Examining the Financial Mathematics in Moneychimp.com (Preliminary Version)
Floyd Vest, July 2015

Moneychimp.com has dozens of investing concepts, formulas, and calculators, and material from financial mathematics. We want to verify that we and our students know some of the financial mathematics which moneychimp uses. We will examine various hot-links on the site. If you have trouble finding a topic, Click Search at the top of moneychimp.

Teachers’ Notes: This article covers hundreds of topics from moneychimp.com. To write out answers, definitions, derivations, calculations, formulas, etc., and write complete sentences would fill many handwritten pages, and print out pages. For many people, to study a topic seriously is aided by a print out of the topic.

In this article, many topics are reviewed by a series of comments and questions, followed by “Report.” To write the Reports seriously requires many pages. Much of the material is covered in this financial mathematics course and thus this article could be viewed as a review and extension. Related articles in this course are frequently cited in the discussions. Students may want to do Report without reviewing the articles.

The teacher and/or student can design their own approach to examining this article and moneychimp.com. It may be best to place this article at the end of this course.

It is unusual to see derivations and proofs of formulas in a financial investment site. This makes you wonder who moneychimp is. To learn more about moneychimp, on the bottom of main page, Click about us. Click The Motley Fool and More Articles. There are over 50 articles by Bill Barker. At the top under Home, Click About the Motley Fool and see a picture of their office, and see a picture of a couple motley fools. Read on and you may find out who moneychimp is.

Moneychimp gave us permission to use their website. Is there some way hits on their website helps them make money? See some of the advertisements in moneychimp.com. Do you think some math and science teachers put up websites, which give instruction, and get a lot of hits and make money from advertisements?

Example 1. Get moneychimp.com. As an example, find and Click Risky Retirement Calculator near the top left. Read and explain the Retirement Planner which they present. Read and interpret the comments below the frame. Don’t change the calculator input. Click Calculate. You will see Results listing periods of years, and number of years money lasts. You notice that for 1966 to 1996, the money lasts 30 years. The goal was 40 years. Print out.

Based on the information given, write a formula for moneychimp’s yearly end of year retirement balance for 1966 and 1967. Define your variables. You can get annual S&P 500 stock returns in improved CGAR calculator at the right side of moneychimp. Write down returns. You can get annual inflation rates from Inflation Calculator at the bottom middle of moneychimp. Write down inflation for 1966 and 1967. Insert the data into your formula. Report the Balance at the end of years 1966 and 1967. For the Balance at end of 1966, we got $915,398.40. For the Balance at end of 1967, we got $1,015,041.90. What inflation rate did you use to calculate the withdrawal at the beginning of 1967? See the Unit 3 in this course on
“Long Term Financial Planning” for articles on the survival of retirement funds. How is moneychimp’s 60/40 portfolio different from those commonly used? Report.

Example 2. On the main page, Click stock valuation next to the graph. You get “Stock Valuation based on Earnings.” Print it out. Read and interpret. If you have trouble with his commentary, see the article in this course “Stock Pricing Formulas” and develop you own examples or general formulas for the three cases. If you have difficulty with sums of different kinds of geometric series, see an algebra book or see geometric series under How Finance Works; (in the middle of main page) and get the formulas and do their derivations. It would be nice if you could derive and explain your own general formulas. Report.

Example 3. Click Investment Return Calculator, at the bottom middle of main page, and you see “Investment Performance Calculator” with complications of Total Additions, Total Withdrawals, and Total Dividends. Try their Example 2 and explain. For more precise calculations, see the article in this course “Time Weighted Return versus Dollar Weighted Return.” Make up and do a more precise example. Report.

Example 4. Click Making Stock Market Predictions near the top of main page. Click Calculate and Re-Calculate on his example and print out. Make and explain a formula which approximates his results. Maybe you can find other information and formulas on this topic. Report.

Example 5. Click Stock Market Randomness (isn’t normal) near the top left of main page. Change the second box to Yearly and 3SD, click Calculate and get “Results” and “Worst Results”, print it out and read it. Unfortunately, the calculator is stuck on 1964 through 2005. For more information, see in this course “The S&P 500 Index of Stocks and Three Sigma Events,” “Comparing Measures of Downside Risks,” and “Standard Deviation as a Measure of Risk for a Mutual Fund.” Were there any calendar year three sigma events? Report.

Example 6. At the top left of main page, click Why index investing makes sense … . Read the “Why Index?” page. Click on Next Page. You get a table of $100,000 invested with a list of Fund Expenses for Index Fund and Active “Managed” Fund. Click Calculate and click on the x.011. Print out the table. How are the ratios entered into calculating the Cost Adjusted rate of return? Discuss the three ratios.

