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****DRAFT****

Just Run the Numbers

**Model Your Retirement for
Better Outcomes and
Peace of Mind**

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1 Overview

This book is about modeling your retirement. The retirement model is a prediction of what you can spend and where the money will come from. Along the way, the retirement model also predicts what your income tax burden will be and how account balances will change over time. The retirement model is the key to creating an effective retirement plan.

The target audience is people preparing to retire, or early in retirement, who will be funding part of their retirement via their personal savings. It will be most valuable to individuals who are interested in drawing their own conclusions; it might also help you select a financial advisor and understand her recommendations. It is certain to make you a more informed consumer of the financial press. This book may also be useful for folks a bit further from retirement who want to get a concrete sense of how the numbers will work in retirement.

This book is not about building wealth for retirement. There are many excellent books on that subject including my favorite *Wealth Your Way* by Cosmo DeStefano (DeStefano, 2022) and bestselling *I Will Teach You To Be Rich* by Ramit Sethi (Sethi, 2019). The assumption is that you have already accumulated your retirement savings or at least have a line of sight to it.

Understanding your retirement numbers does not need to be an expensive or difficult proposition. You can use this book in conjunction with free or low-cost tools to come to your own conclusions.

1.1 Retirement Plan vs Retirement Model

A *retirement plan* proposes a specific course of action for your retirement. It says, “I will retire at age X,” “I will take Social Security at age Y,” etc. A *retirement model* on the other hand allows you to explore different choices and different possible future events. For example, with a retirement model you can explore the impact of different retirement ages and different Social Security commencements. In other words, you use a *retirement model* to help create your *retirement plan*.

I already have a solid retirement plan, why model?

If you have a solid plan, it was created using a retirement model. There isn’t any other way to build a quality plan. This was probably created by your financial advisor using a commercial modeling tool. In that case it is not necessary for you to invest the time and effort to create your own model. You might still find this a profitable activity for any number of reasons including increased peace of mind, but it isn’t strictly necessary. This book will help you make that decision in addition to helping you understand how your adviser arrived at your plan.

1.2 Roadmap

The first 8 chapters of the book address retirement modeling in a tool-independent fashion. The remaining chapters focus on the free open-source tool JRTN (Just Run The Numbers).

Chapter 2 introduces retirement modeling concepts.

Chapter 3 introduces the modeling process itself starting with the creation of very simple models “by hand.” It wraps up with a discussion about creating your own Spreadsheet model.

Chapter 4 discusses what we are trying to model in additional detail. This forms the basis for the core requirements for a model.

Chapter 5 discusses different questions to be answered with a model. These are another set of requirements for the model.

Chapter 6 briefly discusses some other considerations. This provides some additional context and it helps to bound the problem.

Chapter 7 identifies some potential surprises from your modeling activity. This chapter reads *a little* like Internet click bait such as “Can I afford to retire with \$1M?” It is more concrete than most of the click bait because it tries to help you answer the questions yourself and because it shows how the results differ for different situations.

Chapter 8 discusses modeling tools. It closes with a guide to selecting a modeling tool. This includes a comparison matrix. In a prelude to what follows, this matrix is filled in for the JRTN tool.

Chapter 9 is the user guide for JRTN.

Chapter 10 extends the user guide by describing how to use the tool to answer specific questions of the sort described in Chapter 5.

Chapter 11 provides some elaboration such as a list of potential enhancements.

Chapter 12 provides an overview of the JRTN implementation.

2 Introduction

Finances are a concern for most of us throughout our lives and of course our focus changes over time. Early on we might have a vague notion that “retirement is out there” and we should be saving for it. But our primary focus is probably shorter term. Affording a car, paying for weddings, saving for a house down-payment, etc. Later, we will likely have some new mid-term goals such as helping to pay for a child’s college education. Over time the focus inevitably moves towards retirement.

There are many web sites and books about personal finance and more specifically, about retirement. The retirement-oriented books are often looking at decision making – many of them with excellent and in-depth discussions about important topics such as Social Security, Medicare, annuities, etc. One thing all the sources have in common is that they observe that these are personal decisions and that everyone’s situation is different. This is where modeling comes into play; the model captures your specific circumstances to inform personal decision making. This book focuses on modeling; it is best used to augment sources such as:

- The Retirement Planning Guidebook – Navigating the Important Decisions for Retirement Success. (Pfau, Retirement Planning Guidebook, 2021)
- IRA’s, 401(K) & other Retirement Plans – Strategies for taking your money out. (Twillia Siesneck, 2021)
- A Concise Guide to Taxes in Retirement. (Larson, 2016)
- The Truth about Buying Annuities. (Weisman, 2009)

There is also a wealth of less formal information freely available on the Internet. You should be a little careful interpreting what you read on the Internet because most authors are looking to monetize their writing and many of them have a target audience which may or may not be aligned with your situation. With textbooks, the monetization model is obvious and upfront. On the Internet (outside of paywalls), “the words are free,” but those free words need to be read with a more skeptical eye. Is the author over-dramatizing or over-generalizing some decision point to grab more attention (roughly speaking, the *influencer* monetization model), or is the author more directly making the case for a specific financial product? For example, an informative discussion of asset diversification that just coincidentally ends with a link to an annuity sales team. With that caveat, the Internet is a great source of thought-provoking input.

This book does not aim to explain all the rules around RMD’s, Roth Conversions, Social Security, and Medicare, or the nuances of different types of annuities. All of that is important. Some of it is reflected here to frame the financial model discussion, but if you

want a deep understanding of these topics, you are best turning to one of the resources above.

Key Terminology

Scenario	A scenario is a <i>specific</i> prediction about the future. The scenario will identify factors that are part of this prediction such as rates of return and inflation rates. A complex scenario might have different rates of return for different years and asset classes. A scenario will also identify relevant choices that you expect to make such as starting Social Security at a certain date.
Model	A model defines the relationships between various “input” values and a set of derived (output) values. For example, the inputs of income from various sources and tax laws will lead to an output of estimated income taxes, spending, and account balances.
Modeling Tool	A modeling tool is a piece of software that implements a specific model. This software might be custom-built, or it might be a configuration of a spreadsheet.
Spending	This is the total amount of money you have available to spend after paying income tax. Of course, a lot of this “spending” may be on other taxes such as Real Estate tax and Sales tax.
IRA	Individual Retirement Account. This is used as a generic reference to qualified savings accounts containing before tax money including the traditional IRA, 401K, 403B, and SEP IRA. There are some subtle differences between these account types, but for purposes of understanding our retirement finances, we can generally treat them the same.
RMD	Required Minimum Distribution. This is a taxable withdrawal that you are required to take from an IRA once you reach a certain age. The fraction of the IRA balance that you are required to take goes up with Age.
Roth IRA	This is used as a generic reference to refer to accounts that are funded with after tax dollars and are growing tax free. For example, it might be a “Roth IRA,” a “Roth 401K,” or a “Roth 403B.”

This book is different from most financial writings in that it has very little specific **advice**. The advice given is to create models and then make decisions based on the results of the

models. It avoids the use of examples such as “Deciding when to take Social Security if you have a million-dollar portfolio” because these examples are overused in the media and because the examples would dilute the message of running your own numbers.

That said, the book does provide some examples with specific numbers on occasion. This is done first to draw contrasts between different situations to emphasize the need to run your own numbers and secondly because real numbers make the discussion more compelling.

A central premise of this book is that multiple scenarios are needed to evaluate choices such as when to take Social Security. It is only by comparing scenarios that we can make an informed choice. But even after we have made a particular choice, we still need multiple scenarios to address different possible futures. For example, one where I die young and my spouse lives to 97 and another where we both live into our mid-nineties. Of course, at the end of the day, the future will play out in just one specific way. What scenarios allow us to do make informed tradeoffs between different possible futures.

2.1 Just Run The Numbers

There is a steady flow of information, and infomercials related to personal finance and retirement planning. There are a variety of eye-catching themes addressing different decisions. For example, “When to take Social Security,” “Roth conversion,” “Are you ready to retire,” etc. Often these reports draw attention to the notion that these are **individual decisions** based on **individual circumstances** (especially if they are promoting some type of advisory service). Sometimes the reports simply suggest a course of action, making the case for a specific decision because the sound-bite nature of the media forces this. These generic discussions are useful (if a bit repetitive); but you need to run the numbers to make your own decisions and understand your own situation.

A lot of this Internet material is designed to be scary; it is designed to convince you that you need to buy something from someone. But it is not as scary as it sounds; once you run the numbers and think a little bit about your priorities, the choices are often obvious.

What we need is a *model* of the future. The term “model” sounds a little foreboding, but it needn’t be. A model is just a plan with some numbers and relationships between the numbers. For example, a spending model might have a total spending allowance and then some known big-ticket items.

2.2 Key Retirement Decisions

There are **many** decisions to be made as we approach retirement. The most pressing is probably whether we are financially ready to retire, but there are lots of others:

- When do I start Social Security or a pension?
- What Survivor benefits to take on a pension?
- Whether to do Roth Conversions and if so, how much?
- What accounts should to draw from first?
- Should I purchase an Annuity?
- How much of a reserve should be maintained?
- Do we need to change our spending habits?
- Should we purchase insurance of some sort?
- Can I afford a big-ticket expense such as a motor home or second home?
- Will part-time work be required?

One important aspect of these decisions is that they are *not* of equal importance; some are far more consequential than others. For example, the decision about what accounts to draw from is usually going to be less consequential than the decision to retire. A retirement model will not only help you make the best decisions, but it will also help you understand which decisions are more important.

2.3 The Special Sixties

The period of your 60's to your early 70's is special because this is the time when you have the most freedom of action and when you are going to be making most of your retirement decisions. Consider:

- At 59 ½ you can take money from an IRA or Roth IRA without penalty. This makes Roth Conversions easier because there will be penalties for using IRA funds to pay income tax on the conversions.
- At 62 you can start to withdraw Social Security
- Many people “buff up” their insurance at this point
- Most pension plans have a “first age” when the pension can be drawn and it is often in this general timeframe, with 65 being common.
- At full retirement age (roughly 67) you can use Social Security without it being reduced by outside income
- By 70 you will be drawing on Social Security
- At Age 70 ½ you can start making charitable contributions directly from an IRA
- At age 73 (increasing to 75 in 2033) you are required to start taking RMD's. Once RMD's start it is more difficult to do Roth conversions, since the conversion needs to be in addition to the RMD.

Once you reach RMD age your freedom to control income sources (and reported income) is greatly diminished if you have a traditional IRA. It is important to have a plan to ensure you to make the best use of the “flexible 60’s.”

2.4 Predicting the Future

The decisions are generally within our control. But our retirement finances will also be influenced by future events that we can’t predict. For example:

- How long will we or our partner live?
- What will inflation be in the future?
- What can we expect for investment rates of return?
- What will tax law look like?
- What will our medical expenses be?

These uncertainties suggest a modeling and planning approach that embraces a range of possibilities. Take for example the question of when the first partner passes. The best way to get an understanding of the impact of this is to run the entire model with a few different possibilities. For example, three different scenarios:

- First Partner dies at age 75
- First Partner dies at age 85
- First Partner dies at age 95

Look at inflation next. Do we think it will be 1.5%, 2%, 3% or even 4.5%? That is 4 more scenarios. But to understand both the inflation and the lifespan question, you really need to run all the permutations for a total of 12 different scenarios.

2.5 Spending Goal vs Spending Capacity

One popular way to think about retirement spending is to look at your assets and fixed income sources and draw an up-front conclusion about what you will be able to spend using a rule thumb such as the “4% rule” (see Section 3.5 for more details on 4% rule). This spending capacity then drives a series of budgeting and life-style decisions. The alternative approach is to look first at your budget to define a spending goal that you then work towards that goal on a yearly basis using your fixed income sources and assets.

The big difference between the two isn’t whether you are looking to spend as much as you can since a goal-oriented approach can also “solve” for the largest possible spending. The most important difference is in the *mechanics* of the modeling process. A goal-oriented approach will consider many details of your financial situation and “work backwards” to arrive at the desired spending. The other important difference is that a goal-oriented

approach might have you spend less than you can afford to spend in the interests of providing a legacy or self-insuring for late-life possibilities such as long-term care.

2.6 The IRA Proposition

Qualified accounts are a key element of retirement planning for many individuals. A brief level-setting discussion will help here. Your IRA was originally funded by taking “before tax” funds from your top income bracket over a period of years. Eventually you (or your heirs) will need to pay income tax on withdrawals from the IRA. What this means is that the government has a claim to some part of the IRA balance. The tricky part is that the exact amount of this claim is unknown because we don’t know our future tax situation with precision, and we don’t know what tax rates will look like in the future.

The way that the math works out is that “your” portion of the IRA and the government’s portion of the IRA will increase (or occasionally decrease) in value over time *in parallel*. You are relying on growth of the government’s portion to cover the eventual taxes on your portion. The important consequence of this is that your portion effectively grows tax free. This is a *much better* deal than paying tax on the earnings and investing them immediately in an unqualified account. This was your only choice before the birth of IRA accounts in 1974. Before the advent of Roth IRAs in 1998, these were your only two choices. Now there is a third choice. The Roth IRA is funded by after-tax money and grows tax free. What this means is that to a *first approximation*, the Roth IRA and the traditional IRA provide exactly the same benefit of allowing “your” funds to grow tax free! The difference is *when* you pay the taxes and the fact that you don’t know exactly what the ultimate tax burden will be on the traditional IRA. It might be a bit lower than your original marginal rate, or it might be a bit higher. In either case you will most likely have come out way ahead because of the “untaxed” earnings on your portion.

There are important differences between the traditional IRA and the Roth IRA even though they are the same as a *first approximation*. A lot of work can go into optimizing the payment of IRA taxes by converting traditional IRA funds to a Roth as you will see later in this book.

There is a lot of noise in the popular press about whether traditional IRAs or Roth IRAs are a better proposition for individuals saving for retirement. Looking strictly at the numbers, it probably depends on the relationship between your current income level and the size of your IRA account. If your income is relatively high and your IRA balance is relatively small, the IRA makes more sense; you are going to move money out your high bracket and there is not yet a lot of risk of the IRA pushing you into a high bracket in retirement. The reverse is also true. The more interesting questions surround the other two cases: low income with low IRA balance, and high income with high IRA balance. The good news is that the

consequences of “choosing wrong” are likely to be small in either case. You are either going to pay low tax with either choice or high tax with either choice.

But it isn’t just about the numbers. At the end of the day, it may come down to your propensity for risk – how important is it for you to lock down these amounts versus the risk of negative changes in tax law? Other risks include the “risk” you might have much more income in the future than you anticipate. There are also risks with Roth savings. These are “missed opportunity” risks. If taxes go down for you or if your income is lower than you are expecting later in life, you will have paid unnecessary income tax early on. The author suspects that for most folks the traditional IRA probably still makes the most sense throughout much of your career because this money is coming out of your top bracket. At any rate, hopefully the discussion above eases your mind a bit because any differences between traditional and Roth IRAs are second order. The government is likely to get most of “their” piece one way or another.

Note that the IRA is not a loan from the government to you in a traditional sense. If it behaved like a loan, the amount you owe would be defined up front. It is much more like a business partnership with the government participating in your account growth.

2.7 Accounting for IRA withdrawals

As we have seen, money taken out of an IRA after age 59 ½ is taxed as regular income. But what happens with that money?

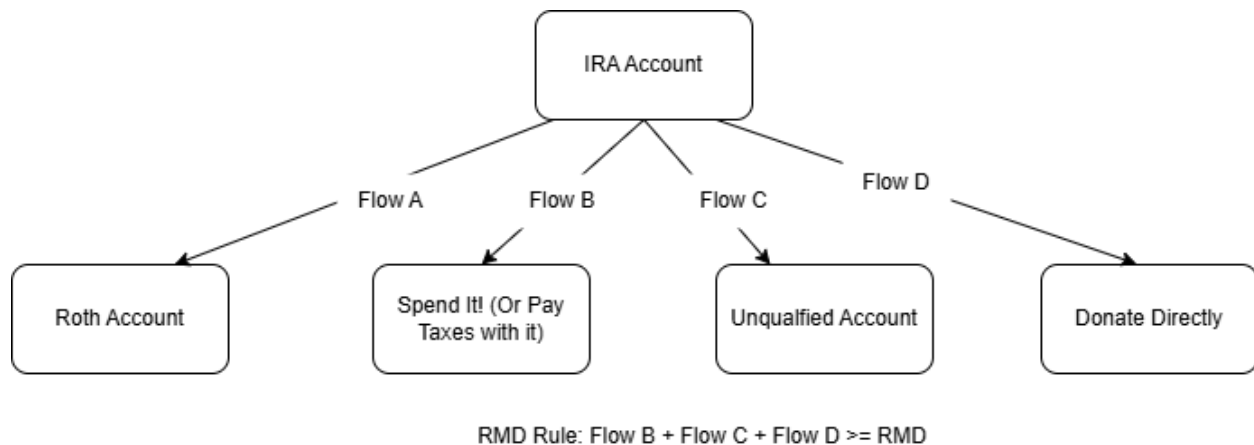


Figure 1 - IRA Withdrawals

There are 4 possibilities as shown in Figure 1. These are the *only* possibilities. For the purposes of this discussion, spending money on yourself is the same as paying taxes or other uses of the money such giving some to family or a charity. The money flow is the

same in each case: the money comes out of the IRA, it is in your hands for some time, and then it is gone.

