ROTHERATOR

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I. GENERAL DESCRIPTION

Rotherator is a program to help decide the best strategy for how (or whether) to move traditional IRA funds into a Roth IRA. If you have a nest egg in an IRA, the required minimum distributions eventually put you into a higher tax bracket than you might have thought, so it might be better to move IRA funds into a Roth account where the gains will not be taxed and there are no required minimum distributions. Should you move it as a lump sum, or spread the transfers out over several years? If you transfer funds from a traditional IRA into a Roth, you pay more tax when the transfer occurs, but from that point forward it accumulates with no additional tax due. I found a couple of calculators on the web for Roth conversion, but they didn't seem to help in deciding how to spread the transfers over multiple years, and didn't appear to account for the various complications listed below. The goal of this program is to analyze cash flow using various assumptions about the economy based on historical data, each with several different assumptions about the Roth transfer scenarios. Several dozen of these scenarios are computed and then the results can be viewed graphically from several different perspectives to see how the Roth transfer scenarios compare under different assumptions about the economy. The program might be useful as a tool to help optimize assets for heirs or to plan spending in retirement. This program is free, and is open source Java code on github.com. To get it, go to https://github.com/jerrygeo/rotherator/releases. If you don't want to bother building it, just pull down the rotherator.zip file (by clicking it). Please notify me if you identify bugs or tragically flawed assumptions.

Why Move To a Roth?

At first glance, it doesn't seem like moving to a Roth would be beneficial, since moving funds out of a 401(k) into a Roth would kick you into a higher tax bracket, and you might never recover from this loss of funds to taxes. To explore this issue, consider a simple case in which a 70 year old person has $100,000 in a 401(k). To simplify the analysis, assume this money would never need to be spent, and that required minimum distributions would be invested. The spreadsheet SimpleRoth-IRAComparison computes 2 scenarios: one in which all the funds in the 401(k) are converted to a Roth, and one in which all the funds are left in the 401(k), and the required distributions are placed into investments. Assume that funds in all accounts are allocated 50% to stocks and 50% to bonds. Then assume:

- the tax rate on funds transferred to the Roth is $Tax_{roth} = 35\%$
- the tax rate on the required minimum distributions from the 401(k) is $Tax_{rmd} = 25\%$
- the tax rate on interest and dividends in the savings account is $Tax_{interest} = 25\%$
- the tax rate on the stock capital gains (when eventually sold) is $Tax_{capgains} = 15\%$
- the tax on funds remaining in the 401(k) would be $Tax_{401k} = Tax_{rmd}$ when these funds are eventually withdrawn; that is, only 75% of the funds remaining in the 401(k) are actually available
- the investments provide the following growth rates:
  - Stock growth: $G_{stock} = 4\%$
  - Stock dividend = $G_{div} = 2\%$
  - Bond interest rate: $G_{interest} = 2\%$

The spreadsheet grows the 401(k) by a factor

$$[.5*(1+ G_{stock}+ G_{div}) + .5*(1+ G_{interest})],$$

then subtracts the required distributions from the 401(k). The RMD is taxed at rate Tax_{rmd} and added to savings. The savings has grown from the previous year by a factor of

$$[.5*(1+ G_{stock}) + .5*(1+ G_{interest}+ G_{div})*(1- Tax_{interest})]$$

since half the savings are in stocks and half in bonds, and since $Tax_{interest}$ applies to both interest and dividends.

Capital gains on the stock growth is tracked as the sum of the previous year's capital gains plus .5*Savings* G_{stock}, since half the savings is in stocks.

The Roth account just grows by a factor of

$$[.5*(1+ G_{stock}+ G_{div}) + .5*(1+ G_{interest})],$$

the same as the 401(k).

Finally, the funds available from the 401(k)+Savings is computed as

$$Savings-CapitalGains*(1- Tax_{capgains}) + 401(k)*(1- Tax_{rmd})$$

Consulting the spreadsheet, it would eventually be better to have moved funds to a Roth, but not until age 97. But, considering that tax rates are at an all-time low (see section V below), they might go up in future. Suppose that, six years from now, the tax rate becomes 30% instead of 25% for the RMD, interest, and dividends, and that the capital gains tax goes from 15% to 25%. Plugging these numbers into the spreadsheet shows that the Roth is better after 18 years (age 88), and that the difference between the moving to a Roth and not doing so is small after about 10 years. If the Roth is inherited by heirs, they will need to take minimum distributions calculated according to the heir's life expectancy, but the account would have a significant time to grow completely tax free.

So, it might make sense to move funds to a Roth, but this may depend upon a particular tax situation and financial position. Rotherator performs these calculations for specific situations, taking into account tax brackets, inflation, investment performance and Medicare premiums.

Rotherator Methodology

A key consideration in the simulation is what to assume about the economy; i.e., inflation, interest rates, stock appreciation rates, stock dividend rates and tax rates. These elements are all coupled in some way, but nobody knows exactly how they are related. Rather than using a statistical model of this coupling as some retirement planners do, this program uses actual historical tax rates and economic data (stock growth/dividend rates, average bond yields, inflation). Other custom assumptions about the economy can be easily added by creating additional "csv" spreadsheet files.

Rotherater divides assets into 3 classes: Savings (all taxable savings, including stock and bond investments), IRA, and Roth, and each class might have both stocks (or stock funds) and bonds (or bond funds). The program assumes that the portfolio maintains fixed stock vs. bond allocation percentages overall. That is, you specify what percentage of the portfolio is allocated to stocks and, for each year of the simulation, the program reallocates the assets for that percentage of stocks vs. bonds, then performs the minimum required IRA distribution plus any extra IRA to Roth transfers, computes taxes, and subtracts spending and taxes (including taxes on the transfers to Roth) from the assets. This process is repeated for all years on each

combination of Roth transfer plan and each model of the economy. The policy of how stocks and bonds are allocated in the various asset classes is discussed later.

Viewing The Simulation Results

- **Final Assets Tab**

The assets remaining in the last year—presumably to be left to your heirs—are compared in a single graph in the **Final Assets tab**. The various Roth transfer plans for a given economy are connected with a line, so the highest point on a line is the best transfer strategy for that assumption about the economy. The display can also present the total funds remaining at various times prior to the end year of the simulation to show the results in the event of your untimely demise, and can present other graphs to show the funds available to you to spend prior to the end of the simulation as follows.