Below the table, read about Transaction costs. For Estimated transaction costs, let $X = .011$ and define $X$ in terms of Transaction costs as percent of total value of NAVs, and Turnover rate as percent of total value of NAVs.

Click on Next Page. Why is it that managed mutual funds, that invest in value stocks, do not do as well as value stocks themselves? See Fama and French, and Bogle. What is style drift? Discuss. What does TSM mean? What is VTSMX and its Turnover rate? How are value stocks defined?

See in this course, “Bogle’s Arithmetic to Compare Expenses and Performance of Actively Managed Funds and Index Funds,” “The Remarkable History of Returns on Small Cap Stocks,” “RAFI, Fundamental Indexing,” and “Valuation Formulas for Stocks.”

Click Next Page and read about Warren Buffett. How do you compare? Click Warren Buffett to read about Buffett’s earning history.
Click More. Click beat their index at the bottom of “index funds and indexes,” and learn something amazing.

In the upper right boxes, Click Size, Growth, Value, and learn about the S&P 500, Russell 1000, Russell 2000 and Wilshire 5000. How many stocks are there in the exchanges in the U. S.? Learn about Value stocks and Growth stocks, Mid Cap Stocks (S&P 400), enhanced indexes, and Index Portfolio Turnover. You can click ETFs and learn about these popular funds. What is SPY? Report.

In the upper right box, Click Portfolio Guideline (1). Read. You see a table for 1927 through 2005, with a box for returns Adjusted for inflation. Give the formula for the Adjusted for inflation, real rate of return y, with nominal rate r and inflation rate I. Turn off Adjusted for inflation. Press Calculate. Make note of the various types of stocks and returns. Continue to read. For the next table, turn off Adjusted for inflation. Click Calculate. Interpret the table. Report.

Click Portfolio Guidelines (2) in the upper right box. Read. Click Next Page. Choose and describe four funds for the graph. Report. For a Mid Cap Fund, go to Google and type in Vanguard S&P Mid Cap 400 ETF, or read back through moneychimp. Type in Vanguard FTSE Emerging Market ETF. For each, look at its top ten holdings, Expense ratio, Price against NAV, Returns. You can buy Vanguard ETFs without a commission if bought from Vanguard. The listed Vanguard ETF VBR (VBR) for small value stocks has a .09% Expense ratio. It uses CRSP enhanced index from the Wharton School of Business, University Pennsylvania. Report.

Example 7. Back on the main page, Click Roth IRA Calculator on the right side of the page. The calculator uses Inflation adjusted returns. They suggest 5%. Put in “your age” 30, current balance $0. The page says nothing about deposits increasing with the rate inflation, or withdrawals increasing at a rate of inflation. For an estimate, from their data, put in your calculator: FV = 1,052,886; N = 35; Pmt = -6000; and calculate I%. This gives I% = 8.08% = nominal rate of return r. Solve for the real rate of return with I = 3% per year inflation, and get real rate = 4.9%. You could calculate more precisely. For rate of return during retirement withdrawals, put in Pmt = 86,597; PV = -1,052,866; N = 30. This give I% = 7.20% and the real rate of return is 4.1%. For real rate of return, see in this course, “Varying Annuities at the Real Rate of Return” and “The Mathematics of Financial and Social Responsibility.”

For an article on Roth IRA, see in this course, “Does T. M. Need a Roth?”. This article assumes that tax equivalent amounts are invested in both the Roth IRA and the traditional IRA. But, this is not required. Discuss the advantages of a Roth IRA over a Traditional IRA.

If you want to increase annual retirement withdrawals at I = 3%, what would be the first year withdrawal with the real rate of return of 5%? What would be the nominal rate of return? Report.

Example 8. Click stock valuation at the top of moneychimp. Give their answer to “How Much are Stocks Worth?” Read about their discounted cash flow model. Write down all their observations. Click Next Page. Click future value mode. Use their calculator to calculate the earnings of $21.59 for the 10th year. Check their answer and explain. What is the “date-time” of the $10.00? Click present value mode. Check their figures. What is the “date-time” of the $7.60? For their discussion of the sum of infinitely many green bars to get $155.40, see if you
can get their number. Read “How Long is Forever?” Click Calculate. See if you can get their number.

Click free cash flow and read. We have already done a separate article under Stock Valuation based on Earnings in Example 2.

Click Next Page to “Price to Earnings Ratio”. Try the Fair P/E Ratio calculator. Put in 0%, 10 years, 0%, 11% and Calculate to get their $9.09. Interpret. See in this course” “Stock Pricing Models,” and “Valuation Formulas for Stocks.” Report.

