

Solving Quantitative Problems in Finance: A Tool for Unlimited Practice

Howard Keen

Students are continuously told that the way to learn finance is to “do finance” which means to practice solving quantitative problems. For this recommendation to work, however, it requires students to have a tool that allows them ample opportunities to practice. This paper presents such a tool and one that instructors can easily create as well as customize to their own way of presenting topics. Moreover, with pressure to keep costs for students down, this tool requires no subscription to any commercially available product. Although this tool has been developed to include many standard finance topics, this paper illustrates the use of the tool for various aspects of the “Time Value of Money” topic. The paper includes a description of how the tool has been applied in an introductory corporate finance course.

INTRODUCTION

Students of Finance are repeatedly told that one “learns Finance by doing Finance” which suggests that practice is critical to learning how to solve quantitative problems in Finance. A big challenge faced by students, however, is that opportunities to practice can be somewhat limited. While it’s true that there are online homework tools available from various commercial publishers such as Pearson’s MyFinanceLab© and McGraw-Hill’s Connect©, they are still limited in scope based on close ties to an underlying textbook or lack of an unlimited number of problems that an individual student can work.

Not all instructors use such tools in their classes nor are willing to offer unlimited attempts for credit. At the same time, publisher-provided tools may not cover topics covered in a course or more frequently may present topics in a way that is different from an individual instructor’s approach.

This paper presents examples of how to develop a practice problem tool that is customized to the way in which the introductory corporate finance course is taught in a large, state-supported university. The tool consists of a variety of spreadsheets that both offers students literally unlimited practice at solving for selected measures and at the same time, offers a framework that enables students to better see the link between “word problems” and the structure of the components necessary to solve the problem.

The spreadsheets are set up to enable students to supply the inputs, attempt to solve for the indicated variables(s) using whatever non-Excel devices that are permitted such as scientific calculators or calculators containing financial functions, and then be able to check their answers against the correct answers that will appear in the spreadsheet. Although the tool was developed to cover a fairly large number of topics, only one topic is presented in the paper to give the reader some insight as to how the tool can be used.

DEVELOPMENT OF THE TOOL

It is perhaps helpful to understand the context within which the tool was developed, which was for the introductory

corporate finance course required of all majors at the Fox School of Business and Management at Temple University. This is a course for which a sizeable portion of students find the quantitative demands of the course to be challenging. Because it is the only required Finance course in the core curriculum--there are no separate courses for majors and non-majors--the goal for the course is to provide a grounding sufficient for Finance majors while not making it unnecessarily difficult for non-majors. To this end, modifications have been made to the course over time such as dropping coverage of topics like semi-annual coupon bonds, multi-stage dividend growth, multiple IRRs, and mutually exclusive capital budgeting projects. It’s important to keep in mind that the tool can be easily modified to delete or add topics as the instructor sees fit.

TOPICS COVERED

The following is a list of quantitative topics for which practice problem spreadsheets have been developed. It’s important to keep in mind that the specific topics and structure of the problems are based on the approach used in the course for which the author is the coordinator and are intended to be illustrative only. Individual instructors would be able to customize the tool to conform to the way in which they teach a particular topic.

- Time value of money (lump sums & multiple cash flows)
- Compound vs. simple interest
- Fixed-payment loans
- Retirement planning
- Fisher Effect
- Bond prices and yields
- Annualized holding-period returns
- Reward - risk ratio
- Required return on equity (CAPM)
- Mean - Variance with Normal Distribution
- Stock pricing
- Impact of changes in expenses on net income and cash
- Cash Flow Identity components

- Break-even EBIT
- Financial ratios
- ROE per DuPont framework
- Annual straight-line depreciation
- Book value
- Cash flow from salvage
- Cost of capital (WACC)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)

PRACTICE PROBLEMS SPREADSHEETS

While spreadsheets have been developed for the full foregoing list of topics, we will select only one of those topics—Time Value of Money (TVM) --to illustrate the use of this tool. While not included in the spreadsheets shown here, spreadsheets for all topics contain the following instructions: Make up input values in the non-yellow cells then work the problem outside of Excel. After you finish solving the problem, hit “Enter” to see if you solved the problem correctly.

The TVM problems consist of solving for the following: (1) Each of the four variables in the lump-sum TVM formulas, (2) Compound versus simple interest, (3) Present Value (PV) and Future Value (FV) of uneven multiple cash flows, (4) PV and FV of an annuity, (5) PV of an annuity with a delayed start, (6) Fixed-payment mortgage loans, and (7) Retirement planning.