- **After Tax Assets tab**

  The Final Assets tab discussed above shows the full value of the accounts (scaled down by inflation to the first year), but some of these assets would be taken by taxes if you spend those assets. The exact amount gobbled up by taxes depends on the profit from stocks in the Savings account, the rate of IRA withdrawal and the tax rates. To provide a rough estimate of the assets available to spend after taxes, the **After Tax Assets tab** displays the total assets after subtracting 15% of the stock profit (long term capital gains) in the Savings account, and 25% of the IRA. Data for all the economies and all the Roth transfer plans for a given year are shown on one graph to allow them to be easily compared. This tab shows approximately how much is actually available for you to spend. This data is also scaled down by the cumulative inflation to correspond to the dollar values at the start of the simulation.

- **Asset History tab**

  Shows how the Savings, IRA, Roth accounts and the total of these evolve over time for a given combination of the Economy and Roth transfer plan. This view is does not scale the assets down by the cumulative inflation, so the absolute dollar numbers in the final year are different from data shown in the other tabs. Pull-down menus for the economy and Roth transfer plan select the specific scenario to display.

- **Total Pre Tax History tab**

  This tab shows the total assets (Savings+IRA+Roth) for the various Roth transfer plans for a given Economy, as functions of time. A pull-down menu allows selecting the economy. If one of the Roth transfer plans specifies that no transfers are made (transfers for all years are 0), then this view allows estimating how long you would need to wait in a given Economy before the plans that transfer funds to the Roth end up being better than no transfers. Since you take a tax hit when the transfer is performed, transferring to a Roth is worse in the short term, but hopefully better in the longer term.

- **Total After Tax History tab**
  This tab is like the Pre Tax History tab, but subtracts an estimate of the taxes from the total values to estimate how much is available to spend; i.e., 15% of stock profit in Savings, and 25% of IRA are subtracted.

The program models the cash flow, taking into account the following elements:

- investment returns (stock gain and dividends, and interest income from bonds) using models of the economy based on historical data or using custom models of economy;
- annual reallocation of assets (into stock funds or bond funds), with the traditional IRA holding primarily bond funds, and the Roth IRA holding primarily stock funds (discussed in "ASSUMPTIONS" section below);
- federal and state taxes, including required minimum distributions and Roth transfers from a traditional IRA account, based on selectable historical tax tables;
- the influence of income (including transfers into Roth account) on Medicare premiums (IRMAA) and tax rates for social security income;
- the effect of inflation on Social security income, spending, tax brackets and Medicare premiums;
- the capability of using different tax tables for each year to estimate the effect of changes to the tax laws;
- automatic evaluation of whether to use itemized deductions or standard deduction for federal tax, with a limit on the amount of state tax that is deductible on the federal tax.

For each year, income and expenses (other than income taxes) are specified in a single text file (saved as a CSV file after being entered using a spreadsheet program). In other CSV files, the various IRA-to-Roth conversion plans are specified for each year, with one file for each scenario considered. For each assumption about the economy (specified in separate CSV files), all combinations of the Roth conversion strategies are calculated:

Program Inputs						**Program Output**
IncomeExpense.csv		RothXfer0.csv		Economy0.csv		Roth0 + Economy0
		RothXfer1.csv		Economy1.csv	=>	Roth1 + Economy0
FederalTax.csv		RothXfer2.csv		Economy2.csv		Roth2 + Economy0
	+	.	+	.		Roth0 + Economy1
StateTax.csv		.		.		.
		.		.		.
						Roth*n* + Economy*m*

The detailed results of the simulation for each combination of { Roth conversion schedule + an assumed economy } are provided in the file *rotheratorOut.csv* which presents a list of each year, showing:

- the assets in the 3 accounts (Savings, IRA, Roth) and the stock allocations of each,
- the taxes paid,
- the minimum required IRA distributions,
- the income-dependent Medicare costs,
- and various other things.

This data can be viewed using a spreadsheet program such as Excel.

Example output and instructions for using the program will be discussed next. Then, the assumptions used in specifying the program are listed, and the (tedious) details regarding the computations are described. Finally, I'll describe the tests used to check that the code properly implements the intent of the design.

This Java code was developed under IntelliJ IDEA Community Edition (which is amazing).

I'm not an accountant so there could be defects in my assumptions or in the algorithms used, in addition to the possibility of errors in the implementation. Also, this program is just a simplified model of how finances will evolve and the output depends on your assumptions about taxes and the economy. So, use this program only as an adjunct to trusted tax and financial advice.

II. USAGE / EXAMPLE

To use the program you need to put all the files into one directory. These files are:

rotherator.jar
Income-Expense.csv
FederalTax.csv
StateTax.csv
RothXfer0.csv
RothXfer1.csv
RothXfer2.csv
RothXfer3.csv
RothXfer4.csv
RothXfer5.csv
Economy0.csv
Economy1.csv
Economy2.csv
Economy3.csv
Economy4.csv
Economy5.csv
Economy6.csv
Rotherator.pdf (this document)
FebBracketHistory.xls (spreadsheet to easily update FederalTax.csv)
StateTaxBracketHistory.xls (spreadsheet to easily update StateTax.csv)

You'll eventually want to provide your own data for (at least) the files shown in bold typeface. Remember to change the description lines at the top of the RothXfer files.

Try running the program using the example data by (in Windows) double-clicking the file rotherator.jar. Since the program is written in Java, it also works on a Mac (but I haven't figured out how to sign it yet, so the Mac will complain). You'll need to have Java 8 or later installed on your machine (https://java.com/). Alternatively, you can run it from a command prompt window—instructions for doing this are readily available on the web. Running from the command prompt will allow display of some diagnostic messages in the event of problems.

After launching the program, it should show a window with 5 tabs as described above.
The detailed output of the simulation is provided in the output file rotheratorOut.csv, which can be loaded into a spreadsheet program to view details of each simulated scenario.

Close the program by clicking the x in the upper right corner of the display window.

To update the data for your own situation, just modify some of the CSV files:

1. Load the Income-Expense.csv file into a spreadsheet program (such as Excel), modify it as needed, then save it (as the same Income-Expense.csv file). Comments in the file indicate what the various fields mean.
2. Then update each of the RothXfer files for different schedules for moving funds from the IRA to the Roth.

You should check that the spreadsheet program does not put any dummy lines with only commas at the end of the CSV file. Sometimes Excel 2003 puts out commas for cells that have been deleted, and if these appear at the end of the file, Rotherator gets confused.

You don't need to update the Economy.csv files unless you want to consider some custom assumptions about the economy. Economy files 1–6 use historical data from Schiller (http://www.econ.yale.edu/~shiller/data.htm) to cover various 30 year periods.

The State tax table (StateTax.csv) is for California, so this file should be modified for other states.

