith)		28-Georgia Institute of Technology (Scheller)	
Minnesota	4	29-Georgia Tech (Scheller)		29-Arizona State (W.P. Carey)**	
Virginia Tech	4	30-Washington (Foster)		30-Florida (Warrington)	
W Virginia	4	31-Southern Methodist (Cox)		31-Texas-Dallas (Jindal)	
Duke (Fuqua)	4	32-Texas-Dallas (Jindal)		32-Washington St. Louis(Olin)	
Kentucky	4	33-North Carolina (Kenan-Flagler)✓		33-Pennsylvania State (Smeal)	
UTAH	4	34-Notre Dame (Mendoza)		34-Minnesota (Carlson)	
Florida State	4	35-Texas A&M (Mays)✓		35-Rochester (Simon)✓	
Nothwestern (Kellogg)✓	4	36-UC at Davis		36-Birgham Young (Marriott)	
Michigan (Ross)✓	4	37-Rutgers*		37-Michigan State (Broad)✓	
SUNY-Bing	4	38-Wisconsin*		38-Georgia (Tewy)**	
MIT (Sloan)	4	39-Birgham Young (Marriott)		39-Ohio State (Fisher)**	
Pittsburg*	4	40-Boston University (Questrom)		40-Utah (Eccles)**	
Tennessee	4	41-Pittsburgh (Katz)		41-Boston College (Carroll)	
Oregon	4	42-Minnesota (Carlson)		42-Southern Methodist (Cox)✓	
Mississipe State	4	43-Michigan State (Broad)✓		43-Texas-A&M (Mays)	
The fourteen schools that have a chech mark(✓)in the first column (Institutional granting highest degrees to four or more chairholders)are also listed in Bloomberg Business week and U. S. News and World Report. The four schools designated with one star* in the first column are also listed in Bloomberg Business week. Another five schools with two stars** in the first column are listed in the U.S. New and World Report.					

Limitations

Some of the limitations of this study include the following: First, it is possible that not all of the endowed chair and professorship positions were reported by the schools via the surveys that were sent out. Secondly, it is possible that not all of the moves made by the holders of these endowed positions were accurately recorded in the dataset. Third, the racial and gender affiliation of the holders of these endowed positions was not available in the directories that we used for data collection, thus preventing us from making any observations regarding racial and/or gender equity in the distribution and awarding of endowed chair and professorships in the academic finance field.

Summary and Conclusion

In this article, we provide a profile of the 896 Finance Chair professorships awarded in 701 U.S. academic institutions as of 2019-2020. It is clear that the number of finance chair professorships increased in early 2005, but the rate of increase accelerated to over 200 percent after 2008. University of Pennsylvania had the highest number of finance chair professorships, i. e. 29 in 2019-2020. The other three institutions that had more than 20 chairholders each include: University of Chicago, Columbia, and Harvard. Pennsylvania produced the highest number (17) of graduates who have been awarded chair professorships. Three other schools that had more than ten (10) graduates serving as endowed professors include: Florida, Texas-A&M, and Texas-Austin.

Most of the institutions that produced large numbers of chair professorships are recognized among the best business schools in the United States.

As of 2019-2020, the three most popular teaching areas for endowed chairs/professors are, Corporate Finance, Investment Analysis, and Financial Institutions and Markets. As far as the most desirable research interests of endowed chairs/professors are concerned, Capital Structure, Asset Pricing Models, and Mergers, Acquisitions & Restructuring topped the list.

Our research focused on the status and trends of finance chair professorships with the hope of encouraging future increase in research volume to keep up with the rate of growth in chair professorship programs in the United States. Any future research studies should focus on, consider, and determine: (1) the best ways to attract donors in creating enough endowments to fund chair professorships; (2) assess the added value, based on the cost benefit analysis of establishing a finance chair/ professorship in the institution. Does the value added improve the program offering, recruitment of students and placement of graduates? (3) determine the critical criteria to be used in evaluating and selecting the best and most qualified candidates for finance chair professorships. Do the criteria change based on the size and accreditation status (AACSB) of the institutions; (4) establish a benchmark for measuring performance of chairholders and matching performance to the compensation package; and (5) research the ways and means to assist institutions to measure the optimal level of job satisfaction associated with finance chair professorships.

Researching these critical issues will provide more insight on these topics that are critical to supportive donors, institutional administrators, and current and future chairholders. Providing new, broader, and better information on these pivotal issues will help improve the degree of effectiveness and efficiency of chair professorship programs in universities nationally as well as globally.

References

- Bell, W. G. (1986). Endowed Position in Gerontology and Geriatrics in Higher Education: Results from Preliminary Survey. *Educational Gerontology*, 12, 507-518.
- Bloomberg Businessweek. (2022). U. S. Best Business School & MBA Programs 2021-2022 U.S. Education.
- Buckley, P. F., Sime, P. J., Collins, L., Eggleston, N., and Davenport, J. E. (2022). The future of endowed chairs in Academic Medicine. *Academic Medicine*, 97, 1583-1586.
- Chin-Hong, P. Loeser, H., Peterson, A., Ramachandran, R., and O'Sullivan, P. S. (2022). Impact of an innovative endowed chair program in medical education recipients. *Academic Medicine*, 97, 1650-1655.
- Fitzpatrick, J. J. (1985). Endowed Chairs in Nursing: State of the Art. *Journal of Professional Nursing*, 3, 145-147.
- Fitzpatrick, J.J. (1986). Endowed Chairs in Nursing: An Update. *Journal of Professional Nursing*, 4, 261-262.
- Hartlep, N., Ball, D., Theodosopoulous, K., Wells, K., and Morgan, G.B. (2016). A national analysis of endowed chairs and distinguished professors in the field of education. *Educational Studies*, 52(2), 119-138.

- Hasselback, J. R. (2020). *The 2019-2020 Guide to Finance Faculty*, (New Jersey), Prentice Hall.
- Hasselback, J. R. (2008). *The 2007/2008, Guide to Finance Faculty*, (New Jersey), Prentice Hall.
- Hasselback, J. R. (2005). *The 2004/2005, Guide to Finance Faculty*. (New Jersey), Prentice Hall.
- Katz, J. A. (1991). Endowed Positions: Entrepreneurship and Related Fields. *Entrepreneurship: Theory and Practice*, 53-67.
- Leitch, A. (1978). *A Princeton Companion*. Princeton University Press. (New Jersey).
- Mathieu, B., McIntyre, A., and Campbell, M. (2023). Best B-Schools: 2023-24. Accessed at <https://www.bloomberg.com/business-schools/methodology>.
- Metwalli, A. M. & Tang, R. Y.W. (2001). Finance Chair— professorships in the United States. *Journal of Financial Education*, 27 (1), 64-71.
- Morse, R., Brooks, E., Hines, K., and Wellington, S. (April 24, 2023). Methodology: 2023-2024 Best Business Schools Rankings: Find out how U.S. News ranks business schools with full-time MBA programs. Accessed at <https://www.usnews.com/education/best-graduate-schools/articles/business-schools-methodology>.
- Murrey, J. H., Jr and Tosh, D. S. (1983). Chairs of Insurance in American Colleges and Universities. *CPCU Journal*, 6, 94-97.
- Rezaee, Z., Elmore, R. C., and Spiceland, D. (2006). An Examination of the Status and Attributes of Chair Professorship in Accounting. *The Accounting Educator's Journal*, 16.
- Tang, R. Y. W. & Metwalli, A. M. (2000). Chair professorship in Business in the United States. *The International Journal of Commerce and Management*. 10 (3&4), 92-106.
- Tang, R.Y.W. (1983). A Profile of Accounting Chair Professorships in 1992. *Journal of Education for Business*, 68, 133-138.
- Tang, R.Y.W. & Griffith, D. (1998). Accounting Chair Professorships in 1997. *Journal of Applied Business Research* 14, 137-147.
- Thorndyke, L. E., Milner, R.J., & Jaffe, L. A. (2022). Endowed chairs and professorships: A new frontier in gender equity. *Academic Medicine*, 97, 1643-1649.
- Tondt, J. M., Beauchamp, B. A., and Counselman, F. L. (2022). Endowed faculty positions in Academic Emergency Medicine: 2021. *The Journal of Emergency Medicine*, 63(2), 247-256.
- U.S. News & World Report . (2022). Best Business Schools, 2022-Edition.
- .

Financial Empowerment for Women: An Investigation into the Factors that Contribute to Financial Literacy Among Working Women

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How financially literate are Indian working women, and what factors influence their financial literacy (FL) level? This study delves into these questions by analyzing primary data collected through a performance test consisting of multiple-choice questions covering three critical parameters. The study classified respondents into two sub-groups based on their FL level, and the results of binomial logistic regression revealed the significant determinants of FL among working women in India. The study found that age, education, monthly income, monthly savings to monthly income ratio, shopping habits, investment experience, and risk tolerance level play a crucial role in determining FL. Based on these results, the study proposes strategies and recommendations to policymakers for promoting FL among Indian women. This study's findings have far-reaching implications for working women in India, providing valuable insights for policymakers, financial education providers, businesses, and community groups to empower women in financial decision-making.

Keywords: financial literacy, demographic and socio-economic variables, working women.

Introduction

Financial literacy (FL) has become increasingly important in recent years as individuals and societies increasingly rely on complex financial products and services. FL involves understanding basic financial concepts like interest rates, inflation, and risk. Research has shown that individuals with higher levels of FL are more likely to save for retirement, maintain emergency savings, and avoid high-cost debt (Lusardi, 2019). Additionally, financially literate individuals have higher credit scores, are more likely to invest in stocks and mutual funds, and have higher net worth (Mandell & Klein, 2009).

FL can have a positive impact on society as a whole leading to better economic outcomes such as increased GDP, lower unemployment rates, and lower poverty levels (Rodrik, 2007). It is also positively associated with financial well-being and satisfaction, as well as lower levels of financial distress (Kaiser & Menkhoff, 2020). Being financially literate is particularly important for women, who may face unique financial challenges, such as the gender pay gap and the need to take time off work for caregiving responsibilities. Bucher-Koenen et al., (2017) found that being financially literate is critical for women to navigate these challenges and achieve financial security. Finally, Taylor et al. (2009) found that FL was positively associated with financial decision-making, as well as with improved physical and mental health.

Gender inequality is a significant issue affecting various aspects of society, including finance (FL). Studies show that women have lower levels of FL than men, despite the increasing importance of financial knowledge and skills. Lusardi & Mitchell, (2014) found that women score lower on FL tests, answering 38% of questions correctly compared to 55% for men. This gap persists across all age groups and educational levels. Fonseca & Lord, (2019) found that women have lower levels of FL and are less confident in their financial decision-making abilities than men. Women are also more risk-averse, which could impact their investment decisions and overall financial well-being. (Garrison & Gutter, 2010) found that the gender gap in FL may be partially explained by differences in financial socialization, as women are less likely to receive financial education or discuss financial matters with their parents or peers. (Škreblin Kirbiš et al., 2017) found that financially literate women are more likely to have higher levels of savings, investment, better credit scores, and financial satisfaction.

The role of women in the workforce is changing, affecting gender, economics, and social justice. Women are increasingly entering leadership roles, breaking traditional gender norms and contributing to greater gender equality. However, women often lack confidence in investing, despite outperforming men in this area (Barber & Odean, 2001; Shue et al., 2023). Studies suggest that lower levels of financial literacy (FL) may contribute to this lack of confidence. Despite taking on financial management responsibilities, women may still lack confidence in their decision-making abilities (Fonseca & Lord, 2019). Increasing FL can help women achieve financial independence and success in the workforce. Financial education can positively impact women's financial behavior, including saving more and making better investment decisions (Collinson and Collinson, 2021).

Despite progress in promoting gender equality in the workforce and FL, there is still much work to be done. Women are underrepresented in high-paying industries and may face discrimination and bias in hiring and promotion (Lusardi & Sävje-Söderbergh, 2021). Addressing systemic barriers to gender equality in the workforce is crucial for ensuring women have the knowledge and skills to succeed in high-paying jobs and manage their finances effectively.