We begin with the problem of solving for each of the four variables in the lump-sum TVM formulas as illustrated in Figure 1.

Figure 1: Lump Sum TVM Demonstration

	(A)	(B)	(C)	(D)
1. TIME VALUE OF MONEY: LUMP SUMS				
2. PV	\$ 179.25	\$ 600.00	\$ 1,354.00	\$ 490.30
3. FV	\$ 750.00	\$ 3,341.80	\$ 415.00	\$ 1,000.00
4. r	7%	10%	10%	10%
5. n	5	15	15	16.37
6. PROBLEM				
7. (A) If you want to have \$100,000 in 10 years, how much must you invest today?				
8. (B) If you want to have \$100,000 in 10 years, how much must you invest today?				
9. (C) If you want to have \$100,000 in 10 years, how much must you invest today?				
10. (D) If you want to have \$100,000 in 10 years, how much must you invest today?				

The problem is stated in Rows 8 - 11 where cell references are linked to the problem's set of inputs or arguments. Students would enter as inputs three required arguments in the lump-sum PV formula--the FV, discount rate, and number of periods in cells B3 through B5, respectively. Students would then be expected to solve for the PV in cell B2 using either a scientific or financial calculator. Students would then be able to compare their answer independently of the spreadsheet with the correct answer that appears in the yellow cell, B2. Similar use of this specific

spreadsheet would provide practice in finding solutions for the FV, discount rate and number of periods in columns C through E, respectively. Two aspects of this are noteworthy: students can literally practice the calculations an unlimited number of times--limited only by the number of sets of different inputs or arguments that they choose to enter--and they can actively participate in setting up the problem by being required to provide those inputs. The latter aspect can possibly aid students' understanding of the problem by giving them a broader perspective of its structure.

We turn next to a problem comparing compound to simple interest earned over both a multi-year period and for a single year which is illustrated in Figure 2.

Figure 2: Comparison of Simple and Compound Interest.

	(A)	(B)	(C)	(D)
1. COMPOUND VS. SIMPLE INTEREST				
2. ANNUAL RATE	8.00%			
3. AMOUNT TODAY	\$1000.00			
4. PERIODS	10			
5. SIMPLE INTEREST FOR FULL PERIOD	\$768.00			
6. COMPOUND INTEREST FOR FULL PERIOD	\$1,214.54			
7. COMPOUND VS. SIMPLE INTEREST FOR FULL PERIOD	\$446.54			
8. SIMPLE INTEREST FOR YEAR WITHIN FULL PERIOD	\$80.00			
9. COMPOUND INTEREST FOR YEAR WITHIN FULL PERIOD	\$101.56			
10. COMPOUND VS. SIMPLE INTEREST FOR YEAR WITHIN FULL PERIOD	\$21.56			

Students would provide the inputs--the annual rate, starting amount, and the number of years in cells B2 through B4, respectively. Students would then be expected to solve for the simple and compound interest for the full period and the resulting difference--cells B6 through B8. Students then select an individual year within the full period in cell B5, such as year 7 in the example illustrated, and then would solve for the simple and compound interest and the resulting difference for year 7 alone in cells B9 through B11, respectively. For each of the calculations, students would be able to compare the answers they got independently from the spreadsheet with the correct answers that appear in the yellow cells.

Problems involving the TVM of multiple cash flows are illustrated in Figures 3, 4, and 5. In particular, five types of problems are illustrated here: Figure 3 illustrates problems involving the PV and FV of an uneven stream of multiple cash flows; the PV and FV of an annuity; and a perpetuity with a delayed first payment. Figure 4 presents a retirement planning application, and a fixed-payment mortgage loan application is illustrated in Figure 5.

For the problems involving uneven multiple cash flows in Figure 3, students supply cash flows for today and then one and two years out in cells B15 through B17, respectively, along with an annual interest rate in cell C15. After solving for the PV and FV of the uneven stream independently of the spreadsheet, students can then compare their answers to those in cells B22 and B23. Problems involving annuities are covered in columns E and F. Students input the payment,

number of years and the annual rate in cells F14 through F16, respectively, solve for either the FV or PV independent of the spreadsheet, and then compare answers with those in cells F18 and F19.