Click Next Page. Read “Price to Sales Ratio”. They define P/S = P / (annual sales per share). They give the formula P/S = P/E × (profit margin). Click profit margin and get the definition, formula. Prove their formula for P/S.

Click Next Page. Read “PEG Ratio”. Try their Calculator with their numbers. Explain. Write down the numbers. To check, Click cash flow calculator. Enter their numbers and $1 for Price. Calculate. Explain. On the bottom of the page they give the definition of PEG. Using this formula and the formula from the top of the page, prove that PEG = 1 for a company that is fairly priced.

Click Next Page. Read “Graham Style Formula.” Go to Make a Formula and get P/E = 9 + 0 × G. Click Carry to top calculator, and get G = 0%, P/E = 9 + 0 × G, Fair P/E Ratio: Graham Formula: 9, Exact answer (DEF): 9.09. Interpret.

Click on Next Page and read “Dividend Discount Model.” Click calculator. Enter Dividend of $1.80 per year. Growth rate of Dividend: 3%. For the next 15 years. Before leveling off at 0%. Discount rate of 5%. Click Calculate. You get Stock Value = $50.21. See the article in this course “High Dividend Yields on Stocks and Low Interest Rates on CDs and Bonds” for a Dividend discount stock pricing model, Reinvestment of dividends, Internal rate of return, Income taxes, Net present value, and The zero growth model.

In the upper right box, Click on ”CAPM calculator.” Put in Beta = .61 for Verizon Stocks (VZ). Press Calculate. Calculate by hand and interpret. See the article in this course: “Measures of Risk and Performance for a Mutual Fund: Beta, Alpha, and Sharpe Ratio.”

On the main page of moneychimp, Click Financial Statements. Learn as much as you want. Informed stock investors gather fundamentals of the company from financial statements, and then use the fundamentals to conduct their financial analysis. List some of the fundamentals and see if you can find them in the financial statements. Report.

Example 9. On lower left of main page, Click volatility basics. This requires Java. Read the pages and note the surprises. Experiment with the Monte Carlo Calculators. See the articles in this course under Unit 3, “Long Term Financial Planning” for tests of survivability of retirement funds for 30 years, and the sequencing effect. Report.

Example 10. On the lower left of main page, Click Modern Portfolio Theory and work your way through the pages. Summarize the major points of each. See the articles in this course on standard deviation, covariance, Sharpe Ratio, Beta, Alpha, and R-Squared. Note the topics on the upper right of the page. Report.
Example 11. On the main page, Click How Finance Works: formulas ... , near the graph. Look over the mostly familiar topics listed in the upper right. You may want to examine the moneychimp’s concepts and formulas, and see how they are treated. Click interactive calculators and work your way through examining the different calculator pages. You can Click formulas and examine their formulas. You could go back and digest their commentary for selected topics and use both formulas and calculators. See the many articles in this course on these topics. Report.

Example 12. You might be interested in payroll deductions. On the right of main page, Click Social Security Contributions. Note the terminology and rates. Put in Salary $30,000 for Employee and calculate. Do it also for Self Employed. Note the employer’s tax deduction on tax return. Click More. You see a list of topics, some of which you many want to study. Report.


Example 14. Click January effect in the middle of main page. Click which months are worst in the stock market. Summarize. What does” from 1950 to 2014” mean? You never know until you check. Which months have a negative average monthly return? How do Jan. and Dec. compare? What about the January Effect? Are the monthly returns annualized or actual? Note the average monthly return for Dec. of 1.59%. What would you guess they mean by “average”? What do you think the best month was? What do you think the worst month was? See the article in the course about the S&P 500 and three sigma events. For annual total returns of the S&P 500, Click Improved CAGR Calculator, on right of main page, which gives S&P returns (including dividends). Report.

Example 15. On the upper left of main page, Click stock market randomness. In the upper right box, Click Long Term Risk, for “Risk and Your Time Horizon.” Read the whole page. How many 10 year periods lost money? How many 15 year periods? What years? How many one calendar year periods lost money? Have there been recent 10 calendar year periods that lost money? What are some of the worst one year losses and their dates, for 10 year losses and their dates? Report.

Adjusted for inflation, report how many 15 year periods had a loss? How many 20 year periods had a loss? How many 10 year periods? What happens for people who are doing annual withdrawals adjusted for inflation from a S&P 500 stock account? What is a bad recent period to start this retirement withdrawal program? See if you can locate the stagflation period with high inflation and low to moderate returns from stocks. What were some of the inflation rates? What were some of the inflation rates around the period of World War II? Were there any one calendar year periods below three sigma? See the article in this course “The S&P 500 Index of Stocks and Three Sigma Events.” Summarize moneychimp’s instructional commentary. Report.