India has experienced significant changes in the role of women in the workforce, but they still face challenges in FL and financial management. Thanki et al. (2022) found that women in India are significantly less financially literate than their male counterparts, possibly due to a lack of access to financial education and resources, as well as cultural norms that discourage women from taking an active role in financial decision-making. Lusardi et al. (2019) highlighted the need for targeted financial education programs to help women develop the skills and knowledge they need to manage their finances effectively.

Several studies have examined the relationship between demographic and socioeconomic factors and FL, but no studies have examined the FL of working women in relation to their socioeconomic background. This study aims to fill this gap by investigating the FL levels of Indian working women and assessing the impact of demographic and socio-economic factors on their FL. The findings will make a significant contribution to the existing literature on the FL of Indian working women.

Literature Review

FL has become a vital component of modern life, enabling individuals to make informed financial decisions. As per OECD, (2020) FL can be defined as “a combination of awareness, knowledge, skill, attitude, and behavior necessary to make sound financial decisions and ultimately

achieve individual financial wellbeing”. The importance of FL has been recognized globally, and policymakers have made significant efforts to promote financial literacy through financial education among individuals. Several studies examined the relationship between FL and demographic factors. This literature review aims to explore the latest research on the impact of demographic factors on FL, providing insights into the current state of research in this field.

Literature documents that an individual’s age has a significant impact on FL. found that younger individuals tend to have lower FL levels than older individuals (Lusardi, 2011; OECD, 2020; Remund, 2010). Moreover, studies have shown that FL tends to decline with age after a certain point emphasizing that individuals aged 75 years and above tend to have lower FL levels than middle-age individuals (Brounen et al., 2016; OECD, 2013, 2020)

Earlier studies also checked the relationship between education and FL and consistently found that individuals with higher levels of education tend to have higher FL than those with lower levels of education (Brounen et al., 2016; OECD, 2020). The relationship between education and FL can be attributed to several factors, including the acquisition of financial knowledge gained through financial knowledge and the ability to understand financial concepts (Putthinun et al., 2021). Individuals with higher levels of education are more likely to have received financial education, which can impact their FL levels (OECD, 2020).

The individual’s monthly income is a significant predictor for FL. Several studies found a direct relationship with financial literacy, implying that individuals with lower monthly income are relatively less financially literate than those who enjoy relatively higher income (Bakar & Bakar, 2020; Jariwala, 2015; Morgan, 2003)

The studies about the relationship between individual’s stage of the life cycle and FL found that individuals in the later stages of the life cycle, such as those nearing retirement, had higher levels of FL compared to those in earlier stages (Xiao et al., 2009). Similarly, other studies confirmed the individuals aged 50 and above had higher levels of FL compared to younger age groups who are single (Chen & Volpe, 2002; Morgan, 2003). The single parents are less financially knowledgeable than married (Jariwala, 2015). However, some studies have found no significant relationship between the stage of the life cycle and FL (Tennyson & Nguyen, 2001).

Research on the relationship between caste/race and FL has shown that individuals belonging to certain castes/races possess lower levels of FL compared to others. For instance, a study by Bhutta, Chang, & Dettling(2020) using data from the Survey of Consumer Finances in the United States found that Black and Hispanic households had lower levels of FL compared to White households. However, some studies have found no significant relationship between caste/race and FL. For example, a study by (Singh & Singh, (2023) in India found no significant difference in FL levels between individuals belonging to different castes.

Earlier studies confirmed the relationship of monthly expenditure to monthly income and monthly savings to monthly incomes on FL. They concluded that the individuals with higher monthly expenditure to monthly income possess a low FL (Hamid & Loke, 2021; Jariwala, 2015; Malaviya & Jariwala, 2019). Several studies also confirmed that individuals who save a larger percentage of their monthly savings to monthly income ratio tend to have higher FL ((Bucher-Koenen et al., 2017; Lusardi & Tufano, 2009; Norvilitis et al., 2006).

Numerous studies have explored the relationship between risk tolerance and FL. Financial literacy is consistently linked to higher financial risk tolerance across various studies (Grable & Joo, 2000; Thanki & Baser, 2019) Grable & Joo (2000) and Thanki & Baser (2019) both found that individuals with greater investment knowledge exhibited higher risk tolerance. Studies also found a significant association between FL and years of investment experience (Krische, 2019;

Maditinos et al., 2007) and the number of times investors shop around/make inquiries while investing (Jariwala, 2015; Morgan, 2003).

Hypotheses:

- H1: Age is a significant determinant of FL level among Indian working women.
- H2: Education level is a significant determinant of FL level among Indian working women.
- Monthly household income is a significant determinant of FL level among Indian working women.
- H3: Stage of the life cycle is a significant determinant of FL level among Indian working women.
- H4: Caste is a significant determinant of FL level among Indian working women.
- H5: Monthly expenditure to monthly income ratio is a significant determinant of FL level among Indian working women.
- H6: Monthly savings to monthly income ratio is a significant determinant of FL level among Indian working women.
- H7: Number of shops around is a significant determinant of FL level among Indian working women.
- H8: Risk tolerance is a significant determinant of FL level among Indian working women.
- H9: Years of investment experience is a significant determinant of FL level among Indian working women.

Research Methodology

Method and Participant

This study has used descriptive research design with a quantitative approach and convenience sampling method was used to survey 540 working women from the Western region of India. The Western region comprises three states: Gujarat, Rajasthan, and Madhya Pradesh, with varying literacy rates of women. The study employed a non-probability convenient sampling technique to select participants, which was chosen due to its practicality and efficiency in selecting participants from a specific region and population, ensuring a more representative sample. The study aimed to provide a comprehensive understanding of the determinants of FL among working women in this region to help policymakers and stakeholders develop appropriate strategies and interventions to promote FL.

Survey Instrument

A structured questionnaire was used to measure financial literacy in India. The test consisted of fifty multiple-choice questions covering standard financial literacy, mathematical financial literacy, and product financial literacy. Out of these fifty questions, twenty questions covered basic financial literacy that includes standard FL and mathematical FL, adapted from a scale developed by van Rooij et al. (2011). The remaining thirty questions measured knowledge about various financial products and services in the Indian financial system. These questions were finalized after conducting structured interviews with experts in financial markets and renowned academicians in India. The performance test was principally knowledge-based, reflecting a conceptual framework. The performance test is used for measuring financial literacy, as self-reported methods assess

perceived knowledge or confidence, leading to overconfidence. The test is typically conducted using multiple-choice or true-false questions. Considering that language should not be a barrier, the entire questionnaire was translated into regional languages, such as Gujarati for the state of Gujarat and Hindi Language for Rajasthan and Madhya Pradesh.

Data Analysis

Various statistical tests are applied to explore the determinants of FL among working women in the western region of India. Specifically, frequency distribution and descriptive statistics were used to summarize the data collected from a personal survey of 540 working women, and bivariate techniques such as correlation and regression were employed to identify the relationships between various demographic and socio-economic factors and FL. These analyses were conducted using the widely used software package, SPSS (Statistical Package for Social Sciences), which is commonly used in social science research (Hair et al., 2019).

Firstly, the respondents' performance test scores were calculated based on the percentage of correct answers for measuring FL as widely used in earlier studies (Jariwala, 2015; Lusardi et al., 2010). Respondents were classified into two sub-groups based on their FL levels using the median percentage of correct answers, with those scoring above the median considered higher financially literate and those scoring at or below the median considered lower financially literate. This approach has been used in previous studies as a way of classifying respondents into two distinct groups based on their FL levels (Chen & Volpe, 2002; Lusardi et al., 2010). The median percentage of correct answers was found to be 57.63%, which was used to classify the respondents into two subgroups based on their FL level (coded as X11). Out of the 540 respondents, 45.6% (n=246) were classified as having a higher level of FL. The average percentage of correct answers among the working women was found to be 57.63%.

To determine the impact of various demographic and socio-economic factors on the FL of working women, a Binomial Logistic Regression Model (LRM) was used to examine variables such as age, education, monthly household income, stage of the life cycle, caste, monthly expenditure to monthly income ratio, monthly saving to monthly income ratio, number of times women shop around/make an inquiry, risk tolerance level, and years of investment experience. The results of the analysis were presented in Exhibit 2, which included descriptive statistics and inter-correlations for all the variables used in the regression models.

Exhibit 2
Spearman correlations for regression model variables (n= 540)

Variables	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁
X ₁	1.000	-0.121*	0.459*	0.682*	0.162*	0.175*	0.331*	0.287*	-0.293*	0.405*	0.422*
X ₂		1.000	0.358*	0.180*	0.336*	0.016*	0.059*	0.042*	0.138*	0.062*	0.010*
X ₃			1.000	0.546*	0.282*	0.235*	0.097*	0.071*	-0.244*	0.225*	0.143*
X ₄				1.000	0.231*	0.173*	.0167*	0.150*	-.0332*	0.294*	0.223*
X ₅					1.000	0.031*	0.057*	0.007*	-0.168*	0.008*	0.021*
X ₆						1.000	0.120*	0.109*	-0.028*	0.164*	0.170*
X ₇							1.000	0.383*	-0.029*	0.450*	0.680*
X ₈								1.000	0.151*	0.419*	0.621*
X ₉									1.000	0.092*	0.113*
X ₁₀										1.000	0.568*
X ₁₁											1.000

*p<0.05

(Source: Authors calculation using SPSS)

The LRM method, based on the maximum likelihood method, is used to examine the relationship between working women's FL level and their demographic and socio-economic characteristics. It generates a probability value between 0 and 1, classifying respondents with higher FL levels as 'Y = 1' and those with lower levels as 'Y = 0.' The nonlinear probability value of Y = 1 is represented by P, ranging from 0 to 1.

LRM is a statistical tool for binary dependent outcomes, such as FL, which is usually measured by a dichotomous scale. Prior research has demonstrated the usefulness of LRM in identifying the factors associated with FL (Chen & Volpe, 2002; Jariwala, 2015). This study examines the potential factors associated with lower levels of FL among working women, and we determined logistic regression to be the most appropriate statistical method for addressing our research question.

$$\text{Log} \left(\frac{p}{1-p} \right) = B_0 + B_{1J1}(X_1)_{1J1} + B_{2J2}(X_2)_{2J2} + B_{3J3}(X_3)_{3J3} + B_{4J4}(X_4)_{4J4} + B_{5J5}(X_5)_{5J5} \\ + B_{6J6}(X_6)_{6J6} + B_{7J7}(X_7)_{7J7} + B_{8J8}(X_8)_{8J8} + B_{9J9}(X_9)_{9J9} + B_{10J10}(X_{10})_{10J10}$$

The proposed model consists of a constant term B₀, which represents the natural logarithm ratio for the independent variable 0. The variable x_j = (j = 1,2,..., m) represents the factors that influence FL level, and β_j represents the partial regression coefficient corresponding to x_j= (j = 1,2, ..., m). This coefficient indicates the natural logarithm ratio variation value caused by a one-unit increase in the independent variable's value, assuming that all other variables remain constant. The index Exp(B) is the result of the natural logarithm (e) at the bottom.

When dealing with categorical independent variables in LRM, the use of dummy variables is necessary to compare different categories. The first category is chosen as a reference for each variable, and the remaining categories are compared. The coefficients in Equation 1 represent the impact of each subgroup compared to the reference group. A detailed description of each variable can be found in Exhibit 3.