Flow D is only available to IRA owners aged 70 ½ or more. Flow C is problematic because we wind up with funds in a taxable account, further increasing our tax burden over time. There is quite a lot of discussion in this book and in the financial press about keeping this to a reasonable level. In terms of this diagram, that means pushing enough funds through Flow A and Flow D that Flow B covers most of the RMD. But this is something that requires planning. Flow A is most advantageous when you are younger, before RMDs start. Flow D can only be done later on.

3 Introduction to Retirement Models

A retirement model provides a view of what your finances will look like in retirement based on your current (or expected) assets and expected fixed income sources, and your anticipated spending. The model might be high-level, or it might be low-level and hence very detailed.

3.1 Retirement Modeling Landscape

There are three largely independent realms to consider as shown in Figure 2.

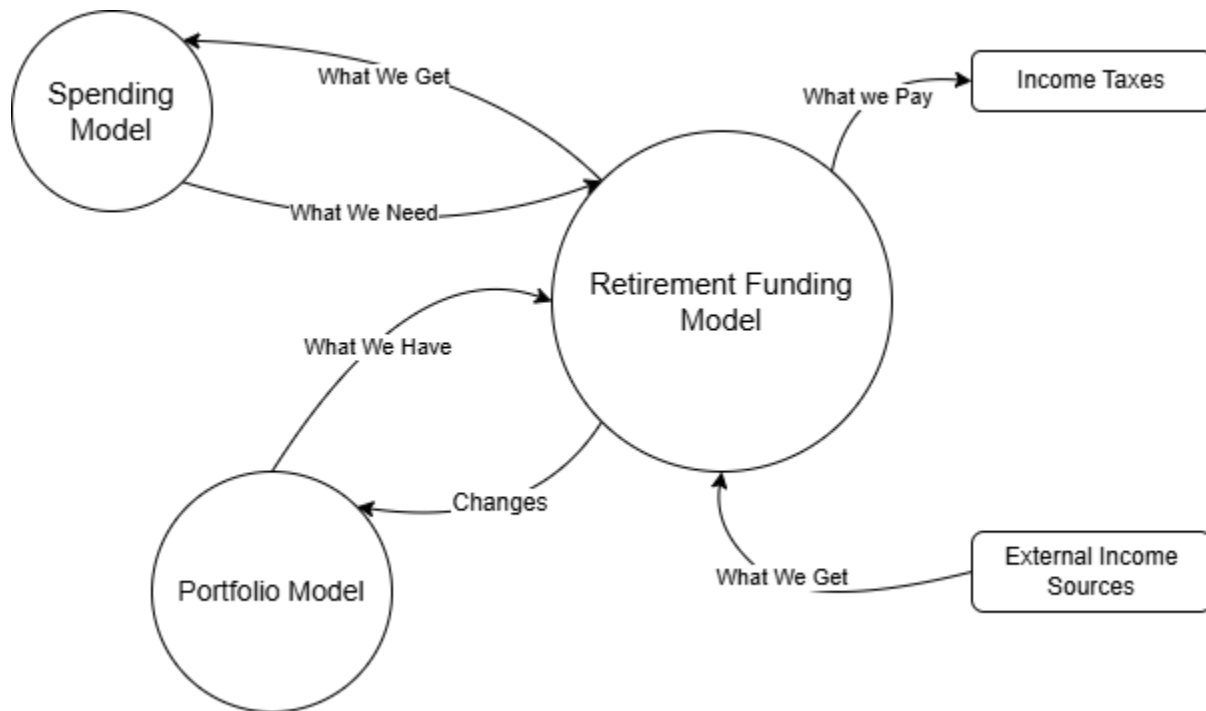


Figure 2 - Retirement Modeling Domains

It is tempting to look at these arrows in terms of money flow, but what this diagram really shows is the *flow of information* between the various model elements on a year-by-year basis. Income taxes and external income sources have complex rules of their own, but for our purposes, those rules are part of the retirement funding model.

The **Spending Model** characterizes your after-tax spending.

The **Portfolio (Investments) Model** characterizes your investments and predicts their future behavior in terms of risk and return.

The **Retirement Funding Model** documents the projected flow of funds over time with a key output for spending capacity.

Some financial planning tools tackle all three of these realms. Others are more focused. Either approach is perfectly sensible. An integrated tool that pulls it all together is fine, but it isn't strictly needed because the handoff between these realms is straight-forward:

- The spending model tells the retirement funding model how much is needed.
- The portfolio model describes the investment balances and how we expect them to behave over time.
- The Retirement funding model describes where the money will come from to fund your retirement spending.

A model that integrates investments and retirement cash flow is empowered to do some additional analysis based on the details of the portfolio, but this is likely to be more valuable from a convenience perspective than an ultimate accuracy perspective.

3.2 A Brief discussion of Spending Models

The spending model will often be based on a budgeting exercise. The classic way to do this is to lay out categories such as:

Category	Monthly Cost
Rent/Mortgage	2000
Property Tax	800
Automobile Costs	540
Health Insurance/Co-Pays	520
Other Insurance	120
Charity	200
Food	640
Dining out and Entertainment	220
Utilities	600
Travel	1200
Other	1000
Savings	500
Total Monthly Budget	\$8340

Table 1- Budget Example

This can be done at different levels of detail. A general rule of planning is that the more detailed the plan, the more accurate it will be. That holds true for budgeting plans too. There are many tools and templates available for this exercise, but this process is not complicated. The value of these resources is that they may help you identify a useful categorization and minimize the risk of missing an expense.

By the time you retire, you may have a good enough idea of your spending needs to not need a detailed budget, but it is a little dangerous to assume that spending will be level or

drop off substantially. In either case the big challenge with planning retirement spending is that your situation is changing as you transition into retirement, so your spending needs will too. While you will be “spending” less adding to your savings and on work-related expenses, you may be spending more on travel and other recreation now that you have more time for these pursuits. You may or may not have plans to explicitly reduce spending such as downsizing a home or reducing the number of automobiles. Another challenge is posed by the timeline. This set of changing needs over time can be viewed in the context of activity level:

- “Go-Go” years early in retirement when you are doing more and likely spending more. It could be lots of travel or time on the powerboat and the golf course.
- “Go-Slow” years later when you are still getting out. But less so.
- “No Go” years late in retirement when you have basically stopped traveling and other “high input” activities.

Going Slow and Not Going generally costs less, but this is going to be counter-balanced by a likely increase in medical and personal-care expenses over time. With all of that, the actual spending might look more like what we see in Figure 3. We could come up with a general budget for this, for example budgeting different amounts for travel at different stages, but it is not really possible to predict exactly how this will play out. For example, you may cut down on travel due to a change in health status or a couple of bad experiences.

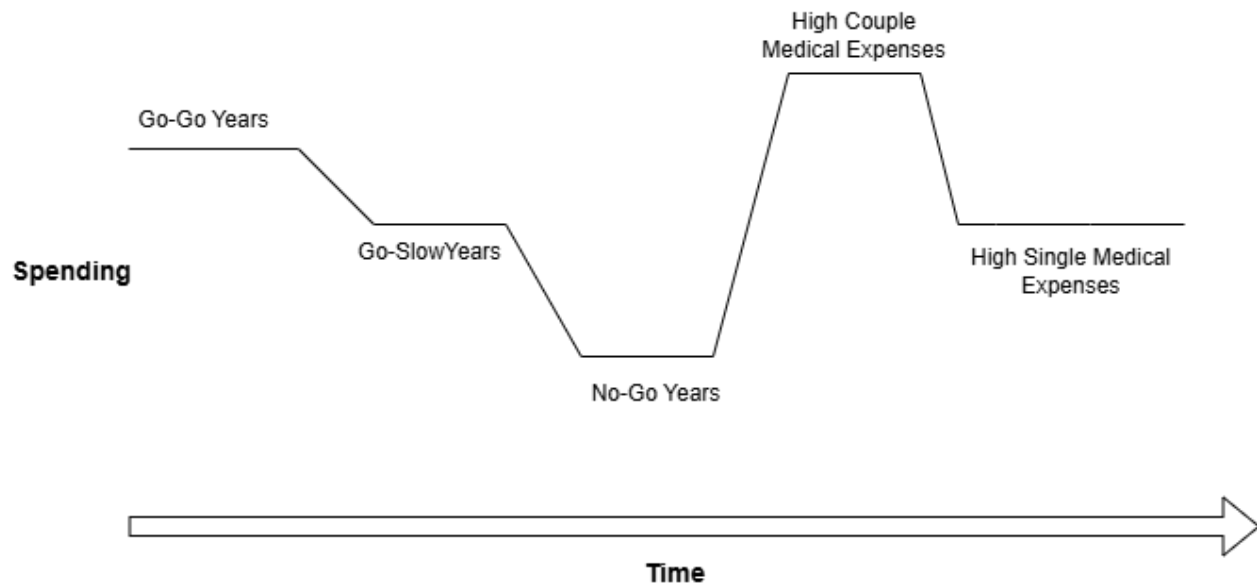


Figure 3 - Spending over Time

Another important consideration for your spending plan is what you expect to be doing for housing. You might be considering a second home. This is likely to significantly impact on

expenses. Later, you might consider a Continuing Care Community. These are communities that combine independent, assisted, and skilled nursing care with a guaranteed residency all funded via a condo-like buy-in model. The buy-in will cover some part of both the assisted living and nursing care which tends to moderate long-term care risks.

This notion of varying spending needs in retirement has, of course, also been addressed by academic and financial professionals. For example, in (Pfau, What is a Retirement Smile?, 2018), Wade Pfau, describes this anticipated dip and subsequent increase in spending as a “smile.”

3.3 A Brief discussion of Portfolio Models

The Portfolio model will do two things:

1. Enumerate and characterize your holdings. This characterization is likely to incorporate information about each holding such as net capital gains, asset class, fund expense ratios, etc.
2. Predict future behavior of the portfolio and possibly the individual holdings or asset class groups. These predictions may incorporate observations about individual holdings such as the Beta of the stock (a measure of its volatility relative to the overall market) and/or broader “asset type” observations such as “power companies behave this way.”

Portfolio models can get very complex; witness all the math wizards who have made very healthy incomes on Wall Street developing them. Most of that effort is devoted to the portfolio’s held by investment funds, but at a high level the goal for an investment fund is the same as the goal for an individual: manage risk and predict future behavior. The portfolio model is a useful tool for managing the portfolio and it certainly relevant to the retirement planning model. That said, retirement planning can be done effectively by incorporating summary information about the portfolio. For example:

- Size of the portfolio accounts
- Asset allocation (e.g. The Equity vs Fixed income ratio)
- Account type (unqualified, IRA, Roth IRA)
- Net Capital Gains

3.4 An Introduction to Retirement Funding Models

The Retirement Funding model takes your assets and other sources of income and maps these to your spending needs. The model will often incorporate decisions along the way such as what accounts to draw from first.

The retirement funding model is responsible for predicting how much you will have to spend (or conversely how much you have left after spending what you want to spend), where the funds will come from, and how your portfolio will change over time. The model will manipulate the value of accounts along the way (Earnings, Withdrawals to support spending, Roth transfers, RMD's, etc.) and calculate income tax liabilities. It will incorporate assumptions about external drivers such as investment rate of return and inflation.

3.5 The Safe Withdrawal Rate

One popular approach to assessing the sufficiency of savings to support retirement spending is to focus on how much you can safely withdrawal. The original statement of this was the 4% rule:

If you take 4% out of your savings in the first year of retirement and then adjust the dollar amount upwards each year for inflation you are unlikely to run out of money.

This is attributed to Bill Bengen, a financial adviser in Southern California who created it in the mid-1990s. Since then, there have been many variations and critiques of this including:

- 3% is safer, especially in “low yield” markets.
- 5% is often possible.
- It is better to adjust the rule based on current market conditions or portfolio changes.
- Is “not running out of money” really the proper goal?

Notwithstanding all the handwringing since the original introduction, this has largely stood the test of time, so it is certainly useful. But it is not really a complete “retirement funding” model because it does not incorporate other sources of income or the many complexities of taxation.

3.6 Simple Retirement Funding Models

We will look at a few “back of the envelope” models of increasing complexity to introduce modeling. The retirement profile is as follows:

- \$60K Emergency fund
- \$38,000/Year from Social Security
- A \$600,000 retirement savings fund that you will start to draw at 4% following the 4% rule
- You are expecting to pay 13% income tax on this income

The model is simple:

$$\text{Spending} = (\$38,000 + 0.04 * \$600,000) * 0.87 == \$54,940$$

Since you are planning to adjust the 4% value by inflation and we know Social Security is indexed for inflation, you have a spending value in today's dollars. That is the entire model and, if you got the average tax right, it is probably close! If you can develop a budget with spending comfortably below \$54,940, you are good to go. If not, you will need to consider alternatives such as continuing to work to increase Social Security payments or working part-time in retirement. If the only question you want to answer is "do I have enough to retire?" this might be enough. But most of us have other questions to answer including this key "comfort" question:

Where will the money come from on a year-to-year basis?

Developing a more accurate view of retirement income requires that we move to an annual view since your situation will change from year to year. To demonstrate this, let's now move on to a slightly more complicated model. Assume that there is also a pension valued at \$30,000/year that is not indexed for inflation. Since we have discovered this pension, we will reduce the saving draw to a more conservative 3%. The spendable income in inflation-adjusted dollars now changes each year. For this we will need another parameter:

Estimated Annual Inflation. We will use a middle-of-the road estimate of 3% for inflation. What this means is that after 20 years your pension is only worth a little more than half of what it is at the start. As a result, our spendable income in "year 1 dollars" has shrunk over time.

Year	Pension	SS Value	Draw	Before tax Income	Spending Ability
65	30,000	38,000	18,000	86,000	74,820
66	29,126	38,000	18,000	85,126	74,060
67	28,278	38,000	18,000	84,278	73,322
67	27,454	38,000	18,000	83,454	72,605
69	26,655	38,000	18,000	82,655	71,910
70	25,878	38,000	18,000	81,878	71,234
71	25,125	38,000	18,000	81,125	70,578
72	24,393	38,000	18,000	80,393	69,942
73	23,682	38,000	18,000	79,682	69,324
74	22,993	38,000	18,000	78,993	68,723
75	22,323	38,000	18,000	78,323	68,141
76	21,673	38,000	18,000	77,673	67,575
77	21,041	38,000	18,000	77,041	67,026
78	20,429	38,000	18,000	76,429	66,493
79	19,834	38,000	18,000	75,834	65,975
80	19,256	38,000	18,000	75,256	65,473

81	18,695	38,000	18,000	74,695	64,985
82	18,150	38,000	18,000	74,150	64,511
83	17,622	38,000	18,000	73,622	64,051
84	17,109	38,000	18,000	73,109	63,604
85	16,610	38,000	18,000	72,610	63,171

Table 2 – Model of Unindexed Pension

Table 2 introduces the use of the Compound Interest Formula:

$$V_{t2} = V_{t1} * (1 + r)^t$$

Where:

- V_{t2} – Value at Time 2
- V_{t1} – Value at Time 1
- r – Interest rate per period expressed as a fraction
- t – The number of time periods

When used for inflation we divide the starting number by the inflation factor, so for example, at age 84:

$$30,000 * 1/(1.03)^{19} = 17,109$$

Let's take this simple model one step further and consider the impact of Required Minimum Distributions (RMD). RMD's are based on the balance of the IRA Account at the end of the prior calendar year and the account owner's age. We need to move to nominal dollars (unadjusted for inflation) values to calculate this and we need to calculate the account balance at the end of each year. To accomplish that, we need to fold in a notion of account earnings. We will assume 5% investment growth.