The number of years simulated can be modified, but make sure that all the RothXfer files and Economy files have data for the same number of years as the Income-Expense file. Additional RothXfer and Economy files can be added by appending sequential numbers to the file names, such as RothXfer5.csv, RothXfer6.csv. When the program can't find the next sequential number, it stops looking for that type of file.

To examine output not displayed in the graphs (such as the tax computed for each year for a given scenario), load the rotheratorOut.csv file into a spreadsheet and hunt for the scenario of interest.

Consider the case of someone who has just retired with $225K in savings and $325K in an IRA account, with a total family income of $55K from social security, and expenses of $80K / year before taxes.

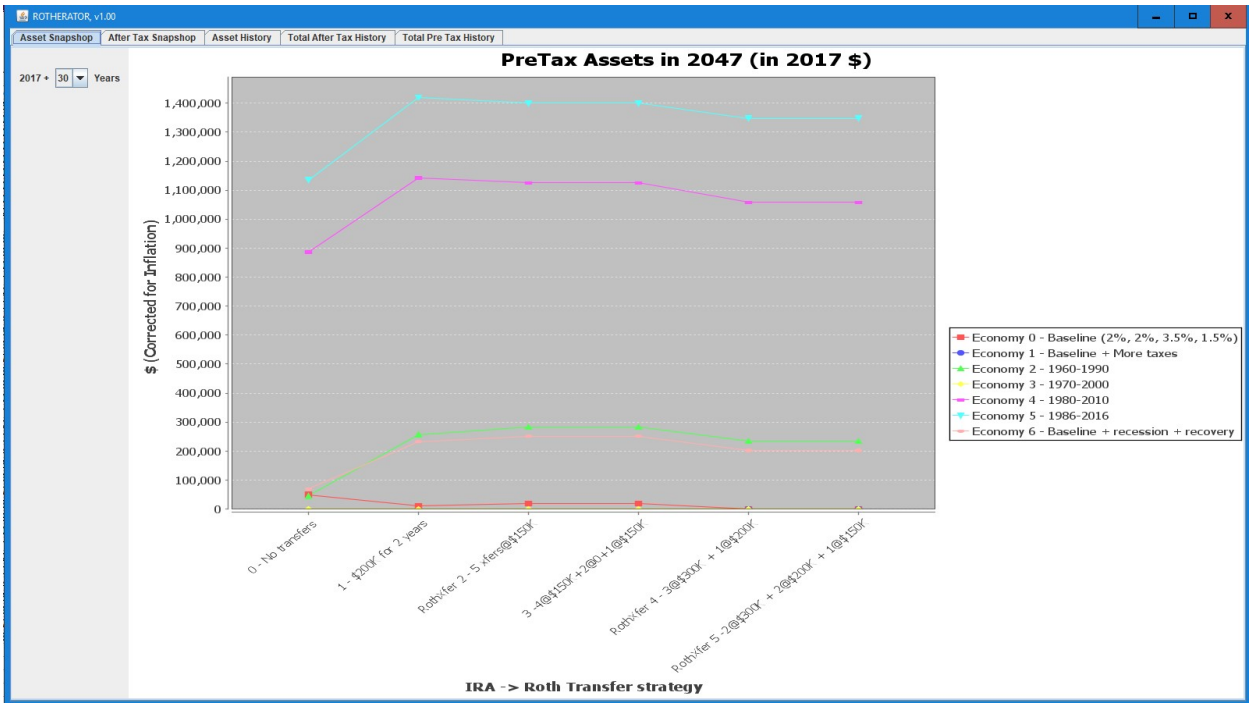
In this example, six different options will be considered for transferring the IRA funds into the Roth account:

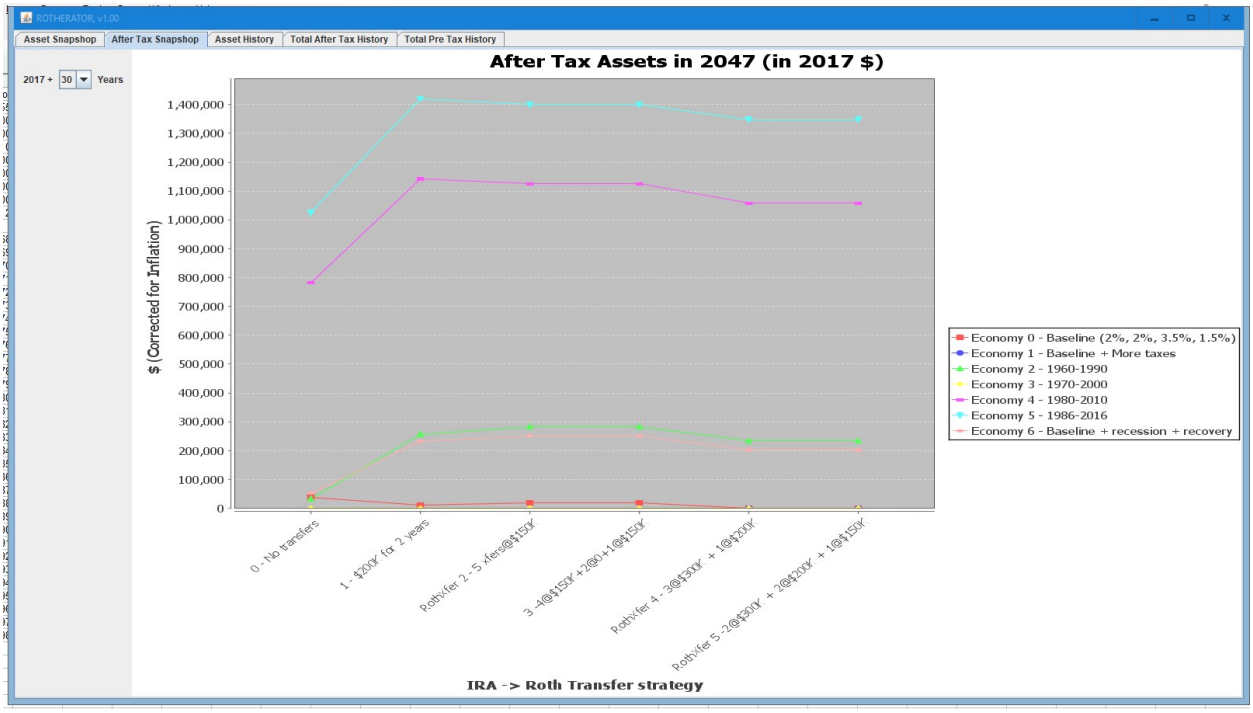
(0) no transfers at all,
(1) $100K for each of 2 years,
(2) $25K for each of 8 years,
(3) $50K for each of 7 years,
(4) $150K for each of 2 years, , and
(5) $100K for each of 2 years followed by $50K for 2 years.