Exhibit 3
Profile of Sample (n = 540)

Variable with Category Code, Mean and SD	Number of Respondents	Proportion
<i>Age (X₁) (M = 2.70, SD = 1.338)</i>		
18 to 25 = 1	102	18.89
26 to 35 = 2	112	20.74
36 to 45 = 3	136	25.19
46 to 55 = 4	110	20.37
56 to 65 = 5	80	14.81
<i>Education (X₂) (M = 4.39, SD = 1.657)</i>		
Primary = 1	38	7.04
Secondary = 2	78	14.44
Higher secondary = 3	130	24.07
Diploma = 4	80	14.81
Graduation = 5	174	32.22
Post-graduation = 6	40	7.41
<i>Household Monthly Income (X₃) (M = 2.54, SD = 1.305)</i>		
Up to 10,000 = 1	144	26.67
Rs. 10,001 to Rs. 15,000 = 2	130	24.07
Rs. 15,001 to Rs. 20,000 = 3	102	18.89
Rs. 20,001 to Rs. 25,000 = 4	92	17.04
Rs. 25,001 and above = 5	72	13.33
<i>Stage of the life cycle (X₄) (M = 3.02, SD = 1.393)</i>		
Young single = 1	82	15.19
Young married without children = 2	92	17.04
Young married with children = 3	146	27.04
Middle age married with children = 4	126	23.33
Middle age married without dependent children = 5	56	10.37
Older married = 6	38	7.04
<i>Caste (X₅) (M = 3.26, SD = 1.289)</i>		
Brahmin = 1	119	22.03
Vaishnav (Baniya) children = 2	157	29.07
Kshtriya = 3	138	25.56
Shudra = 4	126	23.33
<i>Monthly expense to monthly income ratio (X₆) (M = 2.28, SD = 1.321)</i>		
Less than 50 % = 1	64	11.85
51 % to 70 % = 2	113	20.93
71 % to 90 % = 3	177	32.78
Above 90 % = 4	186	34.44

Monthly saving to monthly income ratio (X_7) ($M = 1.53$, $SD = 0.693$)

Less than 50% = 1	294	52.30
51% to 75% = 2	196	43.90
More than 76% = 3	50	8.90

No. of times shop around (X_8) ($M = 2.20$, $SD = 0.923$)

Zero = 1	102	18.89
1 to 3 = 2	212	39.26
4 to 6 = 3	172	31.85
More than 6 = 4	54	10.00

Risk Tolerance Level (X_9) ($M = 3.15$, $SD = 0.928$)

5-10 Lowest Risk Tolerance = 1	30	5.56
11-15 Moderate Risk Tolerance = 2	106	19.63
16-20 High Risk Taker = 3	196	36.30
21-25 High Risk Taker = 4	208	38.52

Investment Experience (X_{10}) ($M = 2.39$, $SD = 1.016$)

Less than 1 = 1	86	15.93
1-5 years = 2	182	33.70
6-10 years = 3	150	27.78
More than 10 years = 4	122	22.59

Total	540	100.00
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(Source: Authors calculation)

Model chi-square, Omnibus testing of model coefficients, -2Log Likelihood (-2LL), Cox and Snell R-square, Nagelkerke R-square, Wald statistics, and Exp chi-square were used to evaluate the model's strength (B) as they assess the model's validity and the strength of the relationship between independent and dependent variables. In addition, the categorization table was studied to determine the predictive power of the model for the FL level of working women in India based on demographic and socioeconomic characteristics.

Similar metrics have been used in the past to evaluate the robustness of logistic regression models. Liu et al., (2021) utilized the classification Table, -2Log Likelihood (-2LL), and Nagelkerke R-square to assess the predictive power of the logistic regression model for non-performing loans. Similarly, (Guo et al., (2021) used Omnibus testing of model coefficients and Exp(B) to investigate the association between rural China's socioeconomic level and hypertension. Exhibit 4 displays the outcomes of the current study's binomial logistic regression.

Exhibit 4
Logistic Regression Model Results
(a) Variables in the Equation

	B	S.E.	Wald	Df	Sig.	Exp(B)
Step 0	-0.579	0.090	41.611	1	0.000*	0.561

*p<0.05

(Source: Authors calculation)

(b) Omnibus Tests of Model Coefficients

	Models	Chi-square	Df	Sig.
Step 1	Step	582.174	37	0.000
	Block	582.174	37	0.000
	Model	582.174	37	0.000

(Source: Authors calculation)

(c) Hosmer-Lemeshow Test

Model	Chi-square	Df	Sig.
Final	1.267	8	0.996

*p<0.05, Significant at 0.05 level

(Source: Authors calculation)

(d) Strength of the Relationship Model

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	123.056	0.660	0.905

(Source: Authors calculation)

(e) Variables in Equation

Categories	B	S.E.	Wald	Sig.	Exp(B)
Age(1)	-3.973	2.124	3.498	0.041*	0.028
Age(2)	3.583	1.303	7.558	0.006*	1.065
Age(3)	2.740	1.132	5.862	0.015*	1.051
Age(4)	-2.971	1.215	5.973	0.015*	0.026
Education(1)	2.158	1.468	2.162	0.041*	8.656
Education(2)	6.416	1.836	12.215	0.000*	611.636
Education(3)	2.407	1.572	2.344	0.026*	11.096
Education(4)	3.022	1.394	4.700	0.030*	1.049
Education(5)	3.069	1.119	7.521	0.006*	21.530
Income(1)	-5.286	1.665	10.076	0.002*	0.005
Income(2)	-4.219	1.554	7.367	0.007*	0.015
Income(3)	-5.206	1.868	7.772	0.005*	0.005
Income(4)	-5.755	1.639	12.329	0.000*	0.003

Stageoflife(1)	0.897	1.986	0.204	0.652	2.451
Stageoflife(2)	-3.259	2.441	1.782	0.182	0.038
Stageoflife(3)	-0.206	1.808	0.013	0.909	0.814
Stageoflife(4)	-0.852	1.756	0.235	0.628	0.427
Stageoflife(5)	-0.686	2.562	0.072	0.789	0.504
CastB(1)	2.650	2.026	1.711	0.191	14.157
CastVai(2)	-1.059	1.293	0.670	0.413	0.347
CastKsh(3)	-0.194	0.987	0.038	0.844	0.824
CastShu(4)	-4.760	1.436	10.991	0.001*	0.009
Monthly_Expenditureto_Income(1)	1.783	1.186	2.262	0.133	5.950
Monthly_Expenditureto_Income(2)	1.342	1.173	1.309	0.253	3.826
Monthly_Expenditureto_Income(3)	0.610	1.250	0.238	0.626	1.840
Monthly_Expenditureto_Income(4)	6.078	2.185	7.736	0.005*	436.037
Mothly_Savingto_Income(1)	-6.714	1.585	17.942	0.000*	0.001
Mothly_Savingto_Income(2)	7.250	1.354	0.034	0.044*	1.284
No.oftimes_shoparound(1)	-0.126	0.958	0.017	0.006*	0.882
No.oftimes_shoparound(2)	-6.079	1.475	16.985	0.000*	0.002
No.oftimes_shoparound(3)	7.652	1.847	17.169	0.000*	1.000
RiskTolerannnce(1)	-1.988	0.919	4.678	0.031*	0.137
RiskTolerannnce(2)	-7.550	1.868	16.338	0.000*	0.001
RiskTolerannnce(3)	9.436	2.903	10.567	0.001*	1.001
Investment_Experience(1)	1.651	1.004	2.705	0.001*	0.192
Investment_Experience(2)	7.541	1.979	14.516	0.000*	0.001
Investment_Experience(3)	10.723	4.121	6.769	0.009*	1.215
Constant	14.881	3.484	18.240	0.000*	2.904

*p<0.05, Significant at 0.05 level

(Source: Authors calculation)

(f) Classification Table^a

			Predicted		
			Level	High	Percentage
Observed			Low	High	Correct
Step 1	Level	Low	336	10	97.10
		High	14	180	92.80
Overall Percentage					95.60

a. The cut off value is 0.500

(Source: Authors calculation)

In the RM, Block 0 was included, which only consisted of a constant. The initial block suggested that 64.10 percent of cases were classified accurately. However, LRM tests the model with all predictors (independent variables) included to determine whether the model is appropriate. The null model in Exhibit 4(a) indicated that the model was significant even without the independent variables ($p < 0.01$), which means that the final equation model could be derived, and adding independent variables would improve the model's performance. Model Chi-Square compared the final model against the constant model to test the model's accuracy of the study indicated that the predictors consistently distinguished between higher and lower levels of FL ($\chi^2 = 582.174$, $p < 0.01$, $df = 37$). The final model was significantly better than the constant model, and independent variables had a significant impact on FL levels. This finding is consistent with previous studies using logistic regression to predict FL levels based on demographic and socio-economic variables (Gaurav et al., 2019; Huston, 2010).

Exhibit 4(c) presented the results of the Hosmer-Lemeshow (H-L) Test, which examined the relationship between independent variables and the dependent variable. The non-significant result of the H-L goodness-of-fit test implied that there was no significant difference between the observed model and the model predicted by the logistic regression. Therefore, the logistic regression model was a good fit for the data.

The Cox and Snell, and Nagelkerke R squared values were used to estimate the variance explained by the model, with the model explaining between 66.00% and 90.50% of the variance predicted from the independent variables. This suggested that the logistic regression was strong enough to predict the classification of working women into sub-groups based on their demographic and socio-economic characteristics (Exhibit 4d). The final model accurately classified 97.10% of working women respondents with a lower level of FL and 92.80% of working women with a higher level of FL, with an overall classification success rate of 95.60% (Exhibit 4f). This indicated that the final model predicted FL levels with 95.60% accuracy, a significant improvement over the null model's 64.10% accuracy. Therefore, the logistic regression model presented in this study was a reliable tool for predicting the FL level of working women in India.

Exhibit 4(e) displays the key components of the equation model's variables. The Wald statistic and associated probabilities signify the importance of each predictor in the model. This statistic is used to test the statistical significance of each coefficient (b) in the model, and it follows a chi-square distribution. The standard error for each variable is estimated, and the Wald statistic is the ratio of the estimated coefficient 'B' to S.E. squared.

Moreover, the "Exp(B)" column in Exhibit 4(e) depicts the effect of increasing the corresponding measure by one unit on the odds ratio. The odds ratio, or "Exp(B)", forecasts the shift in odds for a unit increase in the predictor. An odds ratio of less than 1 implies that increasing values of the variable correspond to decreasing odds of the event's occurrence. On the other hand, an odds ratio greater than 1 indicates that increasing values of the variable correspond to increasing odds of the event's occurrence.

Based on the findings of binary logistic regression, it is apparent that the demographic and socio-economic characteristics have a significant impact on the FL level of women ($\chi^2=582.174$, $df=37$, and $p=0.000$ (<0.05)). However, it is worth noting that among all the variables, the stage of the life cycle, monthly expenditure to monthly income ratio, and caste did not emerge as significant predictors.

Discussion And Implications

Exhibit 5 Results Summary

Hypotheses	Results
H1: Age is a significant determinant of FL level among Indian working women.	Supported
H2: Education level is a significant determinant of FL level among Indian working women.	Supported
H3: Monthly household income is a significant determinant of FL level among Indian working women.	Supported
H4: The stage of the life cycle is a significant determinant of FL level among Indian working women.	Not supported
H5: Caste is a significant determinant of FL level among Indian working women.	Not supported
H6: The monthly expenditure to monthly income ratio is a significant determinant of FL level among Indian working women.	Not supported
H7: The monthly savings to monthly income ratio is a significant determinant of FL level among Indian working women.	Supported
H8: The number of shops around is a significant determinant of FL level among Indian working women.	Supported
H9: Risk tolerance is a significant determinant of FL level among Indian working women.	Supported
H10: Years of investment experience is a significant determinant of FL level among Indian working women.	Supported

The investigation revealed that various demographic and socio-economic factors influence women's FL confirming that age, education, monthly savings to income ratio, and shopping behavior have a significant impact on FL among women. The research discovered that women aged 18-25 and those above 45 years old had a lower level of FL than women in the age groups of 26-35 and 36-45, possibly due to a lack of experience in managing finances among young women and limited exposure to financial options among older women. Additionally, women with a higher level of education and a monthly savings to income ratio of over 75% are more likely to have higher FL. Having good savings habits can positively influence FL.

According to this study, women who are proactive and make maximum inquiries while investing or shopping are more likely to have a higher level of FL. The study also found that women who do not shop around or make inquiries were likelier to have a lower level of FL. This suggests that seeking information and being proactive can positively impact FL. Furthermore, under the risk-profile category, all the categorical variables have highly significant coefficients except for risk-averse ones. Risk-averse women have a higher likelihood of falling under the category of women with a lower level of FL, as indicated by their estimated coefficient (-1.988)

and odds ratio (0.137). In contrast, those who take higher risks have an odds ratio of 1.001, indicating that they are more likely to be categorized as higher literate women.