The formula for the end of the year balance can be:

$$B_2 = B_1 - \text{Draw} + (B_1 - \text{Draw}/2) * \text{Interest}$$

This is an approximation that assumes that money is drawn over the course of the year. This model uses the following assumptions:

- Start of Plan Age: 65
- Withdrawal rate: 3%
- Inflation rate: 3%
- Investment Growth Rate: 5%

Age	SS	Pension	RMD	Spend Draw	Actual Draw	EOY Bal	Taxes	Spend	Adj Spend
65	38,000	30,000	0	18,000	18,000	600,000	11,180	74,820	74,820
66	39,140	30,000	0	18,540	18,540	611,550	11,398	76,282	74,060
67	40,314	30,000	0	19,096	19,096	623,124	11,623	77,787	73,322
68	41,524	30,000	0	19,669	19,669	634,707	11,855	79,338	72,605
69	42,769	30,000	0	20,259	20,259	646,281	12,094	80,935	71,910
70	44,052	30,000	0	20,867	20,867	657,830	12,340	82,580	71,234
71	45,374	30,000	0	21,493	21,493	669,332	12,593	84,274	70,578
72	46,735	30,000	0	22,138	22,138	680,769	12,853	86,019	69,942
73	48,137	30,000	25,689	22,802	25,689	692,116	13,497	87,442	69,027
74	49,581	30,000	27,142	23,486	27,142	700,390	13,874	89,193	68,359
75	51,069	30,000	28,471	24,190	28,471	707,589	14,240	91,019	67,727
76	52,601	30,000	29,856	24,916	29,856	713,786	14,619	92,898	67,111
77	54,179	30,000	31,170	25,664	31,170	718,873	14,995	94,847	66,524
78	55,804	30,000	32,676	26,434	32,676	722,867	15,402	96,835	65,940
79	57,478	30,000	34,259	27,227	34,259	725,518	15,826	98,879	65,371
80	59,203	30,000	35,917	28,043	35,917	726,678	16,266	100,981	64,816
81	60,979	30,000	37,458	28,885	37,458	726,197	16,697	103,167	64,290
82	62,808	30,000	39,254	29,751	39,254	724,113	17,168	105,391	63,764
83	64,692	30,000	40,910	30,644	40,910	720,084	17,628	107,708	63,267
84	66,633	30,000	42,862	31,563	42,862	714,155	18,134	110,062	62,767
85	68,632	30,000	44,635	32,510	44,635	705,929	18,625	112,518	62,298

Table 3 - Model with RMD

We see the spendable income in real (start of plan) dollars drop as compared to the simpler model that did not consider RMD's because we must pay income tax on the entire RMD and not just the part that we plan to live on. Even simple models like this can help us understand the impact of changes to our assumptions. For example, changing from 5% growth to 4% growth reduces the IRA account balance at age 85 to about \$571K.

These simple models demonstrate both the strength and the weakness of a withdraw rate model. The strength is that it is simple and easy to understand. The weakness is that it probably does not reflect what you would do later in life. Consider Table 3 at age 70 or 75; would you take a forced reduction in your standard of living if your portfolio has continued to grow? You probably wouldn't. This suggests an alternative approach to creating a model like we have in Table 3; but rather than selecting a withdrawal target, select a target spending amount – possibly even starting with what the withdrawal target suggests for age 65. Then adjust the draw amount each year to yield the desired after-tax inflation adjusted spending. This goal-driven approach is the focus of much of the remainder of this book. The result of that process is presented in Table 4.

Age	SS	Pension	RMD	Spend Draw	Actual Draw	EOY Bal	Taxes	Spend	Adj Spend
65	38,000	30,000	0	18,000	18,000	600,000	11,180	74,820	74,820
66	39,140	30,000	0	19,440	19,440	605,640	11,515	77,065	74,820
67	40,314	30,000	0	20,923	20,923	610,037	11,861	79,376	74,820
68	41,524	30,000	0	22,450	22,450	613,097	12,217	81,757	74,819
69	42,769	30,000	0	24,025	24,025	614,722	12,583	84,211	74,820
70	44,052	30,000	0	25,644	25,644	614,805	12,961	86,736	74,819
71	45,374	30,000	0	27,314	27,314	613,240	13,349	89,339	74,820
72	46,735	30,000	0	29,035	29,035	609,910	13,750	92,020	74,821
73	48,137	30,000	25,689	30,807	30,807	604,690	14,163	94,782	74,821
74	49,581	30,000	27,142	32,630	32,630	597,455	14,587	97,624	74,821
75	51,069	30,000	28,471	34,510	34,510	588,070	15,025	100,554	74,821
76	52,601	30,000	29,856	36,443	36,443	576,393	15,476	103,568	74,820
77	54,179	30,000	31,170	38,437	38,437	562,277	15,940	106,675	74,820
78	55,804	30,000	32,676	40,490	40,490	545,563	16,418	109,876	74,820
79	57,478	30,000	34,259	42,604	42,604	526,086	16,911	113,172	74,820
80	59,203	30,000	35,917	44,782	44,782	503,673	17,418	116,567	74,820
81	60,979	30,000	37,458	47,026	47,026	478,141	17,941	120,064	74,820
82	62,808	30,000	39,254	49,337	49,337	449,301	18,479	123,666	74,820
83	64,692	30,000	40,910	51,717	51,717	416,949	19,033	127,376	74,820
84	66,633	30,000	42,862	54,168	54,168	380,876	11,180	131,197	74,820
85	68,632	30,000	44,635	56,693	56,693	340,860	11,515	135,133	74,820

Table 4 - Adjusting Draw for a Spending Goal

Table 4 is our first concrete example of goal-driven modeling. Take a moment to compare this to Table 3. The most important difference is that we are living better in retirement. But there are some other important differences. We see that, as expected, the value of the IRA drops considerably more. (Note that even in Table 3, the value of the account has dropped significantly due to inflation). A subtle change is that we are no longer negatively impacted by RMDs since we are planning to take the money out to spend anyway.

This raises the question; can we afford to take the money out at this rate? We will dig into this decision-making in much more detail in subsequent chapters. The brief answer for now, is “maybe.” It will depend on your risk tolerance, desire to leave a legacy, etc.

There are many additional complexities that come into play:

- “Reasonably accurate” tax calculation is *much* more complex than the simple models show in Table 2 and Table 3.
- You might be planning on working part time for a while
- If you are creating a retirement plan with a partner, you need to maintain separate data for at least Social Security and traditional qualified accounts.

- Unqualified accounts need to be considered both for the purposes of supporting retirement spending and calculating taxes
- You may want to account for Roth accounts and Roth conversions
- You might have or be considering an annuity
- Some expenses such as health care and property tax may be income tested
- You might be waiting to take Social Security - leading to a need to draw more up front.
- You might move to a state with different income tax rules

Clearly you don't want to try to address this complexity on a notepad with a portable calculator. You need a tool of some sort that bakes in the simple, but necessary, arithmetic.

3.7 Creating your own Spreadsheet Model

Table 2 and Table 3 just call out for a spreadsheet; that is much easier than doing that math by hand! It is a good idea to develop your own model even if you are looking to eventually use a modeling tool because it will provide you with an understanding of the mechanics – and it really isn't that difficult. The following is a roadmap to building your own personal model in a spreadsheet:

1. Start with columns to capture year and participant ages
2. Add a set of columns representing income sources such as:
 - a. Social Security for each partner
 - b. Any pensions
 - c. Continued work plans
 - d. Draw from qualified and unqualified accounts
3. Add a set of columns for different key accounts:
 - a. Probably an unqualified brokerage
 - b. Qualified accounts – you will need a separate account for each partner, but you can combine the values for each partner, if a partner has more than one account.
 - c. A Roth Account
4. Add columns for RMD's from the qualified accounts
5. Add columns to deal with taxes:
 - a. Calculation of taxable income (quite possibly separate for State tax)
 - b. Calculation of taxes. This will probably include at least a few columns to define brackets. You need columns for the brackets because federal and many state brackets are inflation-adjusted.
6. Add a column that shows the resulting spending before and after inflation.
7. Add cell formulas to define the vertical math:

- a. Indexing SS, brackets, spending etc. for inflation
 - b. Calculating new account values based on withdrawals and earnings
8. Add cell formulas to define the horizontal math:
 - a. Calculation of taxable income
 - b. Calculation of taxes
 - c. Calculation of spending ability

Once you have the model in place you can use the “Draw” columns to adjust the spending for each year.

There are several different “parameters” in play here. The key ones are the expected *investment earnings* and *inflation*. You can just bake these into your formulas, but it is better to start a small table at the bottom of the sheet (or in another sheet) that contains these parameters so that they can be easily viewed and changed.

Keep it as simple as you can, adding new columns and mechanisms only when necessary. For example, the rules for calculating how much of your Social Security income is taxed are a bit complex, but if you fall in the 85% category like an increasing number of people, you can just bake this 85% number in. Once you have your own model you can test it using tax preparation software and a dummy return.

Taxes are complicated. We can’t hope to be 100% accurate because that would demand recreating the functionality of commercial tax software and capturing a lot more data about your personal finances, but you may want to get reasonably close if you are looking for the model to help you make tax sensitive decisions such as Roth conversions.

Federal income tax has three primary components for most individuals:

- Ordinary tax – this is the tax due on the bulk of your income based on what tax bracket you fall in
- Net Investment Income tax. This is additional tax on investment earnings that “high” income individuals must pay
- Long term capital gains tax.

Ordinary tax can be calculated via a single (but rather long) formula in Excel:

$$IF(I < B_1, R_1 * I, B_1 * R_1 + IF(I < B_2, R_2 * (I - B_1), R_2 * (B_2 - B_1) + IF(I < B_3, \dots))) \dots$$

Where:

I – Taxable Federal Income (probably a cell reference)

B₁ – Bracket 1 Cell Reference

R_1 – Rate for Bracket 1 (probably a cell reference)

B_2 – Bracket 2 Cell Reference

R_2 – Rate for Bracket 2

The “IF” statement is an Excel formula element that has the following form:

IF (TEST, VALUE1, VALUE2)

Where:

TEST – A logical expression that evaluates to TRUE or FALSE

VALUE1 – The value to return when TRUE

VALUE2 – The value to return when FALSE

This needs to extend to at least the set of brackets relevant for your situation.

Depending on your situation you might need to consider the following:

- Additional SS tax for “self-employment”
- Paper losses from business activities
- Alternative Minimum Tax

State Income tax calculations range from trivial (no tax at all) to quite complex. You will probably want to focus on just a single state.

If you got this far, you have a usable model. Congratulations! You may or may not want to make this your model. Bear in mind that there are many additional elements that might be folded into it, for example:

- Medicare premium costs go up with income (effectively another tax)
- Federal Tax law is likely to be changing
- Other (“Non Ordinary”) Federal tax such as AMT, Capital Gains, etc.
- Roth conversions

3.8 Spreadsheet Hints

Spreadsheets are marvelous tools, but they are easy to make mistakes with. The following are a few hints that will help you manage more complex spreadsheets:

1. Make liberal use of intermediate-value columns. Often you are faced with a choice of a relatively long formula or a simpler formula that combines intermediate calculations. For example, bracket-based tax calculation can be simplified by

introducing a set of columns that contain the total tax due up to a bracket (the way old-fashioned paper tax forms worked). This will simplify your formulas and sometimes more importantly provide a good means of debugging the behavior.

2. Use an external text editor such as Wordpad for very long formulas. This will enable you to see the entire formula making it easier to spot mistakes. Cut-n-Past the formula back and forth between Excel and your editor of choice.
3. Avoid embedding constants in formulas. Instead use references to cells that contain these constants.
4. Be mindful of absolute cell references vs relative cell references. The explicit cell references in Excel are preceded with a "\$." Sometimes you want one and sometimes you want the other; in general, your references to parameter cells will be absolute whereas your references to other cells in the same row will be relative.
5. When working with a formula, it is generally best to work with the first row. It is then easy to drag this updated formula down to the cells below.
6. Be careful when clicking on a Cell. You will need to do this to examine the formula in a cell. The Excel UI then leaves you ready to edit the cell. It is easy to mistakenly change the value of a cell.

3.9 Other approaches to building your own model

Does it really have to be Excel? No, of course not! Any reasonably complete spreadsheet will support basic retirement funding models. This likely includes even the very first spreadsheet: Visicalc 1.0 released in 1979 for the Apple II, as most of the calculations are quite simple and the scale of the model is modest (30-40 years).

For that matter, does it really need to be a spreadsheet at all? There are alternatives to traditional spreadsheets, but unless you are already familiar with them, they are not going to be reasonable choices. Financial models could certainly be built in MATLAB™ or in Python using its data management libraries. Beyond that, a well-rounded software engineer could pull together a data model and the code to support a basic retirement funding model in any traditional high-level programming language. This might be entertaining, but it is going to be a lot more work than firing up Excel or some other spreadsheet.

3.10 Parameterizing Retirement Models

Section 3.7 discussed capturing your expected rate of return and inflation as parameters off to the side of the main spreadsheet. There are many other parameters that are needed to fully characterize a retirement model; this section digs into model parameters a bit deeper. If you are using an established modeling tool you will find that it looks for most of these and possibly others. If you are building your own tool you will want to consider

organizing the tool to make these parameters explicit. There are several types of parameters for a retirement model. One type of parameter describes your current situation. For example:

- Single or married
- Your Age
- Expected Social Security at different commencement ages
- Retirement Accounts Values
- Tax Jurisdiction (for state and possibly local taxes)
- Pensions
- Spending needs

Another closely related set of parameters relates to decisions that you can make along the way:

- When to retire
- When to start Social Security
- When to start private pensions
- Plans to move to different tax jurisdiction
- What accounts to draw funds from
- Plans for commercial insurance
- Plans for Roth Conversions
- Income goal for couple and for surviving partner
- Plans for legacy or emergency fund

Yet another set of parameters are guesses about what the future will bring:

- Inflation Rate
- Expected Rate of Return
- Changes to tax laws
- Passing of the first partner

The more parameters there are, the more expressive the model is.

Many of these parameters have an aspect of allowing you to guess a relatively safe (financially conservative) future vs one that is less so. For example, inflation has a profound impact over a long period of time. The United States Federal Reserve has a public goal of 2% inflation. It seems unlikely that average inflation will be substantially less than this (although deflation is not impossible).

Parameter/Assumption	Risk Characterization
Inflation	Using a high expected value for inflation is relatively more conservative because it becomes more difficult to meet adjusted spending needs with higher inflation.
Federal Indexing	It is more conservative to assume that indexing does not quite keep up with inflation – in part because retirement expenses tend to be health-care heavy and health care inflation has tended to run ahead of the more general price indexes
Investment Earnings	It is more conservative to assume a lower earning level
Future Tax Law Assumptions	Assuming higher tax rates is more conservative
“Unindexed” Adjustments	Several important tax parameters are not indexed for inflation. Assuming that they will never be adjusted is the more conservative approach.
First Partner Passes	It is more conservative to assume that the first partner passes early because this tends to make retirement finances more difficult.
Minimum Balance Goal	It is more conservative to have a higher minimum balance goal
Social Security Stability	It would be more conservative to assume that Social Security benefits will be reduced at some point in the future, especially if you are at the higher end of payments.

Table 5 - Risk Characterization

Since we can’t predict the future, we should try to incorporate higher risk and lower risk alternatives into our planning process to gain an understanding of just how resilient our plan is to different possibilities.

3.11 Scenario Modeling Approaches

Financial planning involves different scenarios such as different rates of return, inflation levels, mortality, etc.; this is a fundamental aspect of the problem. Different tools take different approaches to the scenarios. Most tools have built in mechanisms for considering important choices such as Social Security commencement – they will report a “break-even year” when you come out ahead by waiting. They are implicitly considering two different scenarios in this case. Monte Carlo methods can be viewed in this same light. The Monte Carlo simulation evaluates many different automatically generated different scenarios and then summarizes the results in a statistical fashion.

Some tools allow for a set of different scenarios to be defined up-front. You explicitly create scenarios 1, 2, 3 etc. For example, a “high inflation” scenario and a “low inflation” scenario.

Other tools require you to rerun the model with a different set of inputs and “take notes” of the results of the different scenarios.

Lastly, it is possible to automatically generate a set of scenarios by creating permutations of different input parameters. For example, we might have parameters representing different rates of return, different first partner mortalities, and different future tax law and then generate dozens or even hundreds of different scenarios by methodically considering each possible combination of parameters. This approach enables you to explore the solution space directly.

3.12 Goal Driven Modeling

Retirement modeling is all about goals; the most important of these goals is the spending goal. There are lots of ways that spending goals that might be expressed:

- Constant after inflation-adjusted spending amount
- Explicitly varying inflation-adjusted spend over the years
- Spending needs on passing of first partner
- Minimum Reserve (which becomes the legacy at end of plan). This seeks out the largest spending that has us never drop below a given value.
- Maximum Reserve. This follows a “you can’t take it with you mindset” or possibly simply avoiding estate tax. This is seeking a minimum spending amount.