The next problem involving multiple cash flows posits a perpetuity with a delayed first payment. This problem is covered in our introductory corporate financial management class to provide a better understanding of the timing of values derived from the formulas of the PV of an annuity and PV of a perpetuity and to provide practice in combining the PV of multiple cash flows and the PV of a lump sum. Students provide the perpetuity amount, the year of the first payment and the annual rate in cells L6 through L8, respectively, then independent of the spreadsheet, solve for the value of the perpetuity one year before the first payment (in cell L9) as well as for the value today (cell L10).

Figure 3: Demonstration of Uneven Cash Flows.

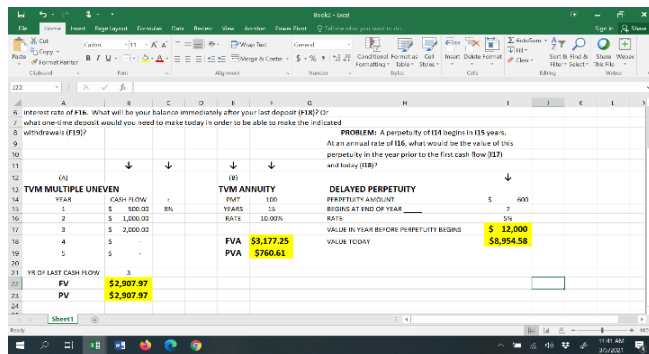
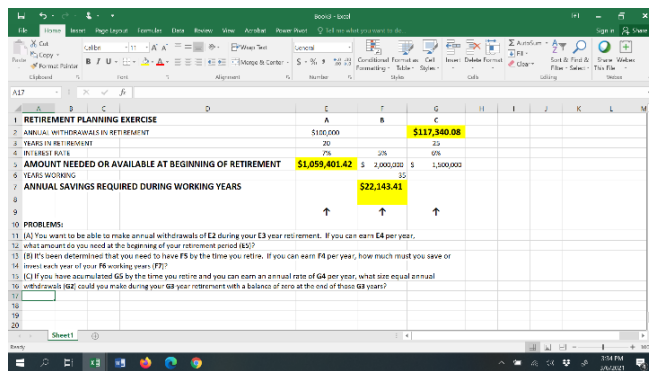


Figure 4 presents two very common applications of multiple TVM functions. Columns E through G, respectively, illustrate problems involving the amount needed at the beginning of retirement, the annual savings required during working years, and the amount available for annual withdrawals during the retirement period.

Figure 4: Annuity Exercises through Retirement Planning.

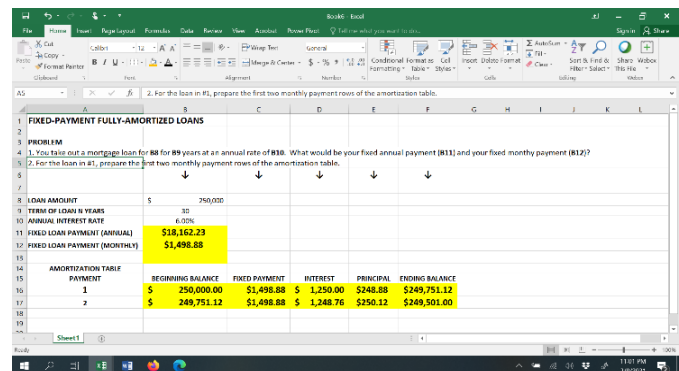


Again, students input arguments in the non-yellow cells, work the solutions independent of the spreadsheet, and check the correctness of their answers with those in the yellow cells.

As with the problems discussed above, students can literally practice this problem an unlimited number of times--limited only by the inputs or arguments that they choose--and they can actively participate in setting up the problem through the opportunity to provide the inputs.

The final set of problems involves fixed-payment fully amortized loans as illustrated in Figure 5. Students would enter values for the loan amount, loan term, and annual interest rate in cell B8 through B10, respectively, solve for the fixed payments independently of Excel, and can then check their solutions for both annual and monthly fixed payments in cells B11 and B12 respectively. Additionally, there is the opportunity to solve for the first two payment rows of the loan amortization table for monthly payments in row 16 and 17, respectively. Additionally, there is the opportunity to solve for the first two payment rows of the loan amortization table for monthly-payment loans in rows 16 and 17, respectively.

Figure 5: Demonstration of Amortized Loans.



ISSUES WITH THE TOOL

Two issues were considered regarding the tool--one involving possible grade inflation from students' use of the tool and the other involving possible ways to reveal the solutions.