Additionally, the study found that women who invest for the long term have significantly higher coefficients, as indicated by their estimated coefficient (10.723) and odds ratio (1.215). These women were found to be more financially literate than those with limited or no experience in investing. This suggests that having experience and investing for the long term positively influences FL.

Managerial Implications

Ensuring FL among women is critical and must be coupled with increased transparency, consumer protection policies, and financial institution regulations. A standardized approach to financial education is necessary to empower women to make informed decisions about financial products and services that align with their needs, goals, and personal circumstances. A specialized approach to financial education should be tailored to the unique needs and circumstances of Indian women. For instance, implementing a nationwide campaign that focuses on educating women about the nuances of banking services, investment options, and savings plans could significantly enhance their financial decision-making abilities. This campaign could involve collaborating with community groups, businesses, and governmental bodies to host workshops, seminars, and interactive sessions, thereby fostering a deeper understanding of financial management principles.

Furthermore, promoting early financial education in family life and integrating workplace programs for female employees can significantly enhance their financial literacy. For example, companies could introduce specialized modules within their corporate training initiatives, covering topics such as budgeting, investment planning, and retirement savings. Ensuring accessibility to financial education for women from all strata of society is crucial. Financial education should be accessible to women from all socioeconomic backgrounds. Promoting financial socialization through the role of parents, peers, and employers in fostering financial awareness among women can also significantly contribute to improving FL. Special attention should be given to women with lower education levels, limited income, widows, and unmarried women. Implementing specialized asset allocation programs can provide them with essential tools for financial independence and security, enhancing their financial security.

Recognizing that financial education is an ongoing process rather than a one-time event is vital. Establishing continuous learning programs, webinars, and online resources that offer updated information and guidance on evolving financial trends and products can aid in maintaining and enhancing women's financial literacy over time. By integrating these targeted strategies and initiatives, various stakeholders, including financial institutions, educational bodies, and policymakers, can promote financial literacy among women in India, enabling informed financial decisions and securing their financial futures.

Societal Implications

Financially literate women can make a significant contribution to economic and societal development in the country in several ways. FL empowers women by providing them with the knowledge and skills needed to make informed financial decisions, enabling them to have more control over their lives and contribute to their own personal development and that of their families. FL can help women lift themselves and their families out of poverty, leading to poverty reduction

in their communities. Additionally, financially literate women can make better decisions about their health and that of their families, leading to improved health outcomes. Overall, FL for women has significant societal development implications, creating more equitable and sustainable communities.

Conclusion, Limitations and Future Scope

The study revealed that factors such as age, education, monthly income, monthly savings to monthly income ratio, number of times women shop around/make an inquiry, years of investment experience, and risk tolerance level were significant determinants while predicting the FL of working women. Conversely, the stage of the life cycle, monthly expenditure to monthly income ratio, and caste were non-significant determinants. These findings suggest that socio-demographic factors, financial habits, and individual characteristics play a crucial role in shaping women's financial literacy. The non-significance of variables like life cycle stage, monthly expenditure to monthly income ratio, and caste highlights the need for a more nuanced understanding of the contextual factors influencing financial literacy. This underscores the importance of considering a multifaceted theoretical framework that encompasses both individual characteristics and broader contextual elements when exploring and conceptualizing financial literacy among working women. Future theoretical developments should thus integrate a more comprehensive perspective that accounts for the dynamic interplay of various factors influencing financial literacy.

While this study provides valuable insights into the financial literacy (FL) level of working women in the western region of India, it has certain limitations that need to be acknowledged. It is important to note that the findings of this study might not be generalizable to other regions of the country due to the regional focus, indicating caution in applying these results to a broader context. The study's exclusive focus on working women restricts its applicability to non-working women, thereby limiting the holistic understanding of FL among women in the region.

Moreover, the study's analysis solely relies on quantitative methods, neglecting the qualitative data that could potentially provide a deeper and more nuanced understanding of the underlying factors affecting FL. The study's reliance on convenience sampling introduces a potential limitation as it may not represent the broader population, impacting the generalizability of the findings. Additionally, the scope of the study is confined to exploring the influence of demographic and socio-economic variables on FL levels, neglecting the role of cultural, psychological, and behavioral factors, which are crucial in shaping financial decision-making.

Future research endeavors should aim to mitigate these limitations by employing more comprehensive research designs, including a mix of qualitative and quantitative methodologies. The future research should expand to include investment decisions, asset allocations, portfolio diversification, and retirement planning to provide a comprehensive understanding of women's financial decisions. Future studies should include a diverse sample of working and non-working women to better understand Financial Literacy (FL) among women in India. Additionally, by incorporating cultural, psychological, and behavioral variables, researchers can gain a deeper understanding.

References

- Bakar, M. Z. A., & Bakar, S. A. (2020). Prudent financial management practices among Malaysian youth: The moderating roles of financial education. *The Journal of Asian Finance, Economics and Business (JAFEB)*, 7(6), 525–535.
- Barber, B. M., & Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *Quarterly Journal of Economics*, 116(1), 261–292.
<https://doi.org/10.1162/003355301556400>
- Bhutta, N., Chang, A. C., & Dettling, L. J. (2020). Disparities in wealth by race and ethnicity in the 2019 survey of consumer finances.
- Brounen, D., Koedijk, K. G., & Pownall, R. A. J. (2016). Household financial planning and savings behavior. *Journal of International Money and Finance*, 69, 95–107.
- Bucher-Koenen, T., Lusardi, A., Alessie, R., & Van Rooij, M. (2017). How financially literate are women? An overview and new insights. *Journal of Consumer Affairs*, 51(2), 255–283.
- Chen, H., & Volpe, R. P. (2002). Gender differences in personal financial literacy among college students. *Financial Services Review*, 11(3), 289–307.
- Fonseca, R., & Lord, S. (2019). Canadian gender gap in financial literacy: Confidence matters. Document de travail.
- Garrison, S. T., & Gutter, M. (2010). Gender differences in financial socialization and willingness to take financial risks. *Journal of Financial Counseling and Planning*, 21(2).
- Grable, J. E., & Joo, S.-H. (2000). A cross-disciplinary examination of financial risk tolerance. *Consumer Interests Annual*, 46, 151–157.
- Guo, J., Li, J., Huang, K., Huang, N., & Feng, X. L. (2021). Socio-economic inequalities in the chronic diseases management among Chinese adults aged 45 years and above: a cross sectional study. *Archives of Public Health*, 79, 1–13.
- Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2019). *Multivariate Data Analysis, Multivariate Data Analysis*. In Book (Vol. 87, Issue 4). Prentice hall Upper Saddle River, NJ.
- Hamid, F. S., & Loke, Y. J. (2021). Financial literacy, money management skill and credit card repayments. *International Journal of Consumer Studies*, 45(2), 235–247.
- Jariwala, H. V. (2015). Analysis of financial literacy level of retail individual investors of Gujarat State and its effect on investment decision. *Journal of Business & Finance Librarianship*, 20(1–2), 133–158.
- Kaiser, T., & Menkhoff, L. (2020). Financial education in schools: A meta-analysis of experimental studies. *Economics of Education Review*, 78, 101930.
<https://doi.org/10.1016/j.econedurev.2019.101930>
- Krische, S. D. (2019). Investment experience, financial literacy, and investment-related judgments. *Contemporary Accounting Research*, 36(3), 1634–1668.
- Liu, B., Wang, J., Chan, K. C., & Fung, A. (2021). The impact of entrepreneurs's financial literacy on innovation within small and medium-sized enterprises. *International Small Business Journal*, 39(3), 228–246.
- Lusardi, A. (2011). Financial Literacy: An Essential Tool for Informed Consumer Choice? In SSRN Electronic Journal. National Bureau of Economic Research.
<https://doi.org/10.2139/ssrn.1336389>
- Lusardi, A. (2019). Financial literacy and the need for financial education: evidence and implications. *Swiss Journal of Economics and Statistics*, 155(1), 1–8.

- Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, 52(1), 5–44. <https://doi.org/10.1257/jel.52.1.5>
- Lusardi, A., Mitchell, O. S., & Curto, V. (2010). Financial literacy among the young. *Journal of Consumer Affairs*, 44(2), 358–380.
- Lusardi, A., Mitchell, O. S., & Oggero, N. (2019). Debt close to retirement and its implications for retirement well-being.
- Lusardi, A., & Tufano, P. (2009). Teach workers about the perils of debt. *Harvard Business Review*, 87(11).
- Lusardi, & Săve-Söderbergh, R. (2021). Attitudes towards Debt and Debt Behavior*. *Scandinavian Journal of Economics*, 123(3), 780–809. <https://doi.org/10.1111/sjoe.12419>
- Maditinos, D. I., Šević, Ž., & Theriou, N. G. (2007). Investors' behaviour in the Athens stock exchange (ASE). *Studies in Economics and Finance*, 24(1), 32–50.
- Malaviya, P. R., & Jariwala, H. (2019). FINANCIAL SOCIALIZATION: A LITERATURE REVIEW. *Prestige International Journal of Management and Research*, 176.
- Mandell, L., & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning*, 20(1).
- Morgan, R. (2003). ANZ Survey of Adult Financial Literacy in Australia-Final Report. ANZ Banking Group, Melbourne.
- Norvilitis, J. M., Merwin, M. M., Osberg, T. M., Roehling, P. V, Young, P., & Kamas, M. M. (2006). Personality factors, money attitudes, financial knowledge, and credit-card debt in college students 1. *Journal of Applied Social Psychology*, 36(6), 1395–1413.
- OECD. (2013). Improving Financial Education Effectiveness Through Behavioural Economics. Financial Literacy & Education Rusia Trust Fund, 1(June), 9–47.
- OECD. (2020). OECD/INFE 2020 International Survey of Adult Financial Literacy. OECD/INFE 2020 International Survey of Adult Financial Literacy, 78. www.oecd.org/financial/education/launchoftheoecdinfeglobalfinancialliteracysurveyreport.htm
- Putthinun, P., Watanapongvanich, S., Khan, M. S. R., & Kadoya, Y. (2021). Financial literacy and alcohol drinking behavior: Evidence from Japan. *Sustainability (Switzerland)*, 13(16), 445–465. <https://doi.org/10.3390/su13168858>
- Remund, D. L. (2010). Financial literacy explicated: The case for a clearer definition in an increasingly complex economy. *Journal of Consumer Affairs*, 44(2), 276–295. <https://doi.org/10.1111/j.1745-6606.2010.01169.x>
- Rodrik, D. (2007). Growth Building Jobs and prosperity in Developing Countries. Why Growth Should Be at the Heart of Development Policy, 1–25.
- Shue, M., Watkins, C. L., & Lead, A. (2023). Women & Investing: A Stronger Grip on Their Financial Futures.
- Singh, B., & Singh, M. (2023). Financial literacy and its determinants among the schedule tribes: evidences from India. *International Journal of Social Economics*.
- Škreblić Kirbiš, I., Vehovec, M., & Galić, Z. (2017). Relationship between Financial Satisfaction and Financial Literacy: Exploring Gender Differences. *Drustvena Istrazivanja*, 26(2), 165–185. <https://doi.org/10.5559/di.26.2.02>
- Taylor, M., Jenkins, S., & Sacker, A. (2009). Financial capability and wellbeing: Evidence from the BHPS. *Occasional Papers in Financial Regulation*, 34(May), 1–98. <http://www.fsa.gov.uk/pubs/occpapers/op34.pdf>

- Tennyson, S., & Nguyen, C. (2001). State curriculum mandates and student knowledge of personal finance. *Journal of Consumer Affairs*, 35(2), 241–262.
- Thanki, H., & Baser, N. (2019). Interactive Impact of Demographic Variables and Personality Type on Risk Tolerance. *Emerging Economy Studies*, 5(1), 42–54.
<https://doi.org/10.1177/2394901519825924>
- Thanki, H., Shah, S., Sapovadia, V., Oza, A. D., & Burduhos-Nergis, D. D. (2022). Role of gender in predicting determinant of financial risk tolerance. *Sustainability*, 14(17), 10575.
- van Rooij, M., Lusardi, A., & Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics*, 101(2), 449–472.
<https://doi.org/10.1016/j.jfineco.2011.03.006>
- Xiao, J. J., Tang, C., & Shim, S. (2009). Acting for happiness: Financial behavior and life satisfaction of college students. *Social Indicators Research*, 92(1), 53–68.
<https://doi.org/10.1007/s11205-008-9288-6>

San Diego State University - Mission Valley Project: An Expanding Mission of a University

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Instructional Case Study: The San Diego State University Mission Valley Project: An Expanding Mission of a University

San Diego State University (SDSU) began the construction of a new stadium for its football team, the Aztecs, in Mission Valley, San Diego, California in summer 2020. Construction of the new stadium required acquisition of land surrounding the stadium site in Mission Valley. Stadium construction became an integral part of the SDSU-Mission Valley (SDSU-MV) Project. The SDSU-MV project had two components: (i) Site Acquisition and Development, and (ii) Stadium Construction.