There are variations and combinations on these. For example, a spending model might start with spending of S_1 and then reduce it after a few years if the reserve dips.

Alternatively, it might start back at year 1 and locate a constant spending amount that results in the desired minimum reserve. A spending model might specify both a minimum reserve and a maximum reserve.

What all the goal driven modeling has in common is that there is some software (code) as shown in Figure 4 that gets us to the goal. We need “code” because it is not feasible to represent these goals as closed-form equations.

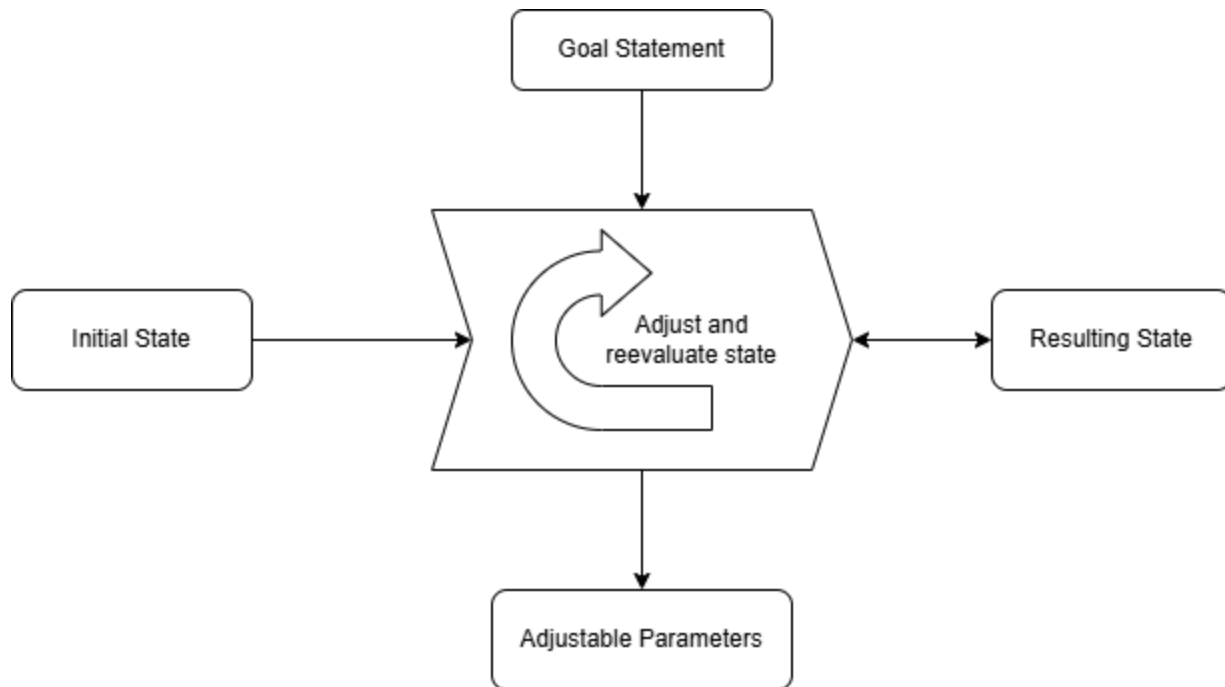


Figure 4 - Goal Seeking

An example of running this code might be:

- Initial State: Beginning of the year balances and expected external income
- Goal Statement: Inflation adjusted after tax spending for year = XXX
- Adjustable Parameters: Draws for IRA, Roth, Unqualified Accounts
- Resulting State: The calculated Draws, the final account balances, taxes, spending, etc. and projected spending that matches the goal.

Goal statements might be more complex including desired Roth conversions, income tax and Medicare brackets to avoid, maximum taxable income, minimum balance to maintain, etc.

Goal statements may be explicit such as “spend a specific amount per year” or optimization goals such as “find the maximum amount I can safely spend.” This type of optimization goal will lead to the use of two different goal-seeking algorithms:

1. The annual goal seeking described above
2. A plan-wide goal seeking that makes multiple passes over the entire plan

Not all models have automated goal-seeking, but it is convenient. That fact that “code” is required for the goal seeking doesn’t necessarily mean that it needs to be written from scratch. For example, Microsoft Excel incorporates a built-in goal-seeking mechanism.

3.13 Monte Carlo Models

A Monte Carlo model randomizes one or more parameters in a controlled fashion to predict a range of outcomes. The variable typically randomized is the *return on investment*.

A small bit of statistics is needed to discuss this. The most important concept is the *normal distribution*. A normal distribution of numbers (the numbers might be randomly generated or the result of a measurement) has the characteristic that numbers are evenly distributed on both sides of an average (mean) value with values clustered towards the mean to form a “bell curve.” There are different ways to characterize these normal distributions. The most common is specifying the *standard deviation*. The standard deviation (σ) is a measure of how dispersed the data is. Numerically, one standard deviation is the average distance of the measurements from the mean value. A more concrete way to view the standard deviation is in terms of how many measurements will be within N standard deviations of the mean:

σ_1 – 68.26 percent of the measurements will be within 1 standard deviation.

σ_2 – 95.44 percent of the measurements will be within 2 standard deviations.

σ_3 – 99.72 percent of the measurements will be within 3 standard deviations.

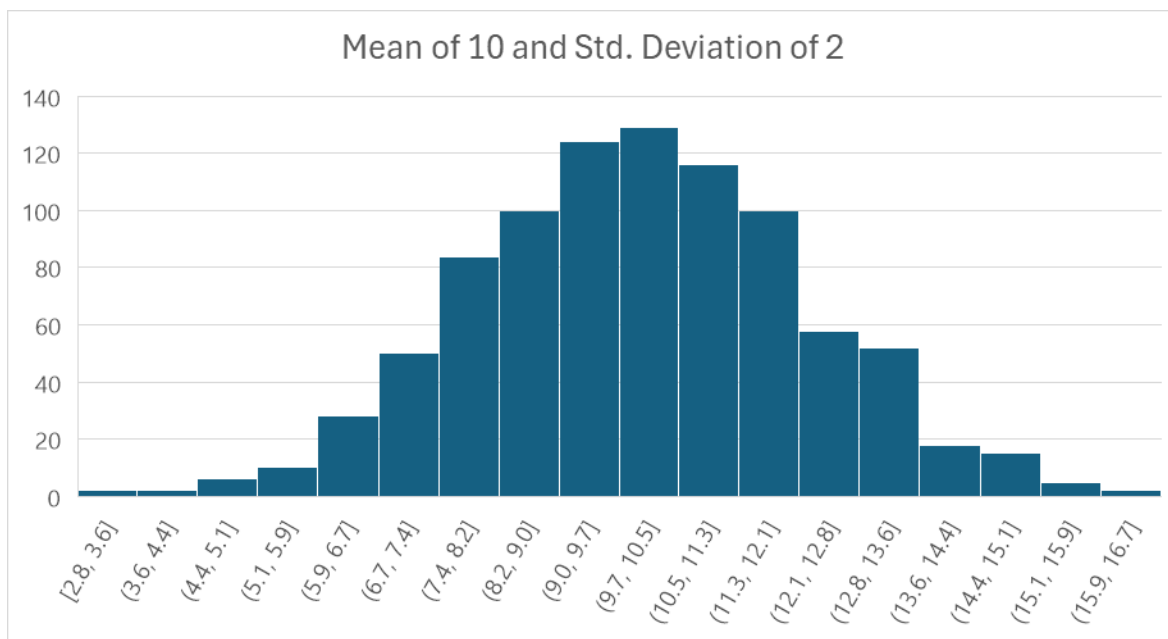


Figure 5 - Small Standard Deviation

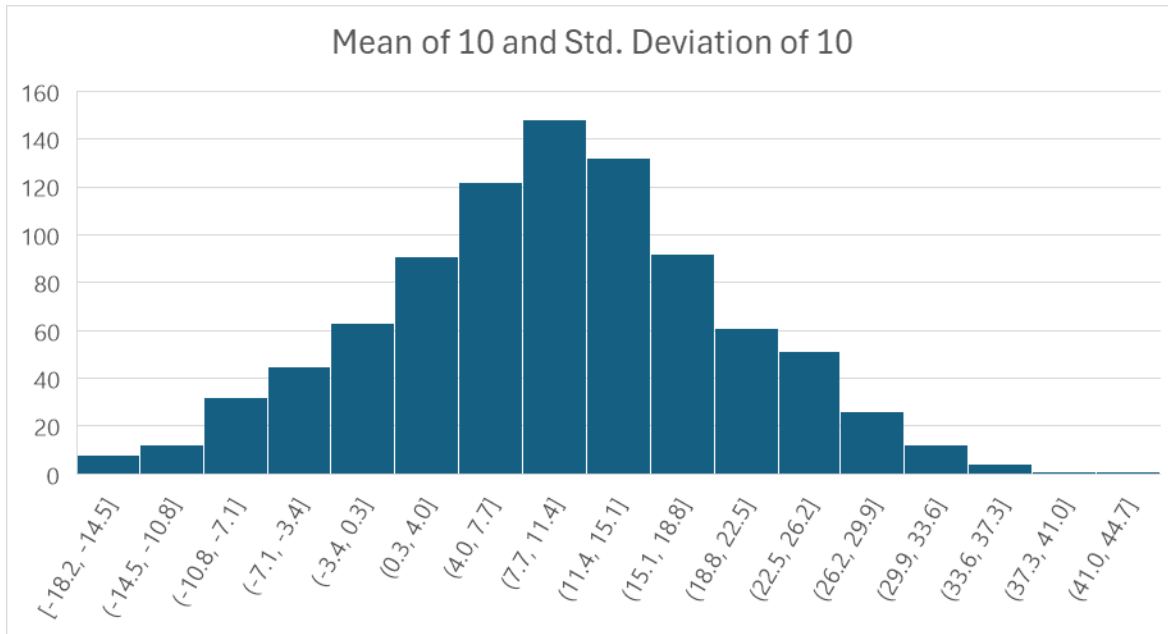


Figure 6 - Larger Standard Deviation

Figure 5 and Figure 6 are examples of normal distributions with the same mean value and different standard deviations. The vertical axis is the number of values present in each block of samples. The horizontal axis shows the data value range defining each block. Note that the horizontal scale is quite different; we can see that the data is much more widespread with a standard deviation of 10 than 2. These two graphs were generated using 1000 random values. If you look carefully, you will notice that the graphs are not perfectly symmetrical. Had we run this with 10,000 values, they would look much more symmetrical.

A random number generator will generate “nearly random” values across a defined range; most commonly from 0.0 to 1.0. How do we go from this evenly distributed set of numbers to a normal distribution? The general approach is demonstrated with a simple example. Consider the following formula:

$$P_2 = (P_1 * 2)^2$$

Where:

P_1 – A number selected randomly in the range of 0.0 to 1.0

P_2 – Resulting number distributed unevenly from 0.0 to 4.0

This is known as a *probability distribution formula*. We can see that half of the results will now be between 0.0 and 1.0 and the other half spread out from 1.0 to 4.0, with relatively

few values between 3.0 and 4.0. The *probability distribution formulas* to generate what we see in Figure 5 and Figure 6 are more complex but follow the same general approach.

Monte Carlo models for retirement modeling (or more generally portfolio modeling) take the following general form:

1. Repeat thousands of times:
 - a. Use a probability distribution to assign a rate of return (and possibly other parameters) for each year (creating a specific scenario)
 - b. Run the model for this scenario.
 - c. Evaluate scenario for success or failure.
2. Report success/failure statistics.

There are important nuances:

- What is the definition of “failure?” The most common approach is to simply use “running out of money,” but you might prefer to view failure as dropping below a threshold.
- Is there any mechanism for spending reduction in “bad” scenarios?
- Most importantly, what standard deviation(s) should I use?
- Does the model evaluate other parameters such as longevity or inflation via Monte Carlo methods?

Where do the standard deviations come from? Standard deviations are based on observations of past behavior for a particular asset class. There are several challenges to this:

- Some types of assets have not been around for all that long. For example, Collateralized Loan Obligations (CLO’s) are relatively new.
- Future volatility may not reflect past volatility.
- Many market indexes are relatively new.
- The sample size (total number of years) we are looking at is small, making statistical evaluation of the numbers suspect.
- Historical returns for equities have fat tails that don’t match normal distributions.

Many models settle on a standard deviation that is in the general neighborhood of the rate of return of that asset (or possibly some factor of that such as 2X of this return); this is aligned with what you would expect since riskier investments will carry a “risk premium.”

What is the standard deviation for a portfolio with multiple asset classes? The typical retirement portfolio has more than one asset class. The simplest view of this is bonds vs stocks, but there is no reason that we cannot have several asset classes with different

rates of return and different individual standard deviations. Simple math combines the standard deviations as follows:

1. Calculate variance for each asset class as the (fraction of total assets)² * (standard deviation for that asset)²
2. Sum the variances across asset classes
3. Calculate composite standard deviation as $\sqrt{\text{sum of variances}}$

Why does the plan sometimes fail? Random distributions have surprising characteristics. One of them is that “unusual situations” are inevitable. If the model is run 10,000 times for 30 years, it will generate a total of 30,000 different rates of return. Let us assume that we are looking at a rate of return of 6% and a corresponding standard deviation of 6%. The normal distribution will result in about 1368 years where we have a return on investment worse than -6% and 84 years where the return on investment is worse than -12%. The *unusual events* that we are **sure** to see are situations where several of these are clustered near each other early in the plan, and plans that have an unusual total number of bad years overall. These unusual events will have a devastating impact on those specific scenarios, making those scenarios much more likely to “fail.”

What about black swan events? A Black Swan event is a market crash that results in a substantial drop in portfolio value. We know that these happen, but they are not well-addressed by the normal distribution mechanism of a classic Monte Carlo simulation. Modeling mechanisms can be used to impose black swan events on top of the normal distribution.

The black swan events are important, but we also have corresponding white swan events. For example, the market was down 40% in 1931 but then up over 50% in 1933 and 1954. A normal distribution that has a large enough standard deviation to impose these events over a typical 30-year span will have a flatter distribution over most of the remaining years than we actually observe. There are two approaches to these “fat tail” events:

1. Impose events on top of a normal distribution with a modest standard deviation.
2. Use a larger standard deviation.

The reality is that the data is sparse enough and noisy enough that it is hard to have confidence that one approach is better than another.

What is the risk of spending too much? Another way of looking at the success/failure of the Monte Carlo simulation is that the risk of failure is a function of the spending level. Of course, risk increases as the spending level increases. This results in a spending-risk curve as shown in Figure 7 that is flat in the middle where spending is adequately supported by

the expected return and then rises steeply as the spending demands unusually good returns.

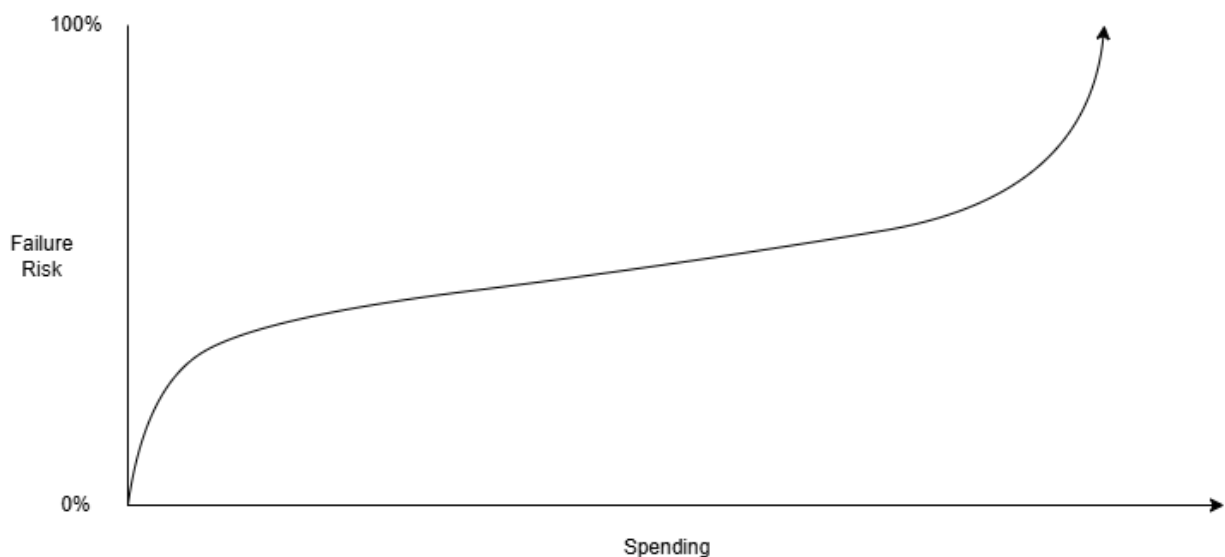


Figure 7 - Spending Risk Curve

You probably want to land somewhere in the long and gently rising center part of the curve: Accepting virtually no risk means you are shortchanging yourself. On the other hand, aiming for high risk means that you are unlikely to be able to maintain the initial spending level and is essentially “a plan to fail.”