The output graphs for this example are shown below. The various assumptions about the economy are discussed after the graphs.

In each of the graphs, the value of a point on the graph can be displayed by positioning the cursor over the point. You need to be very precise in positioning the cursor and then hold it still for a short while to see the values.

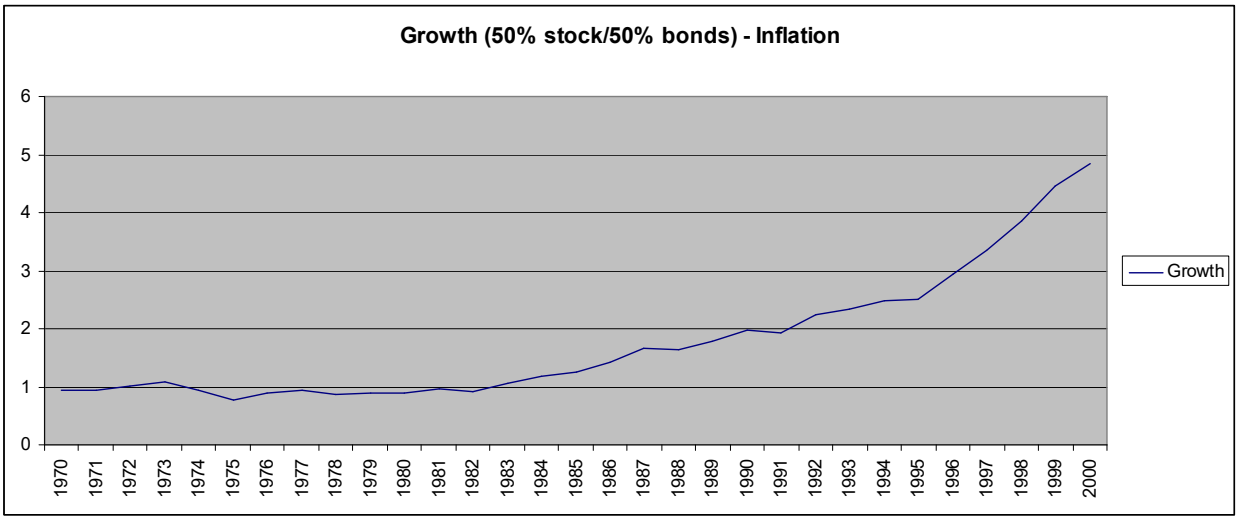
SNAPSHOT TABS





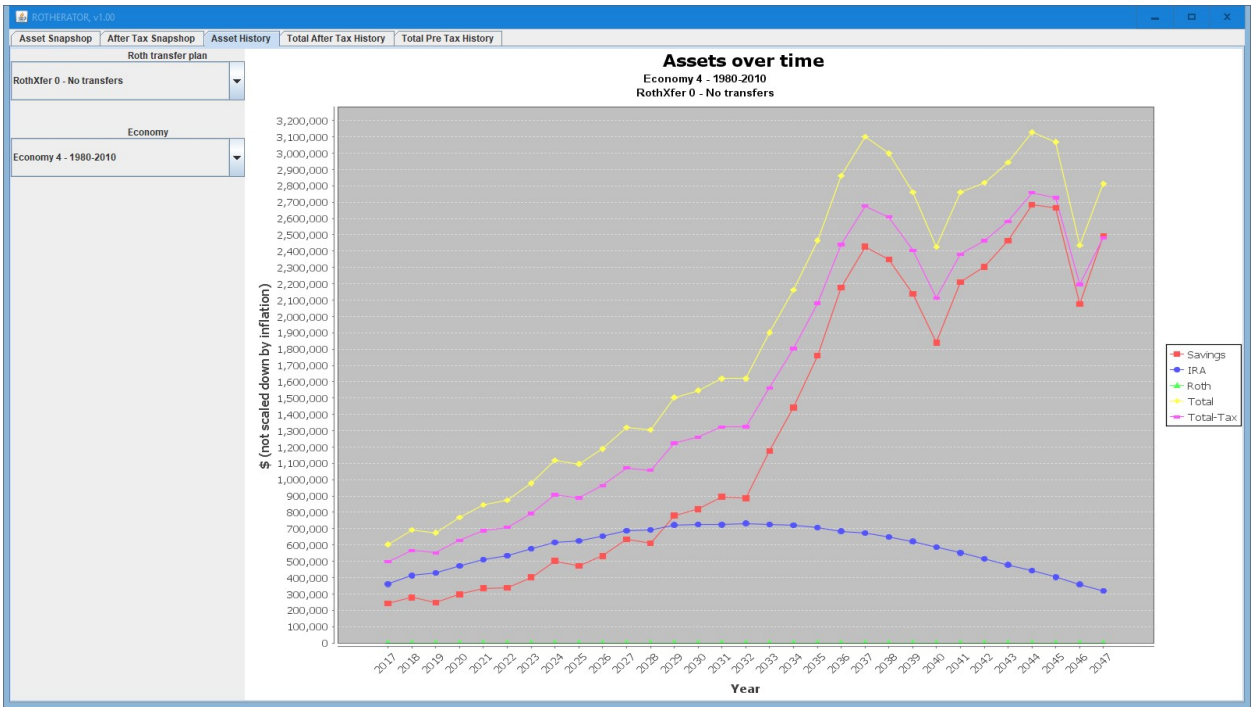
Several things are notable from the above snapshot tabs showing the assets remaining after 30 years:

- The performance of the economy makes a huge difference on the funds remaining. After accounting for inflation, Economy4 (1980-2010) and Economy5 (1986-2016) have dramatically better results than earlier decades. From 1970 until the mid-80's, a mixture of bonds+stocks did not make much headway against inflation. Starting in the mid-80's, the investments outperformed inflation:



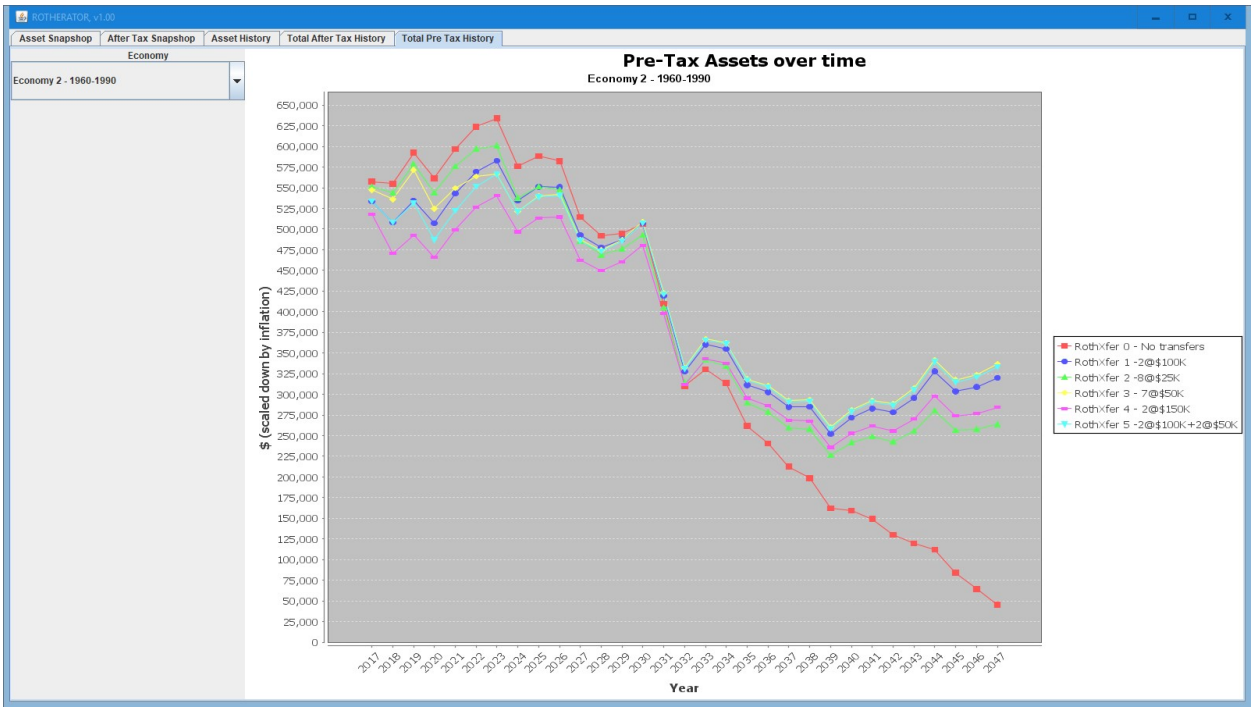
- After 30 years for this example, for all economies except the low growth, low tax Baseline, it's generally better to shift funds to the Roth than not to transfer anything from the IRA to the Roth. The benefit of moving IRA funds to a Roth is about several hundred thousand dollars (in 2017 dollars) in several cases

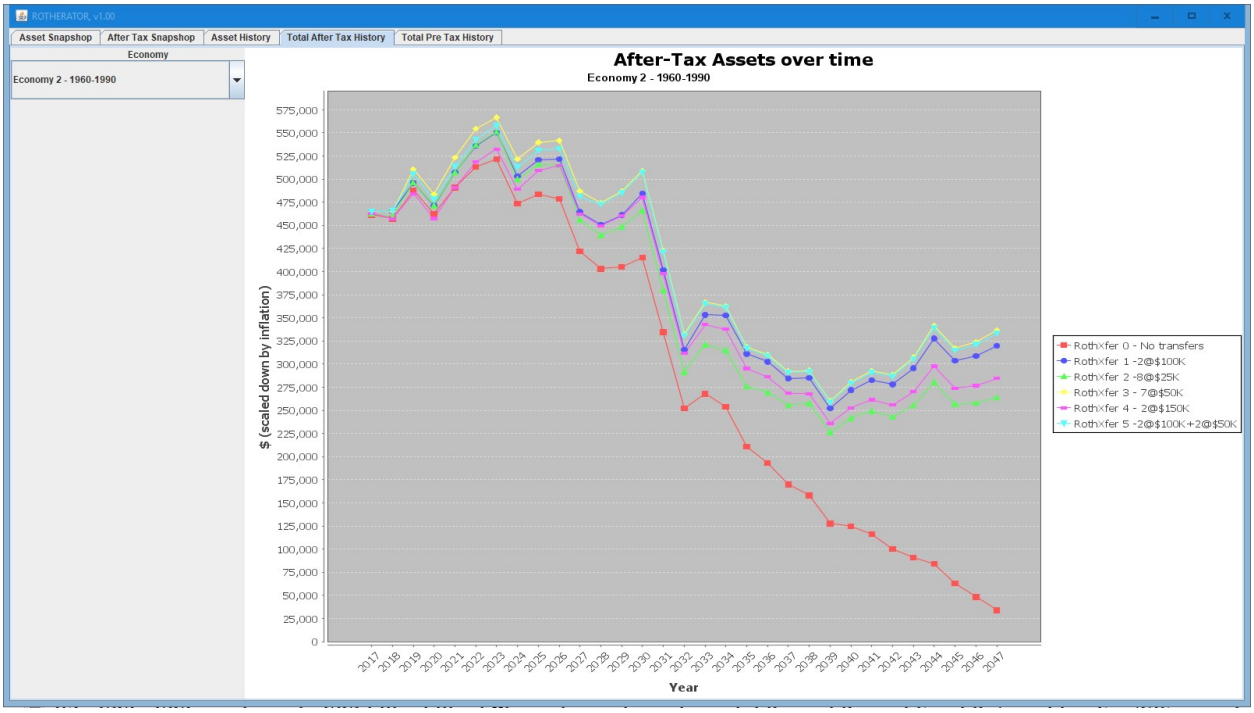
ASSETS OVER TIME TAB



Each of the 42 different asset time histories can viewed on this tab by selecting from the pull-down menus on the left. By examining the rotheratorOut.csv file in the example, you could total the taxes to find about $755K paid over the 30 years in the case Economy4, RothXfer0 (where no funds are moved to the Roth account). In contrast, in RothXfer 4 where $300K is moved into the Roth, a total of only $269K is paid in taxes. Also, by examining the rotheratorOut.csv file, it's clear that Medicare premiums aren't much different among any of the plans for this example.

TOTAL ASSETS OVER TIME TABS





These views show that it would take about 15 years for the pre-tax assets of the Roth conversions to be better than leaving everything in the IRA for the case of Economy2 (reflecting the period 1960 - 1990). However, if you wanted to actually spend the assets, you wouldn't need to wait very long before the Roth transfers are better, due to taxes on the IRA. For Economy0, there is a different result - it's better not to transfer funds to the Roth in this case.

Other Income-Expense situations and other economies will yield different results.

III. INPUT FILES

This section discusses the data required in the .csv files that provide the program input.