The Site Acquisition and Development component would cost \$351 million; the Stadium Construction was estimated to cost \$340 million, for a total outlay of \$691 million. The project outlays would be funded by bonds issued by the California State University (CSU) System beginning 2020; SDSU is one of 23 campuses of the CSU System. With the addition of the financing costs to the project outlay, the total cost of the project was likely to exceed \$1 billion. In addition to the new 35,000 seat football stadium, the SDSU-Mission Valley Project would create through public-private partnerships 1.6 million square feet of office and research space, 4,600 housing units with 10% set aside for low-income households, 80 acres of parks and open space, a 400-room hotel, and 95,000 square feet of retail space, and several thousand parking spaces.

The SDSU-MV Project transformed SDSU's historic mission of teaching, and research and required new organizational capabilities to successfully implement this project. How will the debt created by the project be serviced given that "SDSU officials have repeatedly promised they will not raise student tuition or fees"? What will be the composition and magnitude of the revenue sources to cover the operating expenses and service the debt created in completing this transformative project? What are the risks of this transformative project and how would these risks impact the project's stakeholders?

Keywords: Project financing, Project Risk, Stadium Economics, University Mission, University Leadership.

Introduction

In June 2018, Adela De La Torre, Vice Chancellor for Students Affairs and Campus Diversity at University of California, Davis was appointed the ninth president of SDSU. On June 30, 2020, the San Diego City Council, voted to approve the sale of the 135-acre Mission Valley Stadium site to CSU on behalf of San Diego State University for more than \$88 million. The CSU comprised twenty-three campuses (including SDSU) serving approximately 480,000 students (Exhibit 1).

In August 2020, SDSU President Adela de La Torre, inaugurated the SDSU Five-Year Strategic Plan, 2020 – 2025, in which she offered her strongest endorsement for the SDSU-MV Project:

*“For 123 years SDSU has overcome hurdles and defied expectations, forging ahead to deliver academic excellence, student success, and groundbreaking research. We will continue to do so as we build SDSU’s new chapter of inclusive opportunity for more students, reimagining a university designed to thrive for many years to come, and impacting San Diego, our border region, and the world as never before. **This includes boldly moving forward with SDSU Mission Valley**, which is projected to increase enrollment by up to 15,000 students, generate \$3.1 billion annually for the regional economy, and generate up to 17,000 jobs” [emphasis added].*

SDSU Mission Valley Project is located in the Mission Valley neighborhood/district within the city of San Diego. Mission Valley is located in the central portion of the San Diego Metropolitan area (Figure 1). The community is located approximately five miles north of Downtown and seven miles east of the Pacific Ocean. The subject property has regional access to four major freeways. The proximity to amenity facilities such as regional shopping, companion high quality professional buildings, the onsite San Diego Trolley Station, and the subject’s high visibility-identity and the ease of freeway access to the metropolitan area, makes this area very attractive.

The SDSU Mission Valley Project comprised: (i) a new stadium, which replaced the existing stadium where the SDSU Aztecs have played since 1967, (ii) construction of a 34-acre city-owned river park, and preparation of the site for real estate development. The latter comprised 1.6 million square feet of office and research space, 4,600 housing units with a 10% set aside for low-income households, 80 acres of parks and open space, a 400-room hotel, 95,000 square feet of retail space and several thousand parking spaces. Figure 2 provides an overview of this project including its key components. Financing for this project would come primarily from bonds issued by the California State University (CSU) Board of Trustees. The total project outlay was estimated to be \$691 million; including financing costs, the total project cost was estimated to exceed \$1 billion. The development timeline for this complex project extends out to around twenty years and student classes are not expected to be conducted at the Mission Valley site before 2030.

San Diego is a national hub for biotech, life sciences, technology, defense, and hospitality and tourism. SDSU Mission Valley will provide SDSU with the opportunity to expand its academic and economic impact on the region through a world-class Research and Innovation District just three trolley stops from SDSU. SDSU will also build a River Park for all San Diegans to enjoy, along with much needed housing, and a new multi-use stadium. The annual economic impact of SDSU Mission Valley is estimated at approximately \$3 billion, including \$21 million in annual tax revenue for the City of San Diego.

River park’s open space will serve as a buffer and as a ‘green sponge’ to naturally absorb and filter runoff while creating recreational opportunities and rebuilding the native ecosystem. The design of this park allows for active and passive uses that make for a vibrant green space, not just for the campus community to enjoy, but for all San Diegans to use and take pride in.

The 35,000-capacity Snapdragon Stadium is the venue for Aztec Football, men’s and women’s soccer teams and numerous local high schools use it for their sporting events. With direct service from the San Diego Trolley, the stadium is also the new home to the National Women’s Soccer League’s San Diego Wave Fútbol Club, and talks are underway to bring a Major League Soccer expansion team to the stadium. The stadium has been built to add additional capacity if a professional sports franchise like the NFL returns to San Diego.

The SDSU Mission Valley Innovation District will empower the university and its partners to help people enrich their livelihoods, initiate new career pathways for students, and expand the region's competencies. It will not only provide educational opportunities for local students to enter those fields but also work with these industries to innovate and expand the amazing work already happening here in San Diego.

The Innovation District is an important piece of the equation for achieving SDSU's goal of becoming a premier public research university and joining the 4% of U.S. universities designated as "R1" in the prestigious Carnegie Classification of Institutions of Higher Education. An "R1" status would likely enable further investment in the university from public and private funding sources while enhancing existing regional economic and workforce development efforts.

How would the SDSU Mission Valley project transform SDSU's historical academic mission of teaching and research? How would the debt created to fund this project be serviced given that "SDSU officials have repeatedly promised they will not raise student tuition or fees"? What would be the composition and magnitude of the revenue sources to cover the project's operating expenses and service the debt created to initiate and complete this transformative project? What would be the risks of this transformative project and how would these risks impact the project's stakeholders? What would be the organizational structure through which activities in the SDSU-Mission Valley project be implemented?

Background to the SDSU Mission Valley Project

The old stadium in Mission Valley, known as the SDCCU Stadium just before its demolition in 2021 had a seating capacity of around 71,000. It had been the home of the SDSU Aztecs football team since they played their first football game there on September 15, 1967, against Tennessee State. The Aztecs shared the stadium with the NFL's San Diego Chargers (before the Chargers moved to Los Angeles after the 2016 season) and the MLB's San Diego Padres (before they moved to their new ballpark, Petco Stadium after the 2003 baseball season). The Aztecs continued to play at another venue through their 2020 and 2021 college football seasons. They are expected to move into the newly constructed stadium at the Mission Valley site in Fall 2022.

As the San Diego Chargers prepared to depart in 2016, a group of La Jolla, California investors hoped to purchase a Major League Soccer (MLS) expansion franchise. They offered to purchase the stadium site from the City of San Diego if their application for a soccer franchise was approved, and to construct a smaller, soccer-specific stadium outside the footprint of the current stadium along with a very ambitious mixed-use project.

This new stadium was initially intended to be shared with the San Diego State University football program and thereby meet the needs of SDSU for a stadium replacement. In January 2017, the investor group announced its detailed proposal, known as Soccer City, with the stadium site to be leased from the city and developed with private funding. The proposed partnership with SDSU fell apart over disagreements about design and land control issues. This created significant uncertainty for SDSU about a future venue for the regular home games for its football program post-2017.

The Soccer City group launched a successful signature campaign seeking voter approval, and their ballot proposal was placed on the November 2018 ballot as Measure E. San Diego State University was still interested in the stadium property as it sought to find a solution to a replacement for a stadium. A group of local SDSU supporters announced a redevelopment proposal for the stadium site which would become SDSU Mission Valley. Under this proposal, most of the

stadium property would be bought from the city and used for a mix of purposes including a stadium, academic facilities, student and faculty housing, retail uses, and hotels. After a successful signature campaign, the proposal was also placed on the November 2018 ballot as Measure G. In the November election, voters rejected the Soccer City proposal, Measure E with a "No" vote of nearly 70%. The SDSU Mission Valley proposal, Measure G, however, was narrowly approved with 54% "Yes" votes. SDSU supporters friendly to Measure G donated \$8.43 million to the Measure G campaign, whereas the Soccer City supporters of Measure E donated \$10.6 million to the Measure E campaign. Major donors for both Measures came from the real estate development community in San Diego and reflected their intense interest in the development of the Mission Valley property that would occur under either Measure.

Following the San Diego voters' approval of Measure G, SDSU began negotiations with the city about purchasing the property. The university named Clark Construction as the contractor to build a new multi-use stadium on the site. The stadium as proposed would have capacity for 35,000 attendees and support events including college football, NCAA championship games, professional soccer, and special events such as concerts. Since the purchased property would comprise significantly more land than that used by a new stadium, SDSU would have to develop plans for the appropriate use(s) for the additional land on the purchased property beyond that used by the newly constructed stadium.

Timeline for SDSU-Mission Valley Project

Per presentations by SDSU personnel, the proposed timeline for the SDSU-Mission Valley Project is as follows:

2020	Close Escrow – Begin Construction
2021	Demolition of Existing Stadium
2022	Complete the New Multi-Use Stadium
2023	Complete Site Development and River Park
2023	Begin First Phase of Residential Building Development
2023	Begin Initial Phase of Academic and Research Building Development
2025	Begin Hotel and Conference Space
2037	Complete Total Buildout

The implementation of this project required the creation of an organization and legal structure to address the following critical functions:

1. Alignment of this project with the mission of SDSU.
2. Financing plan, cost, and revenue projections for the project.
3. Division of responsibilities between SDSU, the CSU System, and all other parties engaged in the project.

Evolution of SDSU and its Mission

San Diego State University was founded March 13, 1897, as the San Diego Normal School, a training facility for elementary school teachers. As SDSU grew, its mission evolved from its early days as a teachers' college to that of a major public university with its two major pillars of teaching

and research. Today, *“The mission of San Diego State University is to provide research-oriented, high-quality education for undergraduate and graduate students and to contribute to the solution of problems through excellence and distinction in teaching, research, and service... San Diego State University pursues its mission through its many diverse departments and interdisciplinary programs in the creative and performing arts, the humanities, the sciences, and the social and behavioral sciences.”*

This quest for “excellence and distinction in teaching, research, and service”, served SDSU exceedingly well over the decades since its founding nearly 125 years ago, and SDSU has been recognized as a major public university. It is generally considered a premier member of the 23-campus California State University (CSU) System. Many of its programs are ranked nationally; for example, in the top 50 or 100 best programs in US News and World Report (USNWR) annual rankings.

However, with the initiation of the SDSU Mission Valley Project in 2020, SDSU President Adela de la Torre has transformed SDSU’s mission beyond its traditional teaching and research focus to encompass a major new role in the economic development of San Diego, the US – Mexico border region, and internationally. This enhanced mission now required SDSU’s involvement in a major real estate venture as part of the SDSU Mission Valley Project. In a recent op-ed, in the San Diego Union Tribune, July 20, 2021, President de la Torre suggested that the SDSU-MV project, *“... will also be generating additional revenue needed to help finance expansion of our university, enabling us to educate up to 15,000 more students a year and helping provide the vital skilled workforce needed to continue propelling the San Diego region forward. The economic multiplier effect of this expansion is unrivaled”* [emphasis added].