Example 16. Click on Crashes and Recovery in the upper right box to get “Stock Market Crash and Recovery.” Click Calculate, Calculate. Read the whole page. Notice the recent terrible loss of -37.2% in 2008. For the next table, put in a 5 year horizon, and get the annualized return for 2009 to 2013. Report. Click total return and get 128.7%. Interpret this. Check it
against annualized. For 2009 to 2013, click annualized and adjusted for inflation. Calculate average inflation $I$. What was the average rate of return from 2008 to 2013? Report.

Example 17. In the upper right box, Click on MPT, VaR to get “Modern Portfolio Theory.” Read the page. Report. What does moneychimp say about a random normal model (VaR)? See the articles in this course about VaR and alternative models, including “Investment Portfolio Design to Optimize Performance and Minimize Risk”, which compares the customary MVO(CVaR) method and the M-CVaRp(CvARp) methods for optimization.

Example 18. Click Next Page to get “Beating the Market.” Read and summarize. One of the portfolios grew $1 to $16.045 in 20 years. What was the annual rate of return? What did moneychimp say about some reported financial successes? Report.

Example 19. Back on the main page, Click How finance works, then Geometric Series. Read and check moneychimp’s derivation of the sum of a geometric series. Report. How does this compare to the treatment in an algebra book? What would you call this type of proof? See articles at the beginning of this course in Unit 1: “Mathematics of Finance” for three different types of “proofs” of this formula. Among several, see “Derivations with Recursive Equations in Financial Mathematics,” and “Mathematical Induction in Financial Mathematics.”

Example 20. Click Gross Domestic Product in the upper right. As reported June 24, 2015, the GDP decreased. A healthy economy shows an annualized 3% increase. Guess what they mean by Real GDP. Read as much as you want. Click Gross Domestic Product in the middle of the page and learn an economics lesson. Click Next Page to see who pays taxes. Click Next Page until you get “inflation calculator and buying power calculator.” Examine and Report. See some articles in this course including “Using USInflationCalculator.com,” “The Consumer Price Index and What Does It mean?”, and “Living and Investing with Inflation.” Report.

Example 21. Click The Rule of 72 at bottom of main page, which you already know and for which you probably know the proof. Play around as much as interest you. Click Why Does It Work? Did you know their proof? Report.

Example 22. Click mortgage in the middle of the main page and review a lesson on the Debt owed (the pay-off) for a mortgage with annual payments. See articles in this course: “The Mathematics of Refinancing,” and “The Mathematics of Amortization Schedules on the TI 83.” Report.

Example 23. Click Federal Tax Rate on the right side of main page, and learn the basics of how Federal Income Taxes are calculated and Federal Tax Brackets. Qualified stock dividends are taxed at the Capital Gains rate. What is the tax rate on dividends for those in the 0% and 10% bracket, for the 25% to 35% brackets? What is the maximum taxable income for qualifying for the 0% tax rate on qualified dividends? Report.

Example 24. Click Credit Cards at top center of main page, and put in monthly payment 0. What is the minimum payment? What is the number of years to pay-off? How does the Total Interest Paid compare to the Current Debt (This may be the cost of what they purchased.) Do you think the minimum payment is a constant? Could you build an amortization schedule, or calculate from formulas the time to pay-off, the interest paid, and the payments for successive months? How do they figure the minimum monthly payment? How would you estimate the
monthly interest rate? For the monthly payment of $16, how much is interest, and by how much is the debt reduced? Give a guess. Report.

Example 25. Click Savings Calculator… on the top center of main page. Click Calculate. Report. Change to 10%, Calculate, Report. Change to 50 years from age 20 to age 70. Calculate, Report. Use a formula to verify. Tell your friends how to make a million dollars. People should be multimillionaires by the time they are age 70. Calculate how much would it cost for you to retire at age 70? Make any assumptions you wish. Report.

Example 26. Click compound interest in the middle of main page. In the upper right, Click More Compounding. Maybe you haven’t seen Continuous Compound Interest lately. Write out and explain moneychimp’s derivation and give his formula for Continuous Compound Interest. Write a computer program that shows \[ \lim_{m \to \infty} \left( 1 + \frac{1}{m} \right)^m = e \]. Put a Pause in the program so you can watch the convergence. The sequence converges very rapidly.