What is a reasonable failure rate? At the end of the day the acceptable failure rate is an individual decision, but it should account for the failure criteria (is “failure” running out of money or the portfolio dropping below \$1M?), the freedom to change spending, and individual risk tolerance. Some authors have suggested that projected failure rates as high as 50% being acceptable, while others are looking for the low single digits.

3.14 Back Testing

Back testing is the process of using historic data to make predictions about the future behavior of a portfolio or a specific investment. There is substantial literature about Back Testing, much of it is aimed at investment professionals.

Back Testing can be incorporated into modeling tools that select different series of past rates of return to apply to the model. One challenge with this approach is that the number of such sequences is relatively limited with modern stock market records only going back to the 1870’s, and the further back in time we go the more “different” the past was in terms of taxes, regulations, and business environment.

4 What to model?

4.1 Richness of income and asset modeling

Any retirement model is going to address common income sources such as Social Security, pensions, and the possibility of continued regular (wage) income. It is also going to provide support for 3 key types of accounts: unqualified, regular qualified (IRA/401K/403B) and their Roth variants. There are many possibilities beyond that:

- Tax-advantaged bonds
- Annuities
- Health Savings Accounts (HSA)
- Inherited Trusts
- Inherited IRA or Roth accounts
- Physical assets such as real estate and precious metals
- External passive income
- Life insurance policies
- Bank Accounts

Since these different types of assets generally have different rules and behaviors (especially regarding taxes), a model that supports them needs to support them directly.

Another concern is the support for multiple accounts of the same general type. For example, does the model have support for an open-ended number of qualified accounts or does it assume a single qualified account for each partner? If you are only using the model to predict your overall financial situation, you only need one qualified account per partner. If you want it to predict the value of all of your liquid assets, then you might want multiple qualified accounts. Closely related is whether the model tracks individual assets for both partners or whether it assumes that assets are comingled – for example into a single unqualified account. Tax regulations can also lead to some complexity here. If an individual has multiple IRA accounts, all that is required is to meet the RMD requirements for the total value. However, if an individual has both IRA and 401K accounts the RMD's must be handled independently.

4.2 Income Taxes

The rules for tax calculations are quite complex. For example:

- Federal tax law has additional rules that come into effect based on income resulting in Net Investment Income Tax and Alternative Minimum Tax.
- The amount of Social Security income subject to tax changes with total income.

- Rules vary dramatically from state to state with some states having quite complex math.
- Medicare costs vary as a function of your income 2 years prior; this is best viewed as yet another tax.
- There are other expenses such as ACA (Affordable Care Act) health insurance premiums that are income tested. These expenses are “effectively” income taxes.

But it is worse than that because the situation is not static, even over the short term:

- Federal tax law is almost certain to change in 2025 as the 2017 tax law expires.
- State tax laws change regularly. As a point of reference, the JRNT tool described in the later sections of this book was initially configured to match 2024 tax laws. It needed to be updated for changes to 10 different states for 2025.
- You might move between tax jurisdictions.

Over the long term, things change even more. Tax law at both the federal and state levels change right along regularly depending on the politics of the moment. For example, over the last few years many states have eliminated income tax on Social Security. We also see occasional and completely unpredictable adjustments to tax parameters that are not indexed for inflation, and we may well see changes to how Social Security is taxed at a federal level. We also have had bold proposals to major restructuring such as wealth taxes, flat taxes, etc.

This leads to a bit of a conundrum. On the one hand we would like our tax calculations to be reasonably accurate. On the other hand, it is impossible for a model to accurately predict tax cash flows 20 years from now because we can’t predict exactly what tax law will look like over the next 20 years. But we can have complete confidence that it will *not* look exactly like it does today. One possible modeling approach is to allow the model to consider different possible “tax futures.”

It is quite possible that “taxes may be worse for you in the future,” but from a model accuracy and decision-making perspective it is equally troublesome for “taxes to be better for you in the future.” You will almost certainly be better off late in retirement if taxes are reduced, but how *much* better depends on decisions that you will make along the way. If you expect taxes to be high, the decisions are likely to be different.

4.3 What are we trying to measure and optimize?

The simplest things to measure are “did we run out of money” and “did we meet our spending needs?” (or what is the maximum I can spend). It is useful to go beyond that and provide a more nuanced measure of “goodness” of scenarios that haven’t outright failed. If

we are going to compare different scenarios in this regard, we need a measure of the financial “value” of our retirement. Looking out over the course of our retirement, one measure stands out:

Realized and Adjusted Total Value (RATV) = Inflation-adjusted spending + inflation and tax-adjusted value of assets

These 3 elements are as follows:

- **Realized and Adjusted Total Value.** The total value that you and your heirs achieve.
- **Inflation Adjusted Spending.** The total amount that you spend after paying income tax. This is simply the sum of the annual inflation adjusting spend that your model yields.
- **Inflation and Tax Adjusted Assets:** Balances that are adjusted both for inflation and for the taxes that are eventually due on them. The most important part of the tax-adjustment is to reduce the effective value of traditional qualified accounts (IRA/401K/403B/etc.) to reflect the tax liability, but we might also reduce the value of unqualified accounts to reflect capital gains.

One useful aspect of RATV is that it can be measured at “plan end” or at intermediate points. This allows us to track the impact of decisions such as Roth conversions and Social Security commencement over time. One tricky aspect of this is that RATV can only be estimated since we do not know exactly what the tax burden will ultimately be on qualified accounts.

Another useful aspect is that it values spending equally with assets. This provides a better comparison between plans with different spending amounts. Obviously if you spend more, you are going to have fewer assets at the end, but the difference in realized value will be less (how much less depends on your assumptions about investment growth rates)

How much tax will I owe on the IRA?

The easiest way to think about this question is: “given the current value of the IRA, how much of it is mine and how much of it is the governments?” This turns out to be a surprising hard question to answer.

The *Tax Adjustment* parameter is a *guess* of how much of a qualified (IRA) account you or your heirs expect to eventually hand over to the government in the form of income taxes on withdrawals. It is impossible to know exactly what this will be; we really do need to *guess*. The following will influence how much of the IRA you eventually hand over:

- The size of the IRA. This is a critical factor. The larger the IRA, the larger the RMD, and the larger the RMD, the higher the tax bracket you will land in as money is eventually withdrawn from the IRA. A large IRA will also push you into higher brackets early if you move the money out early via Roth conversions.
- Other sources of income. If you have other substantial sources of income in retirement such as Social Security and pensions, the RMD's should be thought of as "marginal" income above them, and they will land you in higher tax brackets.
- How long you live. RMD's increase dramatically as we age. If you live into your nineties, this can substantially increase tax rates.
- Where you live and when you might move. Taxes for different tax jurisdictions vary a lot, especially at higher income levels.
- Your heirs tax situation, including the number of heirs for the IRA. If you are drawing on the IRA in your nineties, the (unfortunate) probability is that you are doing it as a single. If you have multiple heirs and/or they are married, the required withdrawals are likely to be at a lower tax rate.
- The rate of return that is earned on the IRA over time. A generous rate of return might lead to a much larger IRA late in life, putting you in a less friendly tax bracket and reducing the percentage of the whole that you ultimately claim.
- The impact of other income tested "taxes" including Net Investment Income Tax and Medicare IRMAA.
- Whether any of the IRA is subject to (state) estate tax.
- How close any Roth conversions are to the ultimate "optimal" conversion

For a smaller IRA in a tax friendly jurisdiction and modest external income, this tax adjustment factor might come in at 80% or more (you get to keep most of it). For a large IRA in an unfriendly jurisdiction and/or substantial external income, it can be closer to 50%. Start by looking at your current tax returns and make a guess that is somewhere between your average tax rate and your marginal rate; probably closer to the marginal rate than the average rate. Then be ready to adjust it as your model is refined. Any guess here is going to be better than thinking that all of that IRA is yours to spend!

One interesting aspect of the tax adjustment parameter is that it can change over time. Consider an IRA with a balance large enough to force the owner into higher brackets late in life when RMD's are taken or early in retirement if aggressive Roth conversions are undertaken. Looking at the starting IRA balance the most reasonable view is that tax adjustment parameter is going to reflect these higher tax brackets. Let's say it is 30% for the sake of argument. Now consider this same IRA at age 85 after aggressive Roth conversions and withdrawals for RMDs and possibly living expenses. The remaining IRA might be only

15% or 20% of the original value and the RMDs are no longer large enough to pose a significant “bracket” risk. The tax adjustment factor for the remaining funds in the IRA will be less than for the original IRA.

The modeling required to make Roth conversion decisions can also help find the best value for this tax adjustment parameter. This is discussed in more detail in Section 5.4.

4.4 Setting Plan Goals

There are two related goals to consider. The first is “what is the maximum amount I can afford to spend per year?” The other is “how much will be available at the end of the plan?” These are related because there is a tradeoff between them. Spend less and you obviously have more at the end. These measures are more than just “personal goals;” they are also a vehicle for comparing different scenarios. For example, you might be trying to understand the impact of your investments earning 5% vs 6% a year over the course of retirement. Either of these goals is a perfectly reasonable way to view the same underlying math, but depending on your mindset and your situation, you might find one of them is a little easier to relate to than the other.

How large do you want your estate to be? The modeling process can help you understand what the range of possibilities are, but the model can’t choose your goals for you. Many folks come to this question with a “you can’t take it with you, so the smaller the better” perspective. Others have a desire to “leave something to their heirs.”

Let’s look at the case where the “ideal” estate is just enough to cover end-of-life expenses so that you are not a burden to your heirs (or to the state). Let’s also assume that you desire not to live in poverty or from the charity of others during your last years. This presents a bit of a challenge from a planning perspective since no one knows exactly how long they have. You can look at mortality tables and develop a plan to run out of money at age 90 based on the fact that as a 65-year-old, you have about a 50% chance of making it to Age 88. However, there is also a 24% chance you will live to 95 and a 9.6% chance you will live to 100. If you are a couple doing this math, the chances are higher *one* of you will make it that far. On top of that, the longer you live, the higher your “medical” and “assistance” costs are likely to be at the end of your life. Given all that, what is the “right” end of plan goal? This is a personal decision that needs to weigh your means, your early-in-retirement priorities, and your aversion to the “real but relatively unlikely” chance of being poor late in life. If your plan goal literally is “almost zero dollars at Age XX,” the plan is probably going to fail because the probability of you dying at any *specific* age is low. The plan will either “fail” with too much or it will “fail” with not enough.

Trading off Longevity and End-of-Plan balance

The larger the anticipated end-of-plan balance the closer you can *safely* be to using mortality tables to select the end of plan age. This is likely to come into play if your goal is to leave a meaningful estate but to spend it if necessary. For example, if you plan on an estate of \$1M at age 90, there is probably no need to run the plan out to 95 or 100 to test whether you run out of money. Of course, the reverse is also true; if your plan is to leave little or no estate, you should probably run the plan out a number of years past statistical mortality.

The impact of other assets on the plan

If you have substantial non-liquid assets, such as a house or a business that are not included explicitly in your retirement plan you can afford to be more aggressive with the plan since these assets will provide a “fallback” if necessary. If you are 96 and paying for nursing home care, you don’t really need that family home anymore.

Does your model support higher spending later in life?

Spending will tend to increase late in life for most of us. If your model does not explicitly support this, you may want to build in a bit more of a buffer.

With all that, a “safe” approach is to pick an estate size at a relatively late age that will have enough to carry you further down longevity probability curve if it has to. In other words, the plan is to leave X dollars at age 90 or 95, but if I live to 101, maybe not much at all. Of course, if you actually do desire to leave an estate, this thought process is quite a lot easier. A practical approach to setting this number is to take some fraction of your start-of-retirement assets. For example, a couple with retirement savings of \$1.3 million might decide to aim for 20%. This would be \$260K in start-of-retirement dollars. A little sanity check might then be done, but first a few assumptions need to be made such as:

- Targeted for Age 90
- High quality Assisted Living/Nursing Care is \$15K/Month
- One Partner has passed
- Other Income is \$3.75K/Month

The \$260K would then allow for about 2 years of care. Is that going to be enough? It might or it might not be. 2 years is a long time to spend in a Nursing home, but assisted living is almost as expensive and stays there can be substantially longer.

A Word of Caution

This \$260K is just a *goal*. Depending on the nature of your portfolio and a number of other variables outside of your control such as tax rates and inflation, there may be substantial risk associated with actually having this much money at Age 90. By the same token, there is a reasonable chance you could have several times this much.

Another safe approach is to rely heavily on annuities and other insurance products. With this approach you purchase sufficient annuities to cover close to 100% of your anticipated normal living expenses and then have additional insurance to cover eventualities such as long term and “final expenses.”

4.5 Life stage and situation

The model needs to support your life situation. Most importantly whether you are married or single. It also should support a possible transition from married to single as discussed in a little more detail in section 4.9. Beyond that, the tool might also provide support for the period before you enter retirement as well as some period of time after both you and your partner have passed as shown in Figure 8.

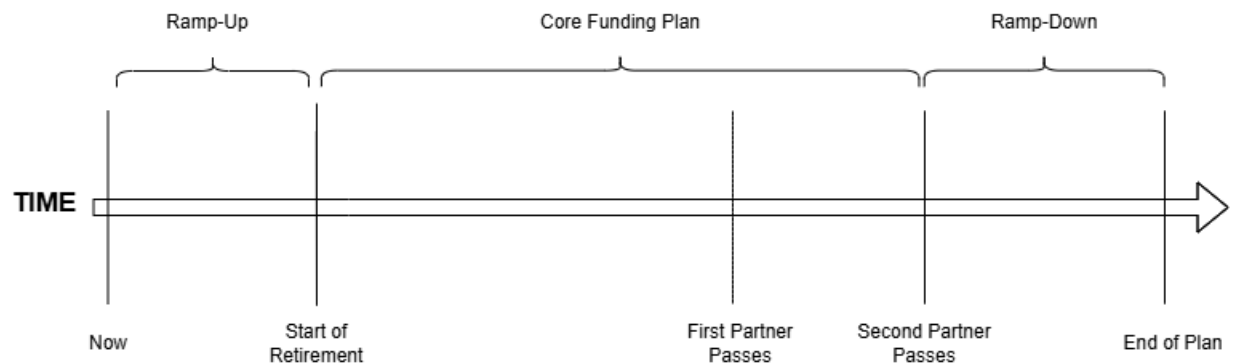


Figure 8 - Planning Stages

The *Core Funding Plan* deals with retirement. This is the period when the plan is responsible for establishing the spending and when assets are typically being drawn down. The Core Funding Plan might be dealing with either a “normal” retirement or an “early retirement.” Early retirement is maybe best exemplified by the FIRE (Financially Independent, Retire Early) movement, but in any case, it is going to have the following general characteristics:

- Waiting for Social Security and possibly pensions to become available
- Possibly waiting for qualified accounts to become readily available
- Using private health insurance, possibly via ACA (Affordable Health Care Act) programs

- A longer overall timeline than normal retirement

The *Ramp-up* period is that period between now and retirement. During this period, we are relying on outside income and are likely adding to our retirement savings. Why do we need this period? The *Ramp-up* period allows the plan to capture starting information such as expected Social Security payments in an explicit fashion. If a tool doesn't provide direct support for this you could estimate these values for some time in the future. It is still part of *your* model, but not part of your tool's model.

The *Ramp-down* period covers a period of time after both partners have passed. Why in the world do we care about modeling that? The primary reason for looking at this is that the value of the inheritance to your heirs depends on how that inheritance is going to be taxed. Federal tax law allows for inherited traditional IRA funds to be drawn for a period of 10 years with taxes paid as the fund are drawn. An inherited Roth on the other hand can continue to gain value untaxed for 10 years. The simplest way to assess the value at the time of inheritance is to run the numbers out another 10 years. That is not to say your heirs are necessarily going to do that, but it is a good way to compare scenarios.

A fully fleshed out ramp-down model will need to consider the potential of estate or inheritance taxes. Since estate taxes are generally based on the entire value of the estate, the model either needs to incorporate a complete understanding of all assets or it needs to be parameterized with an explicit guess about taxation. For example, a "simple" retirement model might not incorporate real estate holdings, but these will be part of the eventual estate.