For the example above, the file Income-Expense.csv would look like this when viewed in a spreadsheet program:

Income-Expense.csv

Income-Expense	Note: SocialSecurity and Expenses are automatically updated for inflation by the software.	
TargetAllocation=	0.55	Put the fraction to be allocated to stock funds here. The remainder will be in bond funds
InitialSavings=	225000	Total taxable savings - includes stocks & bonds in non-IRA accounts
InitialIRA=	325000	
InitialRoth=	0	
AGI2YearsAgo=	130000	Combined income on tax return from 2 years ago for Medicare IRMAA calculation
AGILastYear=	120000	Combined income on tax return from last year
TotalTaxForLastYear=	15000	Use total tax even though some was withheld or prepaid during last year
InitialStockBasis=	150000	Basis (purchase cost) of stock in Savings account

Year	Age	SocialSecurity	TaxableIncome	TaxFree Income	Expenses	PropertyTax	Mortgage Int	Other Deductions	Credits
2017	68	55000	0	0	70000	2300	0	4000	0
2018	69	55000	0	0	70000	2300	0	4000	0
2019	70	55000	0	0	70000	2300	0	4000	0
2020	71	55000	0	0	70000	2300	0	4000	0
			.						
			.						
			.						
2045	96	55000	0	0	70000	2300	0	4000	0
2046	97	55000	0	0	70000	2300	0	4000	0
2047	98	55000	0	0	70000	2300	0	4000	0

The InitialStockBasis is the basis of stock in the Savings account which is required for tax computation, since sale of this stock will be subject to long term capital gains tax on the profit. The column "Taxable Income" should include income other than investment income, such as salary income, business income, commissions, etc.—we'll assume none for this example. The column "TaxFreeIncome" might include anticipated inheritance or repayment of principal from a loan that is not included as Savings. "Deductions" include all tax deductions that might be itemized, not including the standard deduction or the state tax deduction on federal tax. The program will figure up whether the standard deduction or itemized deductions are a better option. The entries " AGI2YearsAgo " and " AGILastYear " refer to the Adjusted Gross Income on the income tax return, which is used in the computation of taxes on Social Security benefits (Modified Adjusted Gross Income is assumed equal to AGI). Mortgage Int is the deductible mortgage interest component of Expenses. Mortgage interest should also be a portion of the Expenses column. However, "Expenses" should not include income taxes or Medicare premiums—these items depend upon taxable income and are computed by the program. Supplementary Medicare premiums, which do not depend on income, should be included in "Expenses".

RothXfer.csv

The file for the second case (RothXfer1.csv), with 2 transfers of $100K from IRA to Roth, would look like this in a spreadsheet:

Year	RothXfer
2017	100000
2018	100000
2019	0
2020	0
.	
.	
.	
2047	0

The file RothXfer0.csv would be the same, but the first 2 entries under RothXfer would be 0, indicating that no transfers are made from the traditional IRA to the Roth.

Economy.csv

A sample economy file (Economy2.csv) looks like this:

Economy 2 - 1960-1990

Year	InflationRate	InterestRate	StockGrowthRate	DividendRate	TaxTable	Reference Year
2017	0.010345	0.0472	0.04333	0.032225	12	1960
2018	0.017065	0.0384	0.029123	0.032652	12	1961
2019	0.006711	0.0408	0.156564	0.02939	12	1962
.			.			
.			.			
.			.			
2046	0.046672	0.0909	0.139321	0.034373	6	1989
2047	0.052023	0.0821	0.191205	0.032768	6	1990

This data reflects the inflation rate, interest rate, stock growth rate, and stock dividend rate that occurred during the period 1960—1990 (from Schiller, http://www.econ.yale.edu/~shiller/data.htm). The "Tax Table" column specifies which tax tables (in FederalTax.csv and StateTax.csv) to apply. All the Economy files assume that there are 4 years of the 2018 Tax plan (tax table 12), then generally revert to the tax appropriate to the corresponding historical reference year. The file Economy0.csv assumes modest returns: 2% for inflation and interest income, dividend rates of 1.5%, and stock growth of 3.5%, and uses tax table 12 (2018) rates throughout. Economy1.csv uses the same returns and inflation, but assumes that taxes will gradually rise to the rates of 1976. Economy6.csv starts like Economy0, but then assumes a recession followed by a recovery. The "Reference Year" column is a note that indicates which historical year was used for the data—this column is not used by the program.

FederalTax.csv and StateTax.csv

The tax tables are specified in the files FederalTax.csv and StateTax.csv. An portion of Federal tax file is shown below. The table years were chosen to include 2016 since I had Turbo Tax for that year to perform validation tests.

FEDERAL TAX	Bracket 0	Bracket 1	Bracket 2	Bracket 3	Bracket 4	Bracket 5	Bracket 6	Bracket 7	Bracket 8
Table 1-1966	Deductions=	0	Personal Exemptions	4566	Max State Tax Deduction=	500000			
Tax Brackets	0	3805	7610	11415	15220	30440	45660	60880	76100
Base Tax	0	533	1103	1712	2359	5251	8599	12404	16666
Marginal Rate	0.14	0.15	0.16	0.17	0.19	0.22	0.25	0.28	0.32
Capital Gains Rate	0.14	0.15	0.16	0.17	0.19	0.22	0.25	0.25	0.25
Table 2-1971	Deductions=	6394.5	Personal Exemptions	4110.75	Max State Tax Deduction=	500000			
Tax Brackets	0	6090	12180	18270	24360	48720	73080	97440	121800
Base Tax	0	853	1766	2741	3776	8404	13763	19853	26674
Marginal Rate	0.14	0.15	0.16	0.17	0.19	0.22	0.25	0.28	0.32
Capital Gains Rate	0.14	0.15	0.16	0.17	0.19	0.22	0.25	0.25	0.25
Table 3-1976	Deductions=	9114	Personal Exemptions	3255	Max State Tax Deduction=	500000			
Tax Brackets	0	4340	8680	13020	17360	34720	52080	69440	86800
Base Tax	0	608	1259	1953	2691	5989	9808	14148	19009
Marginal Rate	0.14	0.15	0.16	0.17	0.19	0.22	0.25	0.28	0.32
Capital Gains Rate	0.14	0.15	0.16	0.17	0.19	0.22	0.25	0.28	0.32

The first line of each tax table specifies the standard deduction, the personal exemptions, and the limit on the amount of state tax that is deductible on the federal tax. The next 3 lines hold the tax schedules (from the government tax forms or booklets) and the 5th line holds the capital gains tax rate. The program does not take into account either the extra capital gains tax for high incomes or the phase-outs for capital gains treatment. This table assumes 2 personal exemptions (double the listed personal exemption). The limit on state tax deduction is set very high ($500K) for years before 2018, since this limit was just introduced in 2018. Except for 2018, the tax brackets, standard deduction, and personal exemption are all inflation-adjusted to the year 2017, and the program adjusts these numbers further for future simulated years.