Example 27. Click Next Page until you get to “Interest on Composite Investments.” Read the page and derive their equation. Use a Solver to solve their equation: 
\[ 3000(1 + r)^{-5} + 4000(1 + r)^{-7} = 2000 \]. See the article in this course “Solving Annuity Formulas for Interest Rate” for an iterative routine. Report.

Example 28. Click Bond Yield in the middle of main page by the graph. Read. Notice that the type of bond they are discussing is not the usual semiannual coupon bond. Why? Follow their discussion. Define \( r \). Define \( B \). What do they mean by “Equation 1 (also Equation 2) can’t be solved exactly?” Is this, in a way, wrong? Why? Express Equation 2 as the sum of two formulas. Solve Equation 2 for \( r \) by using your TI 83 TVM Solver or some other. Try their popup calculator. Define in general their term “current yield”. Change Formula 2 to make examples which illustrate their discussion of “Bonds Selling At …”. Change Formula 2 to illustrate that “bond prices and yields move in opposite directions.” Report. See the many articles in this course on bonds in Unit 4:” Investing in Bonds and Stocks.”

Example 29. Click present value under How Finance Works in the middle of main page. Read. Derive their Formula 2. Derive a formula for \( Y \). What do they mean by “ROR”, “CAGR?” Give your favorite approach to explaining present value (PV). Report. When you see an ad for “8% return on an annuity,” Click on it. Discuss it.

Side Bar Notes:

Negative yields. A number of European bonds have had negative yields recently. “But in periods of deflation, even if you earn 0% or less, you still come out ahead.” (Kiplinger’s Personal Finance, 8/2015, p. 14) Discuss why Europe has negative bond yields. Explain what they mean by yields. For Formula 2 under Bond Yield, give an example of how you could get a 0% yield (ytm). How could you get a -1% ytm?

Is it ethical for a company to terminate its pension? “The lump sum alternative is calculated to be the present value of those future monthly payments, assuming average life expectancy, at a government set interest rate of just less than 3%” The average life expectancy for a 70 year old (man?) is about 16 years. (Kiplinger’s Personal Finance, 8/2015, p. 17)
Gross Domestic Product (GDP) is still the best indicator of economic growth. From 1947 until 2005, the average GDP increase was 3.3%. Since 2001, the average has been 1.9%. GDP fell at an annualized rate of 0.7% in the first quarter of 2015. Northwestern University economist Robert Gordon, in his paper: “Is U.S. Economic Growth Over?” argues that for IR #3, it pretty much is a dud. The first revolution from 1750 to 1830 (IR #1) bringing steam power and railroads had an enormous impact. The second from 1890 to 1972 (IR #2) bringing airplanes, air conditioning, improved public health, increased GDP significantly. Describe IR#3. (Kiplinger’s Personal Finance, 8/2015, p. 21) Kiplinger’s author recommends stocks from emerging markets.

Median home prices. Should young home buyers be influence by Kiplinger’s reported median home prices ranging from $112,000 Columbia Mo. to $662,000 Carlsbad, Calif.? Discuss. (Kiplinger’s, 8/2015)

Life insurance planning. For a 40 year old man, $500,000 in 30 year term life insurance costs about $630 per year. For $500,000 no-lapse universal life which accumulates very little cash value, the cost is about $2850 per year. If he invested the difference for 30 years at 8%, what would it be? If he figures the current cost of retirement living to be $50,000 per year, at 3% inflation, what would it be at age 70. If Social Security pays half the living expenses, how much retirement money does he need by the 4% rule? How much life insurance would he need at age 70? Discuss. (Kiplinger’s Personal Finance, 8/2015, p. 42)

References:

Click Glossary at the bottom of main page. Click on topics you want to read about. For example Click on Weighted Average Cost of Capital (WACC). Enter a topic in Search at the top of main page. For calculators, click Calculator at top of main page. For formulas and derivations, Click How Finance Works: formulas for …, and then Click Next Page or More repeatedly.

See a free course in financial mathematics, with emphasis on personal finance, for upper high school and undergraduate college, at COMAP.com. Register and they will e-mail you a password. Simply click on an article in the annotated bibliography, download it, and teach it or study it. Unit 1: The Basics of Mathematics of Finance, Unit 2: Managing Your Money, Unit 3: Long-Term Financial Planning, Unit 4: Investing in Bonds and Stocks, Unit 5: Investing in Real Estate, Unit 6: Solving Financial Formulas for Interest Rate. The last section is Additional Articles on Financial Mathematics or Related to Personal Finance. In all, there are about seventy articles. For about thirteen more advanced or technical articles, see the UMAP Journal at COMAP.com.