In the course for which the author is both an instructor and the course coordinator, two of the three types of homework assignments involve quantitative questions, the solutions to which students could use the tool to solve the problems and thereby receive credit for the assignments. Of course, prior to the availability of the tool described in this paper, students could have built their own spreadsheets to use in solving quantitative homework problems but there has never been any indication that this was done. After some thought and discussion between the author and Temple's Finance Department Chair, it was decided that with the overall homework component counting for 25 percent of the course grade, the potential benefit from students' use of the tool far outweighed any concerns that the tool might be used to unduly inflate scores on assigned homework and thereby course grades.

The second issue deals with just how the solutions might be revealed in the spreadsheets. As described above and as is evident in the Figures, solution values in the yellow cells are not hidden and will appear as soon as students hit “enter” after inserting the final input value. This is the reason that students are instructed to work the problem outside of Excel before hitting “enter”. Two alternatives will be described here, and instructors might surely be able to think of other ways to prevent the solution values from appearing immediately after students hit “enter”.

One alternative would be to leave the yellow solution cells in the worksheets presented in the Figures above (Worksheet 1) empty or blank and then have a duplicate worksheet (Worksheet 2) which is linked via formulas and would then have the solutions appear when the final input is entered in Worksheet 1. With this alternative, students would not be able to see the solutions upon entering the final input in Worksheet 1 and would have to go to Worksheet 2 to check their work.

Unlike the alternative with Worksheets 1 and 2, a second method involves the use of only one worksheet, like those in the Figures above, but does require some additional effort from students. Before entering inputs, students would select one or more solution cells, then click on the “Number Format” icon at the lower right of the “Number” section in the “Home”. Students would then select the “Custom” format and either select or type in if needed, three semicolons (;;;) which will cause the selected cells to now appear blank. After working the problem, students then select the appropriate format – Currency, Percentage, or Number from the “Number Format” options and the solution values will then appear.

USE OF TOOL TO DATE

Development of the tool described above is relatively recent, so we do not yet have a great deal of experience with its use in the classroom. One of the challenges we face in our Introductory Corporate Finance course is getting students to take advantage of any of the learning aid tools available to them. The tool presented in this paper is no exception and to encourage student use, the following modifications were made: (1) The tool which was originally named “Practice Problem Spreadsheets” was renamed “Practice Tests Spreadsheet”. The new name is certainly not a misnomer, as a very high percentage of the problems provided with the tool are included in a given version of an exam. (2) Students were offered extra credit of up to 2 points onto their course average for submitting one small Excel file per exam with their scores from their initial attempt at the practice test problems. This was never intended to be a very precise measure of how often

or how successfully students used the tool but was merely designed to provide an incentive for its use.

ASSESSING THE TOOL GOING FORWARD

The end goal for the tool is to help students score higher on quantitative exam questions. As a result, any assessment of the value of the tool needs to have this outcome as its focus. Our plans going forward are to explore ways to determine the frequency of use of the tool, and then to compare performance on quantitative exam questions with that frequency of use. While this is an area for further research, we have every reason to expect a strong positive correlation between use of the tool and performance on the quantitative portion of exams.

CONCLUSION

In addition to providing the opportunity for unlimited practice in solving quantitative problems, the tool presented in this paper provides students with a structure that illustrates how the appropriate formula used for a quantitative “word problem” can be viewed or identified by either the variable to be solved for or the inputs or arguments required to solve the problem. It is hoped that enabling students to supply the inputs (arguments) will give them a greater understanding of the totality of the framework in use rather than just focusing on coming up with the correct answer.

Regarding instructors’ use of the tool, no two instructors necessarily present a given topic in the same way. The specifics of the spreadsheets presented in this paper reflect the unique way in which topics are presented in Temple University’s (Introductory) Financial Management course. Although the specific spreadsheets presented in this paper may not reflect precisely how other instructors might present the material, what is provided here can serve as a template to which other instructors can make modifications based on their approach to the subject.

In short, the spreadsheets presented in this paper can help students practice solving quantitative finance problems; they also allow students to develop a broader appreciation of the framework within which a problem is presented. In addition, the framework presented here can also help instructors develop a tool unique to their approach to covering a given topic in a corporate finance course.

Note: The full Excel file containing spreadsheets for all topics listed in the “Topics Covered” section can be obtained by contacting the author.

Howard Keen is an Assistant Professor of Instruction at Temple University.