4.6 Financial Decision Support

The bottom line for retirement planning is making the best decisions. Our retirement model is there to help us make these decisions. There are two aspects of this decision support. The first is whether the tool provides information that might be useful for specific decisions. For example, the decision about Roth conversions might be informed by the following:

- How much of our RMD is being reinvested because it is not needed for spending? Depending on tax projections, this likely represents a lost opportunity as it would be better to have these funds growing in a Roth account than an unqualified account.
- How much of our Income tax is associated with the unqualified accounts as we age? (Income on an unqualified account that has accumulated funds due to unspent RMD's represents a lost conversion opportunity.)
- What is our cumulative tax burden over time?

- What percentage of the estate is in Roth vs Qualified accounts? If your heirs are likely to be in a high tax bracket (say you have just one child who is an executive or a surgeon) getting more to the Roth makes a lot of sense. The reverse is also true.
- What is the Adjusted Value of our accounts as we progress?

The second aspect of decision support is more mechanical. How easy does the tool make it to compare different choices and “possible futures?” Are there graphical representations to help visualize the data?

4.7 Pensions and Annuity Income Sources

Pensions and annuities have complex behaviors:

- Tax treatment of pensions may vary – especially at the state level. Government pensions are frequently untaxed.
- Pensions and annuities may or may not be indexed for inflation.
- Pensions and annuities can have different sorts of survivor benefits ranging from “none” to “complete.”
- Annuities will have different tax consequences depending on how they were funded and details of the implementation.

A model that captures all of this is going to have to have quite a few different parameters to characterize these behaviors. Annuities are discussed in more detail in section 6.4.

4.8 Charitable Giving

Charitable giving during our lifetimes is a special sort of spending because it may have tax implications. A plan to donate some of the inheritance to charity also has tax implications since qualified assets will not be taxed. It would be unfortunate to convert traditional IRA assets to a Roth only to later decide to leave the Roth to a charity. A model which incorporates these plans can provide a better outcome for you, your other heirs, and the charities.

Another possible charity-related impact is the creation of a charitable trust that contains an annuity for the grantor.

4.9 How needs change for a Widow or Widower

The after-tax spending needs will tend to decrease for a single. Exactly how much they decrease depends on the situation. The “go-go, go-slow, and no-go” model presented in section 3.2 provides a framework. When you are younger, say with two cars and are traveling a lot, spending might decrease quite a lot. Later, the change will likely only be modest. One person living in a smaller house or apartment with moderate medical

expenses and little travel doesn't spend that much less than two. Late in life when medical/assisted-living expenses are more likely to dominate, there might again be a significant decrease in expense.

After tax spending is only part of the story here. The other part is that your external income from sources such as pensions and social security is likely to be lower and your income taxes are almost certainly going to be higher as you move to a "single" bracket.

4.10 Broken Promises

Some possible future situations are best seen in the light of "unfortunate but reasonably foreseeable." For example, increases in tax rates, low returns on investment, continuation of historic inflation trends. Others amount to something more akin to a broken promise. Consider for example:

- A pension plan going bankrupt
- An annuity guarantor going bankrupt
- A reduction in Social Security Payments as the Social Security fund runs out of money
- Elimination or drastic reduction in Medicare benefits
- Dramatic increases in Medicare premiums
- A return to the confiscatory tax rates of the nineteen fifties and sixties
- A change in Social Security commencement rules (if you are still far off from collecting)
- A complete collapse of the US equity market
- A dramatic change in government funding model. For example moving to a flat tax or the introduction of a wealth tax
- A move to start taxing Roth accounts
- Failure of a trustee holding uninsured assets such as an IRA
- Fraud on the part of a trustee
- A collapse of the purchasing power of the dollar due to runaway inflation
- World War III

It is possible to have a model and plan for any of these. But that is not a worthwhile exercise for most of us because the cost of accommodating these unlikely situations would dominate the model. If your world view holds one of these to be "reasonably foreseeable," then attempt to accommodate it in your model – either explicitly or by maintenance of sufficient reserves.

Modeling a broken promise is going to be easier if you have developed a model from scratch or if you are using an open and extensible model. For example, it would be trivial to for anyone with modest Excel spreadsheet skills to add a future reduction in Social Security payments to the JRTN modeling tool as the examples in sections 12.1 and 12.2 demonstrate.

4.11 Modeling Retirement Risks

There are lots of different types of risks associated with retirement, but one of the existential risks for many retirees is that their portfolio may not perform as planned. This is an important risk because of the outsize impact that net (after inflation) long-term return-on-investment has on personal finances. The future is full of other sorts of risks. For example:

- Inflation – this risk is tied to the investment risk, but it also stands alone since indexing of non-investment income will often lag. Inflation also presents a Tax risk since some elements of tax law are not indexed.
- Low investment rates and or market corrections
- Tax law changes. Taxes going up are an obvious risk. But your plan is also at risk from your taxes going down since you are going to make decisions now based on anticipated future taxes.
- Unexpected expenses
- First partner mortality

There are two aspects of modeling risk. The first is trying to measure the risk in some meaningful way. The second important aspect is adjusting the model to reach an acceptable level of risk.

There are several approaches to evaluating this risk in a model:

- Use Monte-Carlo methods to predict the “chance of success”
- Evaluate the Funded Ratio
- Evaluate many scenarios and determine which ones succeed and which ones fail

Once we have tools for evaluating risk, it is time to look at what we can do to mitigate it:

- Model the maintenance of a buffer large enough to accommodate a substantial reversal.
- Use conservative model parameters as presented in Table 5 on page 25. Most importantly the growth rate estimates for your “higher risk” scenarios

- Explicitly model black swan events. These are bad years that have substantial negative impacts on investments.
- Maintaining an adjustable spending plan that allows for a reduction in spending when called for.

We will then want to update the model with these risk-accommodation changes. What we will find is that nothing comes for free. Lowering risk will usually come at some cost such as lower spending or a reduced legacy anticipation.

Measuring Risk

Monte Carlo mechanisms were discussed in more detail in Section 3.13. The end result of a Monte Carlo simulation is a probability of success. In other words, how likely are you to not run out of money?

The sufficiency of savings and known future income to support retirement needs is sometimes referred to as the *funding ratio*. This is very simple:

$$\text{Sum}(\text{Assets})/\text{Sum}(\text{Liabilities})$$

Both assets and liabilities have fairly expansive definitions. Assets are of course your retirement accounts, but also income sources such as pensions and social security. Liabilities are income needed for living expenses, desired legacy, contingency fund, etc. If the funded ratio is greater than 1 you are “good.” If it is less than 1 you are not quite as good. One challenge with this is that it is heavily dependent on assumptions about future inflation rates.

The funding ratio essentially asks the question “assuming no investment gain or loss over the course of retirement, do I have enough?” This is a conservative measure since, historically, there has almost always been *some* investment gain.

If many different scenarios are defined and evaluated, it is also possible to simply measure the success rate. For example, JRTN provides the following sort of summary:

Summary Statistics		
	Counts	Percent
Insufficient Funds	737	24.6%
Failed to meet Reserve	573	19.1%
Total Failed	1310	43.8%

This might be horrible, or it might be acceptable. The only way to know is to review the failed scenarios and try to judge just how likely they actually are.

Mitigating Risk

Once you can measure the risk, you can look at ways to mitigate it. The traditional approach to dealing with risk is a combination of accepting the risk and *hedging* against the risk. Hedging generally means making financial decisions that are sub-optimal in the event that the risk does not manifest itself but which improve the outcome when the somewhat unlikely event does happen. Examples of hedging include:

- Doing Roth conversions as a hedge against higher tax rates in the future – even when there is no compelling reason to convert based on today’s rates and your financial model.
- Purchasing commercial insurance
- Waiting to start Social Security as a hedge against living long past what mortality tables project
- Maintaining cash and bond-like investments as part of the portfolio

Modeling risk is a key element of a retirement model because these models are trying to look so far into the future. It is touched on from several different perspectives in this book.

5 Using Your Model to Help Make Decisions

As you face retirement, you are looking at many decisions. Since these decisions are generally *irreversible*, it is important that they be as informed as possible. Consider the “retirement” decision. Depending on your situation it may be difficult or impossible to reverse this decision. Yes, of course, you could change your mind and go back to work. But are you going to find comparable employment opportunities? For many professionals, the realistic answer is “probably not.” Best to get it right the first time. There are lots of other examples:

- There are restrictions on how Social Security can be paused
- A large spend such as motor home or a round-the-world trip is not reversible
- The purchase of an annuity is generally not reversible
- Once an IRA to Roth conversion is done, it cannot be undone
- After January 1, you can not go back and make a Roth conversion for the previous year

5.1 Can I afford to Retire?

This decision requires a view of your expenses, assets, and of incomes streams that are independent of your assets such as Social Security, Pensions, and Annuities. Once you have the numbers, this is a straightforward decision to make, you either have a plan that provides sufficient spending, or you don't. The challenge is in getting to numbers that you have confidence in.

Section 3.6 introduced a very simple model for making this decision: sum up your external income sources and then use the 4% rule to see how much your retirement saving can yield. That is a good start, but you can have more confidence in the numbers when they are provided in the context of supporting details. The gold standard is a year-by-year plan that documents sources of income, taxes, account balances, and after-tax spending. You can also have more confidence when the numbers consider various risks such as market corrections.

Confidence in the overall decision also depends on how confident you are of the spending figure. Is this spending plan similar to existing spending habits? If so, you are probably in pretty good shape. Alternatively, is it based on a careful budgeting exercise? In that case you are probably also in good shape. If on the other hand it is based on a vague guess that you will be able to cut existing spending by a substantial amount, you are likely on thin ice.

5.2 When can I afford to retire?

This is a close cousin to the “Can I afford to retire now” question. If your modeling tool provides direct support for pre-retirement years it may be able to answer this question directly. If not, you can manually iterate a few times through the “Can I afford to retire now” question with different hypothetical start years and financial situations.

5.3 Roth Conversions

A Roth Conversion is a transfer from a qualified account such as a traditional IRA to a Roth account. The transferred funds are taxable as regular earned income at the time the transfer is done. Roth Conversions can be done at any age, but if they are done after RMD’s start then they must be done in addition to the RMD’s. If Roth Conversions are done before the age of 59 ½, then it is important to pay the income tax due using outside funds to avoid the early withdrawal penalty.

Your qualified account balance such as a regular IRA is an asset that you jointly own with the income tax authorities. The part that you owe the government is debt. The Roth Conversion is a tool that allows you to pay off this debt at a time of your choosing rather than waiting for RMD’s to demand the money. The government would like their money as soon as possible. Roth Conversion is a vehicle to entice you to pay this debt early. But just because they have enticed you, doesn’t necessarily mean that this is the best move for *you*. The *enticement* is the allowance to move the money to a Roth; paying taxes and moving the money to a traditional unqualified account is nowhere near as attractive.

Arguments For	Arguments Against	Discussion
Tax rates will increase if one of us passes early		The survivor will then be faced with “Individual” brackets which will increase the tax rate.
Tax rate will increase due to income changes		This is easily modeled. In the future your income streams will consist of fixed income such as Social Security and Pensions, unqualified account income, and RMD’s from qualified accounts. It is not uncommon for this to project a higher marginal tax bracket at 85 than at 65.
Tax rate may increase due to tax law changes		We can expect tax laws to change as the 2017 federal law expires. At any rate high current federal deficits would rationally argue for rate increases.

Arguments For	Arguments Against	Discussion
	Taxes will decrease due to jurisdiction change	The reverse is also true, but since it is more common for Retiree's to move to lower tax jurisdictions, we will account for it here.
	An unnecessary early debt payment	You likely wouldn't pay any other zero interest debt early. The money you are paying out for the Roth Conversion could instead remain invested. This, of course, was part of the original IRA/401K value proposition. This is a weak argument because the government is in fact participating with you as a "joint owner" of your qualified account.
The Roth IRA may be better for my heirs		This largely comes down to a comparison of your tax situation to your heirs. In some situations, the Roth conversion might also help to avoid some inheritance tax.
	The value of taxes I pay in the future is reduced by inflation	Since we are looking at about a 20-year delay, the impact of inflation may be significant. But, this is effectively baked into to increase in value that your account sees. It is true you are paying taxes inflated dollars, but it is also true that some of the increase in tax debt is due to the assets value keeping up with inflation.
Re-investment of unneeded RMD's is a lost opportunity		If you don't need the RMD's for spending then you are most likely to invest them in some sort of unqualified account – the earnings on which are now taxed. We could then say in hindsight that it would have been better to be more aggressive about Roth Conversions.
Having assets in different classes of accounts provides flexibility.		Unqualified, Qualified, and Roth accounts have different tax consequences. It is helpful to have all 3 available to manage taxes.
Conversions done before 65 don't risk increased Medicare premiums		Medicare premiums go up as MAGI grows, so it may be helpful to take this income before using Medicare.

Arguments For	Arguments Against	Discussion
Taxes on RMD's are more likely at the marginal rate.		To the extent that RMD's represent "additional income", this income should be considered at the higher marginal rate. If a conversion accounts for a substantial portion of income at a younger age, the impact is closer to the lower average tax rate.
The total value of RMD's over time is almost certainly higher than the conversion amount due to account growth. Therefore, more tax will be due.		This is the central argument from author and Roth advocate Craig Wear. (Wear, 2022). It is certainly true, but it turns out that the impact of the growth of the government loan to you pays for the additional tax needed for the larger RMD's if you were go the no-Roth route.
There is little change in the effective (taking into account money eventually owed the government) net worth as a result of a Roth conversion.		This could possibly be an argument either way. Rather than being a strong argument in either direction, it acts as a buffer making either decision "not so awful."
	My income is temporarily higher now due to external considerations.	This might be high wage income, an inherited IRA, or some other source. This is an argument for postponing Roth Conversions.
	Roth Conversions may have quite negative short-term consequences.	These include making more of Social Security taxable, increasing the cost of ACA insurance, and increased Medicare premiums. This is all true, but it is easily modeled since these "short-term" impacts have a direct impact on account values over time.
	Expected tax rates in the future may be the same or lower	Some personal situations will result in a high probability that you are not looking at higher marginal tax rates in the future. This is more likely the case for modestly sized IRA accounts. It can be a compelling argument not to do a conversion.

Table 6 - Roth Conversion Arguments

Various arguments are made for and against Roth Conversions as summarized in Table 6. Some people will be in a situation or have a mindset that one of these arguments dominates. For most of us, it just isn't that obvious. We have one set of reasonable arguments arguing for the conversion and then another set arguing against it.

Many books have been published about Roth IRA's. For example, (Wear, Roth Conversion Secrets - The 5 biggest mistakes Roth Millionaires make, 2022) which focuses on Roth Conversion. Most of these sources breathlessly promote conversions. That is overkill. The question just isn't that complicated; and it is best addressed with your financial model. A model driven analysis compares financial outcomes from different conversion scenarios – in effect incorporating both the advantages and disadvantages of converting into a single picture. Don't take my word for it. Just Run the Numbers! When you look at the numbers consider the following:

Modeling Parameter or Result	Discussion
Nominal total tax paid over the years	It is likely that this will argue for doing Roth conversions. It can be an impressive figure for a larger IRA balance.
Total inflation adjusted taxes paid over the years	The inflation-adjusted tax bill is probably a better number to look at. It will be less compelling than the nominal tax bill.
Your inflation and tax-liability adjusted assets over the years	This is the value that is likely of the most importance to you as it is more important what you have than what you pay.
Inflation and rate of return scenarios	These parameters will have a substantial influence on the absolute value of the results that you are looking at and may change the comparison between conversion and no conversion
Scenarios for when the first partner passes	Tax rates go up when the first partner passes since you move to a "single" tax bracket. You will want to assess the impact of one of you passing young as well as the case where you both live well past the "expected" lifespan.
Expectations for tax law change	We can be almost certain that tax laws change in 2025 (and probably again after that). Your guesses as to what happens here can have a significant impact on Roth Conversion sensibility.
How much to convert?	At some point Roth Conversions will likely start to become counter-productive.

Modeling Parameter or Result	Discussion
Plans for Charitable Giving	Plans for substantial charitable giving might argue against doing a Roth conversions since you are essentially sending that money to the tax collector rather than the charity.
Plans for Social Security Commencement	Initiating Social Security will increase taxable income and thereby increase the taxes owed on a Roth Conversion
Plans to change tax jurisdictions	An anticipated change in tax jurisdiction might increase or decrease future tax rates.
Other Taxable income	Other taxable income is a consideration at conversion time since it can increase the tax rate on the conversions. It is also a consideration for later in life. It is generally a good idea to plan on having sufficient taxable income to cover your deductions. Otherwise these deductions are essentially lost money. If you over-convert you might find that your low income late in life “wastes” deductions.
Plans to delay RMD’s	If you are still working and contributing to a 401K, you may be able to delay the RMD’s, but when the RMD’s do eventually start they will be at a higher level.