To apply this program in later years (after 2017), these tax tables should be updated for the inflation between 2017 and the year the program is used. This updating can be achieved using the Excel sheets FedBracketHistory.xls and StateTaxBracketHistory.xls. On the tabs "Historical Tables", adjust cell C1 from 1.0 to the appropriate inflation, which bumps the values in the tab "Inflation-Adjusted Tables". Then copy the entire contents of the tabs "Inflation-Adjusted Tables" to new sheets, and save these as the FederalTax.csv and StateTax.csv files in the Rotherator directory.

IV. ASSUMPTIONS

The simulation calculates only once for each year rather than, say, quarterly.

Retirement accounts are divided into 3 classes: IRA (401k), Roth, and (taxable) Savings, and each class can hold both stocks and bonds.

Investments in each account are divided into 2 classes: stocks (stock funds) and interest-bearing bonds (bond funds).

Roth conversions are made at the beginning of the year.

Living expenses for each year are withdrawn at the end of the year, along with taxes. Ideally, they would be withdrawn throughout the year and only the unspent portion would appreciate, but implementing this alternate model would be messy.

The possibility of tax-advantaged municipal bond funds is not considered as a separate asset category.

Social security income, Medicare premiums, living expenses, and Medicare IRMAA brackets will increase at the rate of inflation. The Medicare brackets assume "married filing jointly" tax returns.

For tax purposes, all stock returns are treated as long term capital gains. Frequent traders will not find this software useful.

The total portfolio (taxable savings + 401k + Roth) has a fixed allocation between stock and bond funds.

- The IRA is assumed to hold a minimum of stock funds since keeping stocks in taxable Savings accounts (rather than IRA's) allows them to receive the benefit of long term capital gains. Gains from stocks held in a 401k will be taxed as ordinary income when they are distributed from the fund, so it's better to not put stocks in the 401k if the other accounts (Savings and Roth) are large enough to hold the stock allocation.
- The algorithm attempts to keep mostly stock funds in the Roth, since the profit from stock growth + dividends is assumed to be higher than bonds, and this larger profit will not be taxed at all in the Roth account. Bond funds are only included in the Roth account if the Savings account is too small to hold enough bond funds to achieve the desired overall portfolio allocation between stocks and bonds.
- The stock/bond mix in the taxable savings and Roth accounts are rebalanced annually to achieve the overall target allocation. This rebalancing is performed at the beginning of the year. Stock growth, income, and expenses pull the accounts away from the target allocation at the end of the year, and these year-end values are the values written to rotheratorOut.csv.

Minimum required IRA (401k) distribution (MRD) is computed at year-end based on the IRA value after its value is increased by growth for the year. The IRA is reduced by the MRD at the beginning of the next year.

If the year's income + the taxable savings is less than total expenses, funds are transferred from the IRA account, and this extra IRA withdrawal is included in the next year's taxes. If the IRA account lacks sufficient funds, then additional funds are withdrawn from the Roth.

There is no attempt to take into account the Alternative Minimum Tax (AMT).

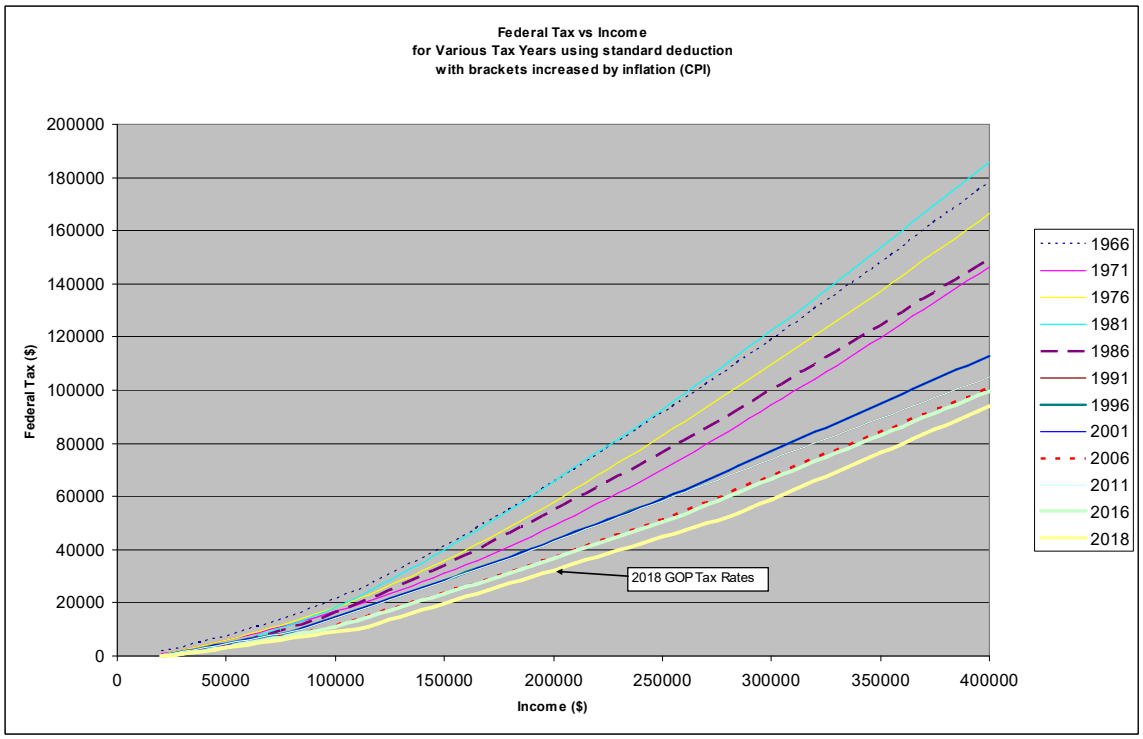
State tax assumes that long term capital gains are treated as ordinary income (per California tax code)

The bulk of the algorithm of the program resides in the methods *computeCurrentYear, growInvestments*, and *payExpenses* in Simulation.java. Here's what it does:

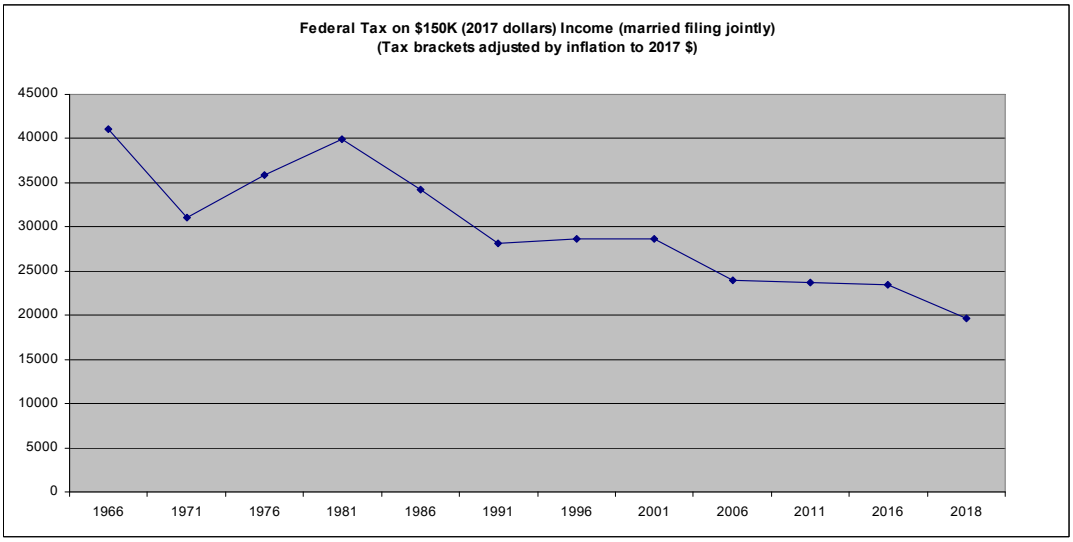
1. It's the beginning of the year. Re-allocate to achieve the desired overall stock vs bond allocation, while attempting to keep bond funds in the IRA and stock funds in the Roth. We start the year with a portfolio that has been pulled away from the target allocation due to the expenses having been withdrawn at the end of last year. So, we'll rebalance stock/bond allocation and remember any capital gains resulting from stock sold from the Savings account.
2. Compute the minimum required IRA distribution, based on your age and the amount in the IRA account. Subtract this amount plus any extra Roth conversion (specified in the RothX.csv file) from the IRA. If an attempt is made to withdraw more from the IRA than it contains, reduce the amount of extra Roth conversion.
3. Grow the accounts by the interest, dividends and stock growth rates specified for the year in the EconomyX.csv file. Interest, dividends, IRA withdrawals and other income will be combined into cash to pay expenses.
4. Update the social security income by the amount of inflation, as specified in the EconomyX.csv file.
5. Add any extra income (taxable income, tax-free income, and social security from the Income-Expense.csv file) to the cash.
6. Compute the "combined income" to allow calculating the tax on Social Security.
7. Compute the state and federal taxes using the tax tables (in FederalTax.csv and StateTax.csv) specified for the year in the EconomyX.csv file. Save the adjusted gross income for use 2 years later in the Medicare IRMAA computation. Tax brackets are updated to account for cumulative inflation.
8. Update the living expenses per inflation, then deduct expenses, tax, and Medicare from the cash. If necessary, withdraw additional funds from the Savings in a way that does not change the stock/bond allocation in the Savings account. If there aren't sufficient funds in the Savings account withdraw from the IRA and, if the IRA is exhausted, withdraw needed funds from the Roth account.
9. Update the inflation factor with inflation for the year.

V. HISTORICAL TAX RATES

The whole point of moving from IRA to Roth is to minimize taxes, so assumptions about tax rates in the future are important. If taxes go up in the future, it might be better to move funds out before the tax increases. For some perspective, here are some historical federal tax rates compared to the 2018 taxes. These rates are for "married filing jointly" using the standard deduction with 2 personal exemptions. The personal exemption phase-out is ignored. The historical tax brackets, standard deduction, and personal exemption are all bumped up by inflation as defined by the consumer price index to the year 2017.



To better show the trend of taxes over time, the tax on income of $150K is plotted as a function of time. The historical tax brackets are adjusted upward to account for inflation so that the $150K income and the corresponding tax amounts represent the purchasing power of those items in 2017 dollars. Adjusting the tax brackets up by the amount of inflation is equivalent to correcting the $150K down by the amount of inflation, figuring the tax, and then adjusting the tax up by the amount of inflation. I found the downward trend of this graph surprising. The computations for these graphs are performed by the Excel sheet FedBracketHistory.xls (Plots of Tax vs Income sheet).



VI. TESTING

The testing is fairly limited, and certainly achieves nowhere near 100% coverage. Also, error checking is limited: errors in input files (.csv files) will probably result in the program stopping with a cryptic error message. Keep the unmodified csv files in a backup directory to allow restoring the original versions.

A. Unit tests
   1. Minimum Required Distribution calculation
      a. For ages 69–99, check that the number of years used to calculate the distribution matches Table III shown in Appendix B of Publication 590-B,.
   2. Medicare Cost calculation (assumes 2 people, married filing jointly, with part B and part D)
      a. Check cost for income midway between first 2 brackets, at exact value of 3rd bracket + $1, and 1.5*top bracket.
      b. Repeat the above tests after 10% inflation, increasing Medicare cost and brackets by 10%.
   3. Tax calculation
      a. From first federal tax table (set to 2016 values) and first state tax table (also set to 2016 values), compute tax for the following cases:
         - AGI midway between first 2 federal brackets,
         - AGI at exact value of 3rd federal bracket,
         - AGI at 1.5*top federal bracket
         - AGI=$353963, deductions = $190K
         - AGI=$353963, deductions = $10K
         - AGI=$150K, deductions=$10K
         - AGI=$150K, deductions=$10K, inflation=1.1

      b. Check the above results against manual computations from Schedule Y, p11 of https://www.irs.gov/pub/irs-prior/i1040c--2017.pdf, or using 2016 TurboTax (ensure that results agree within 10%).
         For the cases with 10% inflation, add 10% to both the income brackets and the base tax amount.

   4. Still need to generate unit tests for payExpenses(...) and growInvestments(...).

B. System tests
   1. With all investment return rates in Economy0.csv set to 0, confirm for an example Income-Expense.csv file that the final assets are consistent with the starting assets together with the total expenses.
   2. Repeat the above assuming a 4% stock return with 0% for inflation, interest, and dividends, checking that the stock basis in Savings is properly

updated, and that profit is properly taxed when stock is sold (in at least 1 example).

3. Inspect the output for the example and at least one other test case, looking for results that are clearly incorrect such as negative account balances, inexplicably growing account balances. Spot check that taxes are inconsistent with the AGI.

Jeremy R. Smith showed me how to implement the UI for this project (by cranking it out with jaw-dropping efficiency in a few evenings) and helped to begin restructuring the project for cleaner code. Hopefully, this process will continue as I get up to speed on Java. Any errors in the business logic are strictly mine.