SDSU Mission Valley Project Financing Plan¹⁰

The SDSU Mission Valley project is expected to be financed from various sources such as bond financing, ground leases, and donations. The project will comprise two components: (i) Initial site acquisition and development including, stadium demolition, site infrastructure, river park, and off-site mitigation, and (ii) construction of the new multi-use stadium. The costs under (i) are estimated at \$351 million, and the costs under (ii) are estimated at \$340 million. Financing for each of these components is discussed below.

Land Acquisition, and Infrastructure for the Project

The first component is the acquisition of the property, preliminary plans, working drawings, preliminary grading, demolition of the existing stadium, and construction of certain public benefit features of the proposed Project, including infrastructure/utility improvements, such as development and construction of the River Park, Population Based Parks, and Open Space. CSU will also be responsible for maintaining all grounds within the SDSU Mission Valley Campus site, including the River Park on City-owned land and the Additional Parks and Open Space ("Population Based Parks") within the Property. It is anticipated that ongoing maintenance will be funded by a variety of sources including ground lease revenue and common area maintenance fees on facilities developed through public-private partnerships.

¹⁰ This section of the case draws extensively on “Attachment 14 to Purchase and Sale Agreement: CSU Financing Plan”; Part 3 of Attachment A to City Staff Report for [San Diego] City Council Meeting on June 17, 2020.

As noted, the total cost of the first component is estimated at \$351 million and will be funded from the following sources: CSU Systemwide Revenue Bonds: \$311 million (comprising two bond issues - \$251 million, and \$60 million, respectively); and Campus and auxiliary resources: \$40 million.

The long-term source of repayment for the Systemwide Revenue Bonds supported by the proposed Project will come from ground lease revenue from future public-private partnership development of the housing, retail, hospitality, and the campus research and innovation components. The debt will be structured as interest only for several years, most likely fifteen to twenty years, with principal payments due in later years. The final structure of the principal payments will be determined at the time of debt issuance depending upon market conditions, but could include bullet maturities, with or without formal sinking funds.

New Stadium Construction

The second component is the construction of the new stadium, upon completion the new stadium will be called Snapdragon Stadium, named after the Snapdragon brand of mobile device processors, developed by Qualcomm Corporation. The total cost of construction of the new stadium will be \$340 million to be funded from the principal amounts of two CSU bond issues as follows: (i) Long-term CSU Systemwide Bonds: \$215 million; and (ii) Short to medium term CSU Systemwide Bonds: \$125 million.

The bonds under (i) would be taxable and issued on a fully amortizing basis over approximately thirty years. The source of repayment for the principal and interest on these bonds will be ongoing multi-use stadium net operating revenues. Per the CSU Financing Plan, “The financial plan and analysis conservatively assume revenues from football games, naming rights, concessions, and some special events. Additional revenues that might be generated from future partnerships with other professional sport teams and additional special events should only improve the financial position of the Project” (see footnote 10). The primary source of repayment for the bonds under (ii) will be philanthropic gifts and revenues from premium seat acquisition licenses. Per the CSU Financing Plan, these revenue streams are forecast to be received over a roughly fifteen-year period, with over eighty percent received within eight years. To date, SDSU has secured signed philanthropic commitments of \$30 million. Exhibit 2 contains a detailed Sources and Uses Statement for the SDSU Mission Valley Project per information in the Series 2020E Bond Prospectus and Minutes of the CSU Board of Trustees. This exhibit includes only the principal amounts for the bonds issued for both components of the project. Exhibit 3 contains the maturity schedule for the bonds issued to finance both components of the project.

Economics of Athletic Programs and College Football Stadiums

US colleges/universities have expended significant sums of money in renovation or construction of college football stadiums. These substantial renovation/construction costs must be funded. The sources of funds range from (i) university operating funds (if allowable); (ii) university athletics budgets; (iii) sponsorships; (iv) television/media rights; (v) ticket sales; and (vi) donor contributions – alumni and others.

A 2010 report by the Knight Commission on Intercollegiate Athletics states¹¹, “In fact, only a tiny number of athletics programs reap the financial rewards that come from selling high priced tickets and winning championships. According to a USA Today analysis, just seven athletics programs generated enough revenue to finish in the black in the last five years.” (Page 3 of the report). Per the same report, athletic spending per athlete was between 4 to 11 times the academic spending per student across Football Bowl Subdivision Conferences; in the Mountain West Conference (to which SDSU belongs) the ratio was 5.1 times. It is important to note that the soccer and lacrosse teams of SDSU are affiliate members of the Pac-12 and SDSU was most recently viewed as a legitimate candidate to join the Pac-12.

In yet another report created for the Knight Commission on Intercollegiate Athletics in 2009, the authors concluded, “In fact, the vast majority of athletics programs reap far less money from external sources than they need to function. Virtually all universities subsidize athletics departments through general fund allocations, student fees, and state appropriations, and the NCAA estimates in a given year only 20 to 30 athletics programs actually generate enough external revenue to cover operating expenses”¹². If the typical college athletics program (of which football programs generally account for the largest share of athletics budgets) ‘barely breaks even’, then paying for costly stadium renovation/construction projects must come from sources other than contributions from university athletics budgets and net athletics program revenues.

Table 1 contains information from several universities on the estimated costs of stadium renovation/new construction in recent years.¹³ By way of comparison, SDSU’s new Snapdragon Stadium (in Mission Valley) to be ready in Fall 2022 is estimated to cost \$340 million which falls within the range of estimated costs in Table 1 and is very close to the mean cost of \$346.5 million dollars. SDSU compares favorably in terms of its size relative to the schools in Table 1; the mean and median student population size in 2023 for the schools in Table 1 is 38,500, and 39,000, respectively (with a range of 8,600 – 73,000 students). SDSU’s enrollment in Fall 2023 is 37,500 students. Exhibit 1 contains university-wide enrollment numbers from 2017-2022 for both SDSU and CSU. The renovations/new stadiums have typically included state of the art acoustics, enhanced score boards, private suites, club, or box seats. These ‘new’ venues have enabled alumni development, developed connections with the local business and political establishments, and enhanced student engagement with the university.

¹¹ Restoring the Balance: Dollars, Values, and the Future of College Sports, 2010. Knight Commission on Intercollegiate Athletics.

¹² College Sports 101: A Primer on Money, Athletics, and Higher Education in the 21st Century, 2009. Knight Commission on Intercollegiate Athletics.

¹³ “America’s Incredibly Expensive College Football Stadiums”, Thom Patterson, CNN US, September 28, 2018.

Table 1
Major College Stadiums Constructed and Renovated in the Last Decade

University	Stadium Status	Year(s)	Estimated Cost	Conference
Texas A&M Univ.	Renovation	2014-15	\$485.0 mill.	Big-12
Univ. of Notre Dame	Renovation	2014-17	\$400.0 mill.	Independent
Univ. of Kansas	Renovation	2018-22	\$350.0 mill.	Big-12
Univ. of Tennessee	Renovation	2018-20	\$340.0 mill.	SEC
UC Berkeley	Renovation	2010-12	\$321.0 mill.	Pac-12
Univ. of Minnesota	New Construction	2009	\$288.5 mill.	Big Ten
Arizona State Univ.	Renovation	2014-19	\$317.0 mill.	Pac-12
Univ. of Washington, Seattle	Renovation	2012-13	\$280.0 mill.	Pac-12
Baylor Univ.	New Construction	2014	\$266.0 mill.	Big-12
Univ. of Michigan	Renovation	2007-10	\$221.0 mill.	Big Ten
Colorado State Univ.	New Construction	2017	\$220.0 mill.	Mountain West

It should also be noted that the schools in Table 1 (except for Colorado State University) belong to the “Big Five” or “Power Five” schools. The Power Five constitute the five athletic conferences that are considered the most prominent and influential in NCAA Division I college football and are guaranteed berths in the "access bowls" associated with the College Football Playoff. These conferences are the Atlantic Coast Conference (ACC), Big Ten Conference (Big Ten), Big 12 Conference (Big-12), Pacific-12 Conference (Pac-12), and Southeastern Conference (SEC). These conferences wield considerable financial power in college athletics. They generate significant revenue through lucrative television contracts, sponsorship deals, and ticket sales. To the extent that SDSU does not belong to a Power Five Conference, its ability to gain significant additional revenue from lucrative television contracts, sponsorship deals, and ticket sales is clearly hampered and thereby impacts the economics of its football program.

Exhibit 4 provides estimates of all operating revenue sources and amounts and estimates of all expense sources and amounts incurred by all SDSU athletics programs for the period 2010 – 2019. It facilitates an evaluation of the financial health of SDSU athletics programs, and their likely contributions to servicing the debt issued for stadium construction in a given year and over the entire period. The data in Exhibit 4 are from the CAFI Database from the Knight Commission on Intercollegiate Athletics.

Cost Estimates for the SDSU-Mission Valley Project

To get a perspective for the financing costs of the two components of this transformative project we have estimated the annual financing costs for the two components by assuming a 2.85% annual yield on the bonds issued by the CSU system to cover the outlays for the two project components - \$340 million for stadium construction, and \$351 million for the Mission Valley Site Acquisition and Development per Exhibit 5. The bonds are issued by the CSU System, proceeds from which are then made available to SDSU for completing the SDSU-Mission Valley Project. Exhibit 5 provides estimates of total financing costs (interest plus principal payments) for both the Stadium Construction component and the Land Acquisition and Development component of the Mission Valley Project. It is assumed that SDSU is responsible for managing the two project components to ensure that they must generate sufficient operating income that at the minimum must cover the financing costs of the two project components. Operating income is defined as

(revenues less all operating costs but excluding financing costs). Thus, the annual break-even operating income for each project component equals the estimated annual financing cost for that project component as indicated in Exhibit 5.

Paying for the SDSU-Mission Valley Project

The proponents¹⁴ of Ballot Measure G (by which the Mission Valley property was acquired by CSU/SDSU) in their Official Argument have stated that Measure G, - “Ensures redevelopment of the stadium property will be in the hands of proven development experts, taking advantage of SDSU’s extensive experience and success in managing over \$482 million in campus development since 2013, including housing, retail and academic projects, many involving public-private partnerships. - Provides a permanent home for SDSU football and other athletics, professional soccer and football, in a state-of-the-art multi-use stadium – at no cost to taxpayers – and relieves taxpayers of continuing maintenance costs for the former Qualcomm Stadium.” The payment sources to cover the project outlays and the associated financing costs for both components of the SDSU Mission Valley Project are expected to be:

1. For Site Acquisition and Development, the primary revenue/payment source will be the net ground lease revenues from real estate development such as multifamily housing (market rate and affordable), retail uses, the innovation hub, and hotel to be constructed on the Mission Valley site.
2. For Multi-Use Stadium, the primary source of repayment will be philanthropic gifts coupled with other revenues from stadium activities beyond SDSU football games. Per a report in the San Diego Union Tribune, August 27, 2019, John David Weicker, SDSU’s Director of Athletics, has suggested that SDSU “would have a third-party running everything, including day-to-day stadium operations, security, concessions, marketing efforts and accounting. The firm will also be tasked with providing direction on stadium design elements based on prior experience. And candidates will need to be versed in digital ticketing”. The new Snapdragon Stadium itself will be used by the SDSU Aztecs for about 7 – 8 home football games. The estimated net revenue contribution by the third-party operator will depend on the management contract with the operator in terms of revenue and cost sharing of the activities conducted in the stadium (on an annual basis).
3. For both components of the SDSU-Mission Valley Project, another potential revenue source (though likely to be temporary) will be SDSU and CSU reserves. For CSU, state law authorizes the university to establish numerous fund accounts and maintain reserves. The CSU Chancellor’s Office adopted a systemwide policy in 2015-16 that sets a target for campuses to maintain uncommitted reserves worth a minimum of three months and a maximum of six months of expenditures. This policy applies to campuses’ core operating funds and many of their non-core funds¹⁵. To the extent that campus reserves are used by

¹⁴ The Proponents were identified as:

Adam Day, chair, California State University Board of Trustees
Sally Roush, immediate past president, San Diego State University
Jerry Sanders, president and CEO, San Diego Regional Chamber of Commerce
Jesse Conner, president, San Diego City Firefighters L145
Dr. Peter A. Anderson, chairperson, Sierra Club San Diego.