Table 7 - Roth Conversion Considerations

There is a lot to consider. With all these variables, a scenario-based approach comes in handy.

The model will help you make your Roth Conversion decisions, but it might not be “all about the numbers.” The tax liability associated with an IRA account is essentially a debt to the government. If you are particularly debt-adverse getting some of this debt off your plate may simply make you more comfortable. It is also a hedge against unexpected but possible increases in tax rates. The other element that is hard to measure with just numbers is risk management. One might look at Roth conversions simply to reduce the risk associated with early passing of a spouse or unfavorable tax law changes. A scenario-based modeling approach can help you understand what this would look like.

Inherited IRA’s and Large Estates

Inherited IRA’s are somewhat problematic if your estate is subject to estate tax. The estate tax law considers the entire value of the IRA, even though a part of this will eventually be owed to the government as regular income tax as your heirs draw down the IRA. In effect the estate tax is taxing you on assets that aren’t really yours. The Federal estate tax on an IRA is largely mitigated because it is a deductible expense for your heirs via the IRD (Income

in Respect to Decedent) deduction. That said, your heirs would need to know about this deduction, and they need to push past the standard deduction to get to it. This may or may not be true for states that impose estate taxes – and would certainly be challenging if the heir lives in a different state than where the estate is filed.

This winds up being another argument for Roth conversion for individuals with relatively large estates (regardless of the size of the IRA accounts).

5.4 Roth Conversion Optimization

Once you have concluded that Roth conversions might make sense, you are faced with the question of how much to convert, when to do the conversion, and any control parameters you would place on the conversion such as avoiding a specific Medicare IRMAA bracket. Roth conversions are interesting from an optimization perspective. You could simply take the long view and only consider only “end of plan” numbers, but this may have such a significant impact on the short term, that you want to back off a bit on long term optimization and try to have the short term a little closer to it’s optimum.

An important question to get out of the way is “what to optimize?” The financial press and some advisors would have us optimize (e.g. minimize) the amount of tax paid. This is intuitively attractive, but it is not the right answer for two reasons:

- The first, and most fundamental, reason is that the money you have “earmarked” for taxes in your IRA grows right along next to “your part” until you withdraw funds from the IRA. *Naturally* the tax bill is going to be higher because the amount being taxed is more. But tax rates being equal, this is just fine because now you have more money earmarked to pay the taxes.
- The second reason is related to the fact that tax rates are likely NOT to be equal as you age. High RMD’s late in life may push you into higher tax brackets. This “extra” tax you are paying due to higher rates is NOT OK. The problem is that it is difficult to accurately characterize just the *extra* tax because of the impact of Net Invest Income Tax, IRMAA, and the likely larger size of unqualified accounts from RMDs.

A more sensible approach is to focus on your financial situation at one or more points in the future. There are three advantages to this approach:

- It incorporates the complexities of taxes over time (including the fact that IRMAA is based on a 2-year look-back at income)
- It addresses concerns with “short term optimization.” By looking at your anticipated situation several years out, you are incorporating the potential impact of paying too much tax up front.

- It addresses the impact of inflation on the value of tax payments.

Taxes *are* important. In fact, they are the underlying driver for doing any sort of Roth conversion. If we thought that our tax rates were going to be lower in the future it would not make sense to do any Roth conversion (the original IRA premise). Indeed, this is the case for many retirees. For them, the optimal Roth conversion is zero. You should be skeptical about claims from a tool or an advisor to save you X dollars in taxes because they probably can't measure X. The only number that is meaningful here is the "Extra Taxes that are NOT OK." This is a difficult number to measure or even define; it is probably *not* what you are being presented with. It is helpful to run your own numbers and to look at the projected key values such as net assets and excess RMDs. Try to ignore the actual tax dollar values.

This is another opportunity for code-based optimization. For example, if we express the goal as "maximizing the tax-adjusted total value at a specific age," we can turn some software loose to find the corresponding Roth Conversion amount.

Roth conversion decisions are best approached in a two-stage manner. In the first stage we assess the approximate situation we would like to be in "mid-retirement" before RMDs become large. This might be expressed as a total amount remaining in the qualified accounts, an amount to convert, or a ratio of Roth/Qualified. Using a tool (or pushing a financial advisor) to create a picture like we see in Figure 9 can be a big help with this. Next, fine-tune your approach to meeting this total conversion goal, ultimately projecting how much to convert each year. This plan can then be tuned on an annual basis. For example, if the market has an outstanding year and your IRA is up 15%, you might want to consider increasing the conversion to enable you to continue to march towards a relatively small IRA balance.

With all of this we can propose a "personal algorithm" for managing your Roth Conversions:

1. During initial planning:
 - 1.1. Find a target conversion amount. With this you are probably also identifying a target "mid-retirement" financial situation in terms of how much is in Roth and how much is in qualified accounts. You likely wouldn't be too far wrong starting with something like a 75% Roth/25% IRA split.
 - 1.2. Consider different life and economic scenarios. For example, different rates of return and a partner passing young.
 - 1.3. Tune the approach to reaching this goal. For example, can you avoid a specific IRMAA bracket? Should you be converting much more in the early years? Some of this may depend on individual factors such as how you are funding your spending during these years.

- 1.4. Do a sanity review of what your finances look like on a yearly basis. Do you see reasonably flat marginal tax rates, do you avoid a lot of excess RMD payments?
2. Each Year:
 - 2.1. Review change in value of qualified accounts
 - 2.2. Review your personal finances including how much other taxable income you expect to have.
 - 2.3. Select Rollover amount

From a math perspective, the optimal conversion is almost certainly going to be something less than a complete conversion, but it is worth considering what full conversion looks like. Since you will have eliminated your overhanging qualified-account tax liability, you are less at risk to changes in tax law and you are going to see lower “excess” income taxes in the form of Net Investment Income tax and Social Security IRMAA’s. You might find it worthwhile to go with the less optimal solution for improved peace of mind.

A full conversion *might* make sense if you anticipate substantial taxable external income. It does not make sense if you expect your external income to be so low that there are no income taxes associated with it, since you would be effectively “giving away” your standard deduction. Full conversion also does not make sense if you plan for significant charitable contributions later in life.

Testing the Roth Conversion

There are a few things to look at when considering whether you have a Roth conversion plan that is close to the optimal:

1. Does increasing it or decreasing the conversion decrease the total value of your assets at some point in the more distant future such as age 90 or 95? Don’t get hung up on whether you “care” about assets on hand at that point. For this analysis we are just using this as a handing yardstick.
2. Does your marginal tax rate remain “relatively” constant? It is probably OK for the rate to rise a bit during conversion, but if you see a sharp spike up or down later on you likely are converting too little or too much.
3. Are your remaining RMDs equal or less than your spending needs?
4. Is there enough remaining in your qualified accounts to cover anticipated charity contributions?
5. Do you have enough projected income late in life to cover expected deductions? If you don’t, you are almost certainly over-converting.

One thing you should **not** pay much attention to is the total amount of taxes being paid. The “IRA math” discussed in 2.6 will almost invariably lead this number to be lower when taxes

are paid sooner rather than later, but if the tax rate in effect during the early conversion is higher than what you expect to be paying for your RMDs, you will still come out behind.

Using Roth Conversion Analysis to find the IRA tax liability factor

As discussed in section 4.3, the IRA tax liability factor is a number used to discount the value of your IRA to account for the amount owed to the government. It is significant in the calculation of effective net worth when the IRA is a substantial part of your assets.

Start by finding a Roth Conversion that appears to be close to optimal as discussed above. Now focus on a year shortly after you expect to complete Roth conversions. We will use Age 75 as an example. Next consider the total value at Age 75 under a few scenarios:

1. No Roth Conversion at all. In this case, the relevant wealth is still in the traditional IRA that you are discounting by the IRA tax liability factor
2. The optimal conversion amount
3. Possibly one or two points in-between

If the total asset value at 75 remains relatively constant, your conversion factor is *about* right.

One problem with using a single tax liability factor is that it tends to undervalue smaller IRA balances. One piece of evidence for this effect would be marginal tax rates that are relatively low later in retirement. If you see this happening, you can tune the tax liability factor slightly, or use a tax liability factor that changes based on IRA account value (if your modeling tool supports this). The reverse is also true, if you see marginal rates that are “high” late in retirement, you might want to adjust the liability factor upwards.

5.5 When to take Social Security

Everyone entering retirement in the United States is likely aware of the broad picture. You can start Social Security any time between age 62 and age 70. The longer you wait the higher the payment will be. This means that there is probably going to be a date in the future where you come out ahead by waiting, if you live long enough to see it.

The Social Security commencement decision is made by many people without a lot of attention to the actual numbers. The decision is either forced by circumstances or is made on an emotional level. Modeling Social Security commencement is unlikely to change that. But what it can do is to help quantify the impact of the decision. It turns out that the impact of this decision can be substantial or can be surprisingly little depending on your situation and assumptions about what the future holds. The following factors should be considered:

Parameter	Discussion
Commencement Ages	To understand the impact of difference scenarios, you need to model the different scenarios.
Projected Rate of Return	If you delay Social Security, you are likely drawing down investment assets, so you are giving up potential growth. Higher rates of return argue for taking Social Security early.
Inflation Rate	Inflation rate comes into play in two ways. The first is that it impacts the real rate or return (what we care most about is the after-tax Rate of return). Secondly, Social Security Indexing has not history kept up with the inflationary pressures on retirees.
First Partner Mortality	This will have a big impact in the sensibility of starting one Social Security stream early.
Relative size of the two Payments	If the two payments are significantly different in size there is less to gain by waiting on the smaller of the two since the surviving spouse can switch to the larger.
End of Plan Situation	What we are looking at here is the total assets at different ages. If, for a given spending level, the assets are approximately the same, we can judge the commencement date has little impact at that age.

Table 8 - Parameters for Social Security Decision

Use your model to try to answer the following questions:

- What is the break-even age based on inflation and tax adjusted account values?
- What is the impact of different rates of return?
- How much different in relative terms is my financial situation at different ages?
- What is my maximum spending with different commencement scenarios?

Investing pundits are prone to claiming that “Social Security Commencement” is the most important financial decision you will ever make. This is true for some people, but it isn’t for others. It all depends on your personal situation. Working through the model results will help you understand not only what the best decision is for you personally, but also how important the decision actually is.

In some cases, it makes virtually no difference when you start the first of your Social Security streams. If starting Social Security sooner “feels right” to you, why not just go for it?

5.6 Should I purchase an Annuity?

Modeling the annuity purchase decision is complex because of the variations in annuity design and the impact on your portfolio. Your annuity salesman is likely to have a model for you to use, but that is a little like letting fox guard the henhouse. You should have an independent model. Keep in mind that at the end of the day this is an insurance product. You are most likely to come out ahead with an annuity if you outlive the mortality tables, and most likely to come out behind in the reverse (this is referred to as mortality credits in the insurance industry); this amounts to a subsidy from people who die younger than expected to those that die older. Along the way, the insurance company takes their cut. With all that it might *still* make sense. Or it might not.

The straight-up alternative to an annuity is to purchase investments with a defined return and hold them to maturity. The classic approach being to build a “bond ladder.” Part of the value proposition for a commercial annuity is that the insurance companies can more efficiently purchase these sorts of investments due to scale and expertise. There alternatives to traditional bond ladders including bond funds and “dividend focused investment.” If you are concerned about the security of your income stream, then your modeling should incorporate this level of investment analysis.

Scenario-based modeling provides a tool to understand the impact of this. Be sure to look at the situation both before and after your expected lifespan. Annuity modeling will be simpler if you stick to a simple product like a “fixed immediate annuity.” Your annuity model should incorporate the following:

Parameter	Discussion
Change in investment capital	You want to model the impact of reducing your portfolio by the amount of the annuity purchase
Characteristics of Deferred annuity	Some annuities start paying immediately. Others are “deferred.” If the annuity is deferred then are going to be an additional set of parameters related to growth of the funds in the interim and rules for determining the ultimate payments.
Different Lifespan possibilities	You should consider different scenarios for both partners

Rate of Return	One important purpose of an annuity is to lock in an (implied) rate of return. You want to model different potential rates of return on your portfolio to understand this.
Inflation Rate	Inflation is important regardless of whether the annuity is indexed or not.
Is the Annuity Indexed for Inflation?	An inflation indexed annuity will have a lower starting monthly payout
Does the annuity have survivor benefits?	An annuity with survivor benefits will have a lower starting monthly payout

Table 9 - Parameters for Evaluating Annuity Purchase

Look at your overall financial situation (inflation and tax adjusted assets are a good measure) under different scenarios. When do you come out ahead with an annuity? It is not just about “coming out ahead.” Section 6.4 discusses the notion that some of our decisions amount to paying for peace of mind. The retirement model will help you understand how much you might be paying for that peace of mind.

5.7 Where should I draw funds from?

Your retirement income is likely to have a “foundation” of relatively safe fixed income sources such as Social Security, a Pension and, if the Insurance salesmen got their way, an annuity. For many people this will not be enough to meet their desired spending so they will draw from their savings; after all, this was the whole point of saving for retirement.

There are 3 different types of accounts to consider:

1. After tax. These accounts are subject to traditional income tax for dividends, interest, and capital gains. They might incorporate accrued capital gains.
2. Tax Deferred. IRA, 401K, 403B, etc. Regular income tax is due on these accounts as money is withdrawn. Typically, these funds cannot be touched until age 59 ½ without penalty. Then there are required withdrawals (RMD’s) starting at about 73 (increasing to 75 in the future). Tax deferred accounts in an estate must be drawn down over a period of 10 years.
3. Untaxed. These are the Roth accounts that contain after-tax money but where the earnings are not taxed. There are no RMD’s during the life of the original owner. Like Tax Deferred accounts they cannot be accessed without penalty before age 59. In addition, there is a 5 year holding period before the earnings are completely tax free. Roth accounts in an estate must be drawn within 10 years.

The question then becomes: which accounts should I draw from at different stages of my retirement? Much has been written on the subject. See for example: (Charles Schwab,

2022), (Fidelity), (Merrill). Most sources agree that the Roth accounts should be used last since they are the most advantageous from a tax perspective for both you and your heirs. They also agree that once you are taking RMD's you should fund your spending from the RMD's first. That said, non-linearities in the tax code might push you to make withdrawals from a Roth account if this helps you keep your income at some desired lower threshold. As with everything else in retirement financing, it depends on your specific situation. Your income sourcing model should take the following into account:

Parameter	Discussion
Are you funding Roth Conversions?	If your model also has you funding Roth Conversions, it is more likely so show that you want to fund spending via your after-tax accounts.
Capital gains on the untaxed account	If you have substantial gains in your untaxed account, it might make sense to leave the money there and spend from the IRA since you have to pay tax on the IRA eventually anyway.
Capital Accessibility	Assets in different accounts may be relatively inaccessible. For example, CD's or bonds that you have purchased with an intent to hold to expiration.
Anticipated RMD's	If your tax deferred accounts are large enough that your RMD's will substantially exceed spending needs, it may make sense to draw down the tax deferred accounts before RMD's are due. This is a close sibling to Roth Conversion.
Anticipated rate of return and inflation	These impact the growth of accounts over time and can impact the sensibility of different strategies
Potential changes to tax jurisdiction	A move to a different tax jurisdiction can impact your future taxes for better or for worse.
Potential change to tax Law	Higher or lower anticipated future tax rates will certainly impact the analysis.
Taxation Details	This is a catchall for "tax accuracy." If we are trying to use the model to make withdrawal decisions, the model should capture details such as the very different ways tax jurisdictions deal with income sources.

Table 10- Modeling Withdrawals

This decision-making process is more complicated early in retirement when you have more choices. At the end of the day the decision will probably come down to the relative size of the accounts. But the devil is in the details. You need to run the numbers to make the best choices.

5.8 Should I self-insure?

The purpose of most insurance is to transfer the risk associated with a potential, but uncertain, future situation or event. For example:

- Personal Liability insurance
- Catastrophic loss insurance for a home
- Longevity insurance – the cost of outliving your plan.
- Long term care insurance – the chance you will need expensive personal care.
- Traditional term life insurance – the risk of dying young.

Insurance companies sell policies to address these risks and more. Some of these will make sense to you; others might not, depending on your situation. The answer might be different for different types of insurance. Personal liability insurance addresses unlikely but potentially very expensive events; it is relatively inexpensive. Longevity and Long-term care insurance address more likely events. These events might be relatively expensive, but that expense is less open-ended than personal liability. These insurance policies tend to be quite expensive.