¹⁵ Budget and Policy Post, November 10, 2020, “An Analysis of University Reserves”, Legislative Analyst’s Office, CA Legislature. <https://lao.ca.gov/Publications/Report/4295>

the SDSU-MV Project, they have to be repaid/replenished from the future operating revenue streams generated by the two project components. In addition to SDSU staff, these activities will necessitate the use of consultants with specialized expertise to augment that of the SDSU staff.

The above discussion suggests that net ground lease revenues from (1.) can augment the revenues from (2.) should the latter not be sufficient to cover all the costs for (2.). Additionally, SDSU staff will be engaged extensively with the activities associated with the Mission Valley Site Acquisition and Development. These activities will entail identification of real estate development partners, formulation of long-term contracts between these partners and SDSU/CSU, seeking and formulating contracts with the innovation hub partners, and seeking and formulating contracts with a prospective hotel partner.

The uncertainty in estimating the operating income from the Site Acquisition and Development component stems from uncertainty in determining the private partners, the types of housing and innovation hub projects to be completed, the ground lease revenue streams from these projects, and of course significant uncertainty in determining the costs to SDSU of managing this component of the project. Operating income uncertainty thus translates into Operating Margin uncertainty for both project components; $\text{Operating Margin} = (\text{Operating Income}/\text{Operating Revenue})$; $\text{Operating Income} = \text{Operating Revenue} - \text{Operating Costs}$ ¹⁶. Exhibit 6 provides financial performance data for two sectors of the US economy relevant to this project: (i) the Consumer Discretionary Sector, and (ii) the Real Estate Sector. The activities within the new Snapdragon Stadium fall within the Consumer Discretionary sector, whereas the activities associated with the Site Acquisition and Development component fall within the Real Estate sector.

Per the SDSU-Mission Valley Project timeline, the Stadium Construction is projected to be completed by Fall 2022; 2022 – 2023 is then assumed to be the starting year for operating income generation for the Stadium. For the other project component, the First Phase of Residential Business Development is expected to start in 2023, and Final Buildout is expected to be completed in 2037; thus 2023 is assumed to be the starting year for operating income generation for the Real Estate Development component. It should be noted that approximately \$125 million of the Stadium Construction costs are expected to be funded through donations; to that extent such donations would lower the costs associated with Stadium Construction. Also, to the extent that the debt was to be structured as interest only for several years, most likely fifteen to twenty years, with principal payments due in later years, the annualized financing costs in Exhibit 5 could be lower than the estimates provided.

While the CSU System/San Diego State University operating revenue forecasts from both project components are not publicly available, the CSU system has provided estimates of debt service coverage ratios for the SDSU – Mission Valley Project. “Based upon the available campus and system revenues, the debt service coverage for the interest only period of the debt is forecast to be 1.40 per year, which exceeds the CSU minimum benchmark of 1.10. Under a conservative scenario where the principal payments are made over a 14-year period from 2042 through 2055, the debt service coverage ratio starts at 1.08 and increases to 1.46, levels that compare favorably to the CSU minimum benchmark of 1.10. When combining these revenue stream projections with 2018- 2019 actuals for other campus pledged revenue programs, the campus’ overall net revenue

¹⁶ By way of context here are 2020 operating margins = $(\text{Operating Income}/\text{Revenue})$ for some of the most profitable US Companies: Visa (63%), Berkshire Hathaway (58%), Microsoft (40%), Facebook (40%), Nvidia (30%), Apple (27%), Alphabet (25%), J&J (25%), Amazon (6%), and Tesla (5%); Source; Financial Times (US ed.), June 8, 2021.

debt service coverage for the first year of the interest only period is projected to be 1.43, which exceeds the CSU campus benchmark of 1.35. With respect to the campus' overall net revenue debt service coverage when principal repayment begins, the debt service coverage ratios compare favorably to the CSU campus benchmark of 1.35 under different scenarios and assuming conservative growth assumptions for other campus pledged revenue programs".¹⁷ The Debt Service Coverage, DSC equals (Operating Income or EBIT)/(Interest + Principal Payments); this assumes that the income tax rate for SDSU/CSU is zero. Additionally, the Operating Margin, OM equals (Operating Income)/Revenues. Using a range of plausible values for DSC, and OM, respectively, estimates for Ground Lease Revenues can be obtained which at a minimum will cover the operating and financing costs of the SDSU-MV Project.

Organization Structure of SDSU-Mission Valley Project¹⁸

The scope and complexity of the SDSU-Mission Valley project will require a significant ongoing commitment of organizational resources from the university. SDSU has established a new leader- ship structure to oversee the entirety of the SDSU-Mission Valley Project. Per President Adela de la Torre, "SDSU Mission Valley will engage all facets of the university but through this leader- ship structure, I am confident we will be successful. We are leveraging expertise from across the University, and we have already accomplished so much towards this important endeavor."

Gina Jacobs, Associate Vice President for Mission Valley Development, will serve in the SDSU- Mission Valley Project's leadership role, reporting directly to President de la Torre and working closely with Hala Madanat, Vice President of Research and Innovation, Vice President of Business & Financial Affairs and Chief Financial Officer Agnes Wong-Nickerson, and their teams. Wong- Nickerson will continue to oversee the financial management of SDSU Mission Valley and the New Snapdragon Stadium in close coordination with Jacobs and JD Wicker, Director of Intercollegiate Athletics. Wicker will be responsible for managing the operations of Snapdragon Stadium.

Jacobs' role will serve as the central point of contact for all operational aspects of SDSU Mission Valley, including the process to select development partners, meeting the obligations of both the purchase agreement and environmental impact report, and keeping the campus and community updated about its progress. Hala Madanat will lead the effort to establish research and academic partnerships with both public and private entities. These partnerships will entail very significant in-house or outsourced expertise in technology commercialization, financial and accounting, and marketing expertise, negotiation and contracting skills as SDSU must deal with a myriad of private partnerships in the technology space. The innovation district is expected to create an environment to significantly enhance SDSU's research productivity and thereby provide significant impetus to SDSU's long-term goal of achieving a Carnegie R1 Doctoral Institution

¹⁷ Meeting Minutes, JOINT COMMITTEES ON FINANCE AND CAMPUS PLANNING, BUILDINGS AND GROUNDS, CSU System, January 28, 2020.

¹⁸ This section draws upon, "SDSU Mission Valley Continues Progress in 2021", Strategic Communications and Public Affairs, San Diego State University.

classification from its current classification as a R2 Doctoral Institution (SDSU Five-Year Strategic Plan, August 2020).¹⁹

Risks of the SDSU Mission Valley Project

By initiating the SDSU Mission Valley Project, President Adela De La Torre, and the CSU Board of Trustees have transformed the traditional mission of teaching and research of SDSU. The risks of this transformative, complex, and long-term project can broadly be classified as: (i) project financing risks, and (ii) project implementation risks associated with both Stadium Construction and Land Acquisition and Development components of the project. Stadium Construction is expected to be financed with CSU System debt, acquisition gifts from premium seat holders, advance ticket revenue and philanthropy, with debt repaid from annual gifts, sponsorships, ticket revenues, naming rights and concession revenues. Land Acquisition and Development is expected to be financed with CSU System debt, and campus and auxiliary resources with long-term repayment coming primarily from public-private partnership ground rent revenues. At a minimum the total financing cost of both project components must be collectively recouped through the revenues from both project components.

In the first quarter of 2023, the first phase of Riverwalk San Diego, a 200-acre transit-oriented mixed-use development, has broken ground in close proximity to SDSU Mission Valley. When completed, the project will transform the Riverwalk Golf Club in western Mission Valley into a 4,300-unit multifamily community. The developers of the project are Hines Interests Limited Partnership and USAA Real Estate. At this point in time, this development will directly compete with the 4,600 apartments that will be built as a part of SDSU Mission Valley.

In a recent op-ed, in the San Diego Union Tribune, July 20, 2021, President De La Torre eloquently articulated, “Over the next 10 years, we will be creating 80 acres of open space, trails and a community river park; establishing academic public-private partnerships resulting in a unique innovation district; and much-needed housing opportunities.” The implementation risks then come from finding the appropriate partners for both project components. If stadium operations will be outsourced to a third party, the long-run operating profitability of stadium operations will be determined by the implementation capabilities of the stadium operator. The success of Land Acquisition and Development is predicated on the private parties (in the public-private partnerships) investing 3 billion–3.5 billion for implementing the various real estate projects – both housing and innovation hub - to generate the needed ground lease revenues to cover the total project financing costs. Finally, one cannot underestimate the time and attention commitment of the senior academic leadership at SDSU in managing this project without adversely impacting the core academic mission of teaching and research at SDSU.

¹⁹ R1: Doctoral Universities – Very high research activity, R2: Doctoral Universities – High research activity. As of 2021 there are 146 universities that have a Carnegie R1 classification. The first two categories of doctoral universities from the Carnegie Classifications of Institutions of Higher Education include only institutions that awarded at least 20 research/scholarship doctoral degrees and had at least \$5 million in total research expenditures (as reported through the National Science Foundation (NSF) Higher Education Research & Development Survey (HERD)).

Conclusion

Following the passage of Measure G by the voters of San Diego in November 2018, SDSU President Adela de la Torre spearheaded the SDSU Mission Valley Project that included: (i) the construction of the new multi-use Snapdragon Stadium to be completed by Fall 2022 at a cost of \$340 million to replace the existing stadium that was home to the SDSU Aztecs since 1967; and (ii) the site acquisition and development of the property acquired in Mission Valley alongside the stadium at a cost of \$351 million. The latter required that SDSU be engaged in a major real estate venture to be completed through public-private partnerships; this venture comprised an innovation hub, hotel construction, and housing development; the public-private partnerships were projected to spend about \$3.5 billion. The SDSU-Mission Valley Project transformed SDSU's historic mission of teaching, and research and required new organizational capabilities to successfully implement this project. How will the debt created by the project be serviced given that "SDSU officials have repeatedly promised they will not raise student tuition or fees"? What will be the composition and magnitude of the revenue sources to cover the operating expenses and service the debt created in completing this transformative project? What are the risks of this transformative project and how would these risks impact the project's stakeholders? The impacted constituents of this project over the coming years will likely be the San Diego State University students, staff, and faculty; the senior administrators of the Cal State University System and SDSU; the City of San Diego, the private development partners, and more broadly the California taxpayer. How would the costs and benefits of this transformative project be distributed across and paid for by its varied constituents?

Figure 1
Regional Context of SDSU Mission Valley Project



Figure 2
Site Plan of SDSU Mission Valley Project



Exhibit 1
CSU and SDSU university wide enrollment Fall 2017-22

California State University Enrollment Fall 2017-22

2017	2018	2019	2020	2021	2022
484,297	481,210	481,929	485,550	477,466	457,992

San Diego State University Enrollment Fall 2017-22

2017	2018	2019	2020	2021	2022
33,917	33,870	34,031	34,512	34,842	35,723

Exhibit 2
Sources and Uses for the SDSU Mission Valley Project

A. Site Acquisition and Development

Sources		Uses²⁰	
Bond Proceeds: Series 2020E ²¹	\$251,070,000	Acquisition	\$87,700,000
Bond Proceeds: Series 2021B ²²	\$60,215,000	Site Development Infrastructure	\$169,000,000
Campus & Auxiliary Resources ²³	\$40,000,000	On and off-site traffic improvements	\$40,000,000
		Fees, Contingency, Services ²⁴	\$54,585,000
Total	\$351,285,000	Total	\$351,285,000

²⁰ The total cost (uses) for the site acquisition and development component was obtained from the minutes of the “Joint meeting of the committees on Finance and Campus Planning, Buildings and Grounds” on January 28-29, 2020.

²¹ \$251,070,000 was allocated towards acquisition and the infrastructure improvements of the SDSU Mission Valley site from the Series 2020E (taxable) systemwide revenue bonds (Appendix H of the bond offering memorandum).

²² \$60,215,000 was allocated towards acquisition and the infrastructure improvements of the SDSU Mission Valley site from the Series 2021B (taxable) systemwide revenue bonds (Appendix H of the bond offering memorandum).

²³ Contribution from campus and auxiliary reserves was obtained from the minutes of the “Joint meeting of the committees on Finance and Campus Planning, Buildings and Grounds” on January 28-29, 2020.

²⁴ Fees, Contingency, Services were grossed up by \$1,285,000 because of the total bonds issued in 2020 and 2021.

B. Stadium Construction

Sources		Uses ²⁵	
Bond Proceeds: Series 2020E ²⁶	\$214,940,000	Acquisition Cost	\$225,815,000
Bond Proceeds: Issuance Pending ²⁷	\$125,000,000	Site Development	\$17,378,000
		Design Fees, Plan Review, Permitting	\$15,922,020
		Campus Contract Management Services	\$14,953,590
		Contingencies and Escalation	\$32,223,138
		Fixtures, Furnishings, Moveable Equipment	\$3,708,000
		Capitalized Interest ²⁸	\$29,940,252
Total	\$339,940,000	Total	\$339,940,000

C. Combined

Sources		Uses	
Site Acquisition and Development	\$351,285,000	Site Acquisition and Development	\$351,285,000
Stadium Construction	\$339,940,000	Stadium Construction	\$339,940,000
Total	\$691,225,000	Total	\$691,225,000

²⁵ The total cost estimate (uses) for stadium construction was obtained from the minutes of the “Joint meeting of the committees on Finance and Campus Planning, Buildings and Grounds” on March 22-24, 2020.

²⁶ \$214,940,000 was allocated to fund construction of the stadium from the Series 2020E (taxable) systemwide revenue bonds (Appendix H of the bond offering memorandum).

²⁷ \$125,000,000 allocated to fund construction of the stadium from yet to be issued systemwide revenue bonds.

²⁸ Capitalized Interest was grossed up by \$4,940,000 because of the total bonds issued in 2020 to accommodate additional net financing costs, such as capitalized interest and costs of issuance.

Exhibit 3
Maturity Schedule for the CSU Systemwide Revenue Bonds

A. Series 2020E Bonds (Taxable)

Maturity (November 1)	Principal Amount	Interest Rate	Price	CUSIP (13077D)
2023	\$5,375,000	0.475%	100%	NB4
2024	\$5,405,000	0.685%	100%	NC2
2025	\$5,450,000	0.885%	100%	ND0
2026	\$5,505,000	1.138%	100%	NE8
2027	\$5,575,000	1.338%	100%	NF5
2028	\$5,655,000	1.490%	100%	NG3
2029	\$5,745,000	1.690%	100%	NH1
2030	\$5,845,000	1.740%	100%	NJ7
2051	\$302,180,000	2.897%	100%	NK4
2060	\$80,370,000	3.267%	100%	NH1
2060	\$38,905,000	2.967%	100%	NM0
Total	\$466,010,000			

B. 2021B Bonds (Taxable)²⁹

Maturity (November 1)	Principal Amount	Interest Rate	Price	CUSIP (13077D)
2022	\$4,010,000	0.196%	100%	QK1
2023	\$4,590,000	0.346%	100%	QL9
2024	\$37,220,000	0.563%	100%	QM7
2025	\$58,790,000	0.862%	100%	QN5
2026	\$58,275,000	1.142%	100%	QP0
2027	\$58,025,000	1.361%	100%	QQ8
2028	\$58,885,000	1.521%	100%	QR6
2029	\$59,830,000	1.674%	100%	QS4
2030	\$60,865,000	1.794%	100%	QT2
2031	\$59,380,000	1.854%	100%	QK1
2032	\$54,610,000	1.994%	100%	QL9
2033	\$53,960,000	2.144%	100%	QM7
2034	\$55,155,000	2.274%	100%	QN5
2035	\$54,100,000	2.374%	100%	QP0
2036	\$33,810,000	2.424%	100%	QQ8
2037	\$34,680,000	2.525%	100%	QR6
2038	\$29,985,000	2.625%	100%	QS4
2039	\$14,760,000	2.675%	100%	QT2
2041	\$144,940,000	2.795%	100%	QU9
2044	\$78,305,000	2.845%	100%	QV7
2052	\$325,450,000	2.939%	100%	RV6
2052	\$324,460,000	2.719%	100%	RW4
Total	\$1,664,085,000			

²⁹ The total amount of bonds issued under Series 2021B Bonds is \$1.6 billion. This offering includes \$60 million that will be used to fund a portion of SDSU Mission Valley. The offering memorandum doesn't offer a breakdown as all the uses of the financing are all comingled amongst the tranches.

Exhibit 4
Expense and Revenue Data for San Diego State University Athletics, 2010 - 2019

	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019
Sum of Excess Transfers Back	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Sum of Other Expenses	\$5,635,826	\$5,693,859	\$5,897,007	\$6,321,595	\$6,816,853	\$6,494,761	\$7,716,121	\$7,068,736	\$7,390,927	\$7,581,502
Sum of Medical	\$424,232	\$691,551	\$827,171	\$944,559	\$813,274	\$929,767	\$844,421	\$819,877	\$867,023	\$575,548
Sum of Competition Guarantees	\$594,240	\$757,666	\$1,100,097	\$1,173,118	\$856,233	\$1,257,733	\$987,944	\$886,076	\$955,316	\$1,606,836
Sum of Recruiting	\$531,034	\$419,641	\$459,622	\$536,224	\$525,717	\$596,500	\$579,815	\$596,713	\$684,266	\$675,789
Sum of Game Expenses and Travel	\$3,818,260	\$3,715,485	\$4,839,865	\$5,493,016	\$5,344,048	\$5,078,781	\$6,628,660	\$5,611,579	\$7,222,844	\$6,372,252
Sum of Coaches Compensation	\$6,614,688	\$7,860,939	\$8,421,907	\$9,175,084	\$9,307,221	\$9,766,098	\$9,868,942	\$10,600,147	\$10,478,285	\$7,121,121
Sum of Facilities and Equipment	\$2,524,946	\$4,862,762	\$4,504,544	\$5,265,594	\$5,892,886	\$12,748,151	\$11,277,022	\$7,707,772	\$7,851,373	\$11,066,930
Sum of Support and Admin Compensation w/Severance	\$6,928,255	\$6,559,722	\$6,724,043	\$7,172,794	\$8,202,022	\$8,996,712	\$9,254,442	\$9,704,639	\$10,674,786	\$11,201,033
Sum of Athletic Student Aid	\$5,558,171	\$5,492,606	\$6,242,998	\$6,767,339	\$7,305,139	\$7,739,406	\$8,128,168	\$8,574,313	\$8,808,212	\$9,178,163
Sum of Total Expenses	\$32,629,652	\$36,054,231	\$39,017,254	\$42,849,323	\$45,063,393	\$53,607,909	\$55,285,535	\$51,569,852	\$54,933,032	\$55,379,174
Sum of Other Revenue	\$1,023,453	\$2,043,532	\$1,703,384	\$1,197,034	\$1,320,373	\$1,435,826	\$1,741,802	\$1,710,334	\$1,709,211	\$1,334,993
Sum of Corporate Sponsorship, Advertising, Licensing	\$4,219,691	\$4,053,464	\$4,217,893	\$4,654,625	\$4,152,595	\$4,282,598	\$4,405,285	\$5,422,091	\$5,134,850	\$5,190,276
Sum of Donor Contributions	\$3,233,772	\$11,089,506	\$3,923,059	\$5,643,426	\$9,581,991	\$8,071,494	\$10,388,209	\$8,826,053	\$8,589,327	\$6,673,651
Sum of Competition Guarantees	\$384,803	\$1,106,773	\$1,440,300	\$982,649	\$1,414,200	\$1,246,000	\$1,423,000	\$651,500	\$456,500	\$5,000
Sum of NCAA/Conference Distributions, Media Rights, and Post-Season Football	\$3,711,758	\$4,826,895	\$4,884,353	\$3,803,828	\$5,236,740	\$5,207,163	\$6,459,217	\$5,712,785	\$5,630,354	\$5,709,359
Sum of Ticket Sales	\$3,042,365	\$3,941,409	\$4,955,141	\$5,350,541	\$6,768,575	\$4,793,777	\$5,850,716	\$5,809,058	\$9,149,380	\$6,596,027
Sum of Institutional/ Government Support	\$6,745,994	\$8,410,650	\$7,256,395	\$7,860,022	\$8,507,764	\$13,818,160	\$15,647,711	\$13,238,377	\$13,734,946	\$17,517,951
Sum of Student Fees	\$10,220,740	\$9,729,474	\$9,622,766	\$9,719,702	\$9,995,951	\$10,156,727	\$10,635,088	\$11,084,589	\$11,282,616	\$11,704,147
Sum of Total Revenues	\$32,582,576	\$45,201,703	\$38,003,291	\$39,211,827	\$46,978,189	\$49,011,745	\$56,551,028	\$52,454,787	\$55,687,184	\$54,731,404

Exhibit 5
Summary of Estimated Financing Cost for both Project Components³⁰

Financing Cost Summary for Land Development and Acquisition

Estimated Project Cost	\$351,285,000
Amount Financed	\$311,285,000
Annual Interest Rate (Weighted Coupon Rate)	2.85%
Loan Period in Years	40
Start Date of Debt Issuance	1/1/2021
Monthly Payment (estimate)	\$1,087,611
Annual Financing Cost (estimate)	\$13,051,332
Number of Payments	480
Total Interest	\$210,768,295
Total Cost of Debt	\$522,053,295

Financing Cost Summary for Stadium Construction

Estimated Project Cost	\$339,940,000
Amount Financed	\$339,940,000
Annual Interest Rate (Weighted Coupon Rate)	2.85%
Loan Period in Years	30
Start Date of Debt Issuance	1/1/2021
Monthly Payment (estimate)	\$1,405,487
Annual Financing Cost (estimate)	\$16,865,844
Number of Payments	360
Total Interest	\$166,164,910
Total Cost of Debt	\$506,104,910

³⁰ The tables have made assumptions about: (i) annual interest rate, (ii) loan period for each project component, and (iii) start date for debt issuance.

Exhibit 6
Financial Performance Information for US Consumer Sectors
(Five-Year Averages, 2016 – 2020)

	Consumer Discretionary Sector	Real Estate Sector
Revenue Growth Rate (%)	2.6	6.7
EPS Growth Rate (%)	7.6	0.3
Gross Margin (%)	32.0	51.2
Operating Margin (%)	7.8	21.7
Pre-tax Margin (%)	6.3	16.0
Net Margin (%)	7.2	11.6

Consumer Discretionary Sector

Contains companies that provide products and services directly to the consumers, and their purchasing habits are non-cyclical in nature (discretionary). Includes companies that manufacture and distribute Household durable goods, apparel, home electronic devices, leisure equipment, and automotive and related parts. The services segment includes hotels, restaurants, retail/e-retail, passenger transportation, and other leisure facilities. Also includes media companies that engage in entertainment content creation and traditional advertisement. Excludes web-portal/hosts that generate revenue through advertisement, which are classified under Technology - Consumer Digital Services.

Real Estate Sector

Consists of companies engaged in real estate investment, development, and other real estate related services. Also includes Equity REITs. Mortgage REITs are classified under Financials Industry. This Sector includes the following Subsectors: Real Estate Holding and Development, Real Estate Services, Diversified REITs, Health Care REITs, Hotel and Lodging REITs, Industrial REITs, Infrastructure REITs, Office REITs, Residential REITs, Retail REITs, Storage REITs, Timber REITs, and Other Specialty REITs.

Source: MERGENT, Report Date: August 9, 2021.