In each case there are three choices:

- Purchase the insurance.
- Plan to have sufficient resources to cover the event
- Accept the risk

The decision is likely to be different for different types of insurance. Life Insurance (Term, Whole, Universal etc.), longevity, long-term care, and possibly even catastrophic loss are reasonable candidates for self-insurance. Your model needs to assess the likelihood of having sufficient resources to address the risk as well as the cost of the insurance policies. The maintenance of resources along the way might follow an “estate or, if needed, surprise expense” model. That is, most of the money is mentally earmarked for your estate with an understanding that expenses such as long-term care might eat into it. This can be modeled.

Modeling Consideration	Discussion
What is the desired estate size?	The asset pool can be multi-purposed to either “self-insurance” or the estate. To the extent you desire to leave an estate, there is less impact from self-insurance.
Amount of money ear marked for the risk	For example, average long term care costs for people who require it is something in the neighborhood of \$300K.

Cost of the insurance	The model should explicitly incorporate this cost into a spending scenario.
Worries about a small estate	Insurance products can help guard the “worst case” size of your estate. Of course this comes at a cost to the “typical” size.
Impact of delaying Social Security commencement	Delaying social security improves cash flow late in life impacting the amount of insurance actually needed.
Life Insurance for Wealth Transfer and Estate Tax Optimization	Life insurance products can be used by wealthy individuals to pass assets on to heirs in a tax-effective fashion. These situations are outside of the scope of this book.

Table 11 - Self Insurance Considerations

5.9 Life Insurance vs Pension Survivor Benefits

Most pension plans provide options for selecting survivor benefits. The flexibility of the plans varies, but you usually have at least the choice of “all” or “none.” If you select a non-zero survivor benefit, then the initial pension payout will be less.

If you want to provide for the survivor with this income stream you have two choices:

1. Take the pension with survivor benefits.
2. Take the larger pension payment and invest some of higher payments a life insurance policy.

Which one is right for you? Of course, it depends. Taking out a life insurance policy is going to provide a lot of additional flexibility beyond the “one size fits all” approach that the pension provides. On the other hand, this flexibility has a cost associated with it because, well, insurance companies are in business to make money. This decision is also tied to whether the pension is indexed for inflation. If it is not indexed for inflation the survivor benefits are worth relatively less because they are most likely to accrue years from now.

5.10 How much difference will a change in tax jurisdiction make?

Your tax will change, although possibly not in a completely obvious fashion due to the complexities of state tax laws. It is also likely that your expenses will change. Many states with lower income taxes have higher expenses of other sorts. For example, higher sales tax and higher real estate taxes.

Ideally your model allows you to easily compare the net impact of these combined changes.

6 Other Considerations

The mechanics of the retirement model is only part of the story. It is helpful to step back a little and look at the overall context. The retirement model is just one part of your plan for the future.

6.1 The Likely vs the Possible

Someone in good health in their mid-sixties can expect to live till their mid to late eighties. Many people die earlier, and many other people die much later. It is no surprise that our financial decisions have different implications for different timelines. Some people are going to be relatively more concerned with “possible” events others with “likely” events. Many of our financial decisions should be evaluated in the context of this “likely vs possible” dichotomy. For example:

- We know in retrospect that someone who passes at 75 should have started Social Security immediately (especially if they were the lower wage-earner or single) and that someone who passes at 95 probably should have waited till 70. Dying young is possible, but it is not that likely. For better or for worse, living to 95 is also not all that likely.
- An annuity purchase is going to be much more compelling for the unlikely case of living into our late 90's.
- Spending plans while younger are really incorporating a sense of how much we want to reserve for when we are “surprisingly” old.
- Roth conversions are relatively more favorable in the unlikely case that one partner dies young.
- The likely mortality for a couple is mid to late eighties. Financial decisions such as both parties waiting on Social Security are likely to reduce estate size at the “likely mortality” age while increasing it if both parties live into their mid nineties.

Mortality is the most important example of this likely vs unlikely dichotomy, but it is not the only one. The broken promises discussed in section 4.10 amount to another class of “unlikely events.” Another might be an unusually long stay in a Nursing home. For folks who wind up in a Nursing home at the end of their life this is around 2 years. But it could be much more.

You may elect to try to hedge against these unlikely events in your financial plan. In some cases, a modest sacrifice in the value of the typical case can have a big impact in the unlikely case. Sometimes the reverse is true. You must run the number for your situation to get a good sense of this.

There is no right or wrong here in terms of your focus on the likely vs the possible; but it is good to understand the impact this can have on your finances in both cases.

6.2 The Role of Financial Professionals

Does “running the numbers” yourself enable you to do this all on your own? If you have hired a financial planner/advisor, is there any point in running the numbers yourself?

Let’s step back and take a slightly easier question first to get it out of the way. If you do not run the numbers yourself, you should certainly consult with a Financial Planner because *someone* needs to run the numbers. In that event, this book should prove useful in selecting your Financial Planner and in guiding your discussions with the planner by making you a more informed consumer of these services.

If you are interested and able (if you can do your own taxes, you are certainly *able*) to run the numbers yourself, then there is a choice to make. You can likely get by without hiring a Financial Planner. But that may not be a good choice. It really comes down to your confidence in the process and your interest in working through the details, as well as the full set of services that you would look to get from a Financial Planner. A common practice in Software Engineering is *code review*. The code review process involves one developer reviewing another developer’s code before it is put to use. A financial advisor can provide this same important role for your retirement plan.

Understanding cash flow over time is important, but there is much more to a comprehensive financial plan than just running the numbers:

- Estate Plan
- Investment review and plan
- Insurance Plan
- Spending Plan

Again, there is no right or wrong here, it comes down to your interest in self-managing all this and above all, your confidence. It also depends on where you are with it. Have you engaged with an attorney about your estate plan? Have you engaged with your brokerage firm to review your portfolio? Or possibly you are using a brokerage firm to manage your assets. One place to start might be with a limited scope fee-for-service (project) engagement with a Financial Planner.

Finally, if you are working with a Financial Planner, is there anything to be gained by having your own cash flow plan? The most important thing you are likely to gain is a deeper understanding of the plan; for example, it is easier to evaluate the impact of different choices you might make with your own plan as opposed to directing your planner to ask

these questions. It can also provide a better understanding of the professionally created plan. For example, the professional plan is likely to quote a “break even” for Social Security commencement. Does this break-even calculation incorporate income on your portfolio? How does it deal with inflation?

It may be possible to have the best of both worlds. Some financial planners will provide direct access to a model that you can work with. This might be a spreadsheet or an on-line tool.

A Cautionary Word

Some project based financial advisor engagements have the flavor of “Provide me all of your parameters. I will then create a plan that includes key recommendations (read: I will make the decisions for you) and then bill you.” This sort of engagement might be quite helpful, but it is unlikely to provide you with the opportunity to use models to guide your own decision making. If you are looking to really participate in the decision-making process, you will want an engagement that is more interactive.

6.3 It isn't just about the Numbers

It's about the numbers, but it isn't just about the numbers. Some of these decisions come down to individual views of the short-term vs the long term. Maybe you don't care what sort of financial shape you are in at 90 or 95 and are much more concerned about making the best of your 60's and 70's. Maybe you want to extract as much as you can from Social Security as soon as you can because you have doubts about either your longevity or Social Security's. Or maybe, just because. There are many variations on this theme. This doesn't argue for not running the numbers; running the numbers allows you to make these decisions in an informed fashion. It turns out that in some cases the “optimal” approach is *much* better than a sub-optimal approach. In other cases, there is almost no difference. It is helpful to be able to look at the numbers in this light.

One way to think about this is to try to describe the best possible outcome for you. Is it to leave a large estate? To leave a modest estate and/or self-insure for late-life expenses? To be financially independent while leaving almost no estate? To live as well as you possibly can early in retirement while you are healthy enough to enjoy it? Running the numbers can help you get to *your* best possible outcome.

Another way to think about this is to consider what failure means to you. Is it a failure to run out of money at 95? Is it a failure to wind up with an estate so large you pay federal estate tax on it – and yet you flew halfway around the world in economy when you were 70?

This book is about creating and using models of your retirement. Your financial situation in retirement *is* important and it is worthy of a focused discussion, but at the end of the day a good understanding of your retirement finances is just a means to an end and not an end in and of itself. Be sure to think a bit about what you will be doing with the time and money that you will hopefully have on hand during retirement. Thinking that through might even change the model a bit.

6.4 Paying for Peace of Mind

Some financial products are intended to increase your peace of mind. The most compelling and expensive examples are annuities and managed investment accounts. What these have in common is that both take control over a substantial amount of your assets with the promise that you can then think, and maybe more importantly, worry, less about those assets. There may be implied promises of “better returns.” You should be skeptical of any such notions; this is mostly about your effort and peace-of-mind.

Annuities are far and away the more complex of the two. There are a staggering number of product variations. Here are a few examples:

- Is the annuity indexed for inflation?
- Is it joint life or single life? (or something in-between)
- Is it immediate or deferred?
- If it is deferred what is the nature of the interim investment?
- Is there a guaranteed payout term?
- Is the investment “indexed” for growth?
- If it is indexed for growth, what is the index based on? (some annuities use “custom” indexes)
- What is the expected taxable income over time?
- What is the cash value over time?
- How is my agent being compensated?
- What is the reputation of the underwriter?
- What sort of “backup” does the underwriter have and does this backup place any limits on the size of annuity that guaranteed?

Your annuity purchase decision should also incorporate any impact on your other investments. For example, if you have a traditional 60/40 portfolio, are you planning to buy the annuity from “40” and thus change the portfolio mix to something like 80/20? Modeling annuity purchases is discussed in section 5.6

The peace of mind offered is the reasonable guarantee of a specific cash flow. (There is a chance that the underwriter goes out of business, but that is unusual, and it is even more unusual for that to result in a default to customers.) That peace of mind has a couple of important costs associated with it. The first is opportunity cost; you are giving up the chance of changing your mind and doing something different with the money because annuities are difficult to exit. If it is even **possible** to exit the annuity, there may be substantial financial costs. For some retirees, this is the very opposite of peace of mind. The second cost of annuities is the direct financial cost. This cost is often hidden. It is the difference between what your return *most likely* looked like held in your portfolio and what the annuity is paying you. For some annuity products this cost might be fairly small, making the annuity a reasonable alternative to investments such as bonds or bond funds. Annuities can be used to help postpone taxes but for the most part this is only feasible for annuities purchased with unqualified funds. Annuities can also have a negative impact on taxes by effectively converting potential Long Term capital growth into regular income.

Other forms of commercial insurance also have this *paying for peace of mind* aspect.

Managed Investment accounts generally follow a pricing model of “X% of managed assets per year.” Today, “X” is typically ranges from somewhat less than 1% to somewhat more than 1% for a million-dollar portfolio. It is likely to be more for a smaller portfolio and a bit less for a larger portfolio. It may also be more at “boutique” investment firms that provide more personalized services. At any rate, modeling this is straight-forward, you simply reduce the expected return on investment by this cost. The not-so-subtle inference here is that the investment professional is unlikely to do better than you in terms of the rate of return. History shows that is probably true if you follow a modern low-cost fund approach to your investing. (Bogle, 2017)

In these cases, a model will show some circumstances where you come out behind financially. It may even show that you come out behind in all cases. If you go into the decision process with a mindset that you are purchasing peace of mind this might be OK.

Some of your “non-product” financial decisions can also come down to peace of mind. For example, if you are concerned about your cash flow later in life, postponing Social Security commencement can improve peace of mind. If you are concerned about tax rates, aggressive Roth conversion can improve peace of mind.

6.5 Parameter Sensitivity

Your retirement model will have a number of different input parameters as discussed in Section 3.10. Your retirement model also may have a number of “outputs” such as spending ability, valuation of different types of assets, taxes owned, etc. The parameters

are all “important” or it wouldn’t make sense to capture them. But they are not all *equally* important and, more significantly, their importance can vary depending on your circumstances.

It is useful to get a sense of how important different parameters are to both your overall plan and the decisions that you will make along the way. For example, if you project that Social Security will be large part of your spendable income in retirement, then the commencement decision is more important than it would be if you plan to rely on Social Security for only a small portion of your income.

Sometimes this sensitivity can come as a surprise. For example, you may find that the decision on when to take Social Security has little impact on the optimal Roth conversion. Sure, it will impact the amount of taxes you pay now, but there may be very little difference in the net financial situation later in life.

7 Some Potential Surprises: What a model may tell you

As Middle-Ages maps say, “here lie dragons.” This section reviews a few surprises that may come up as you “run the numbers.” You are likely to find additional surprises for your specific situation when you run your own numbers. This chapter comes dangerously close to “providing advice” contrary to the goals set out in Introduction because it uses a set of retirement profiles with actual dollar values. This is a risk but the presentation is much more compelling this way. All the examples were developed using the JRTN retirement modeling tool described in later sections of this book.

The purpose of the discussion is to get you thinking about what you want to accomplish with your model and what you might look for in a modeling tool.

7.1 Example Profiles

The behavior of retirement models changes substantially based on individual circumstances. To help illustrate these differences, 3 hypothetical retirement profiles are introduced.

	Profile 1	Profile 2	Profile 3
Social Security @ Age 67	\$38K/Year	\$55K/Year	\$71K/Year
Unqualified Savings	\$60K	\$120K	\$300K
IRA	\$600K	\$1.2M	\$3M
Unindexed Pension total starting @ 65	\$10K/Year	\$20K/Year	\$35K/Year
Spending Goal	\$55K	\$90K	\$135K
Desired Minimum Plan-End Balance	\$55K	\$300K	\$1M
Baseline Roth Conversion	0	\$15K	\$105K
Assumed income tax on IRA	16%	20%	27%
Risk Profile	High	Moderate	Low
Roth Account Balance	\$0	\$0	\$0
Current Ages	62,62	62,62	62,62
Partner Asset & SS Income Split	60/40	60/40	60/40
Primary Income Tax Jurisdiction	MA	MA	MA
Secondary Income Tax Jurisdiction	NH	NH	NH
Plan Age	95	95	95
First Partner Passes at	85	85	85
Spending rate for Survivor	80%	80%	80%
Average Rate of Return	5%	5%	5%
Average Inflation	2%	2%	2%
Roth Conversion Ages	62-73	62-73	62-73
Social Security Start Ages	70,62	70,62	70,62
Future Federal Tax Rules	TCJA	TCJA	TCJA

Table 12 - Example Retiree Profiles

The first few rows of the Profile capture the retirees' financial situations and goals. Profile 1 is close to reports about "average savings" and "average Social Security." Profiles 2 and 3 bump these numbers up to reflect couples in different circumstances. The dollar values move up in parallel because this is the most likely case. A wage earner who has been near the top of the social security withholding scale for most of her career is also likely to have been in the position to grow her IRA and other savings the most over time, and to have higher spending and legacy expectations.

The Roth Conversion is in the general neighborhood of the "optimal" Roth conversion for this profile (more on this later). The IRA taxation rate is used to discount the value of funds held in a traditional IRA. This will naturally tend to be higher for more affluent retirees and it will be higher in some tax jurisdictions than others.

The Risk Profile is an indication of how likely the profile is to survive adverse circumstances. As defined with 5% growth and 2% inflation, these profiles result in the following:

- Profile 1 will yield an estate of approximately the desired \$100K.
- Profile 2 will yield an estate just a little over the target of \$300K.
- Profile 3 will result in considerably larger residual estate than the \$1.2M goal.

Profile 3 is thus better able to survive high inflation or a large market reversal than the other profiles because it has a larger buffer. This approach to profile definition makes the examples more interesting and probably reflects typical choices since more affluent retirees can afford a larger buffer.

The remaining rows document other aspects of the profiles; they are held constant across the profiles to facilitate comparisons. Massachusetts is chosen as the tax jurisdiction because it is in the middle of the road in terms of tax impact. Some states such as New Hampshire and Florida are a lot less. Others such as California and New York are considerably more.

7.2 Roth Conversions may not make much difference

Sections 5.2 and 5.4 discussed modeling of Roth Conversions. What you are likely to find after going through this exercise is that, as measured by net worth at the end of the plan, "it just doesn't make all that much difference." At any rate, it almost certainly won't make much difference until late in life when RMD's rise precipitously. There are many exceptions to this general observation. If you are planning large charity contributions, then Roth conversions will certainly hurt (the charities). If you anticipate inheriting a large traditional IRA pushing you up a couple of brackets, this could change the math of the Roth

conversion for your own savings to make it more compelling. If you plan to spend just as much as possible along the way, Roth conversions are also going to be of limited value – or even have adverse impacts. The bottom line is that generalizations are risky.

We will look at a few examples to flesh this out a bit. These examples show total assets at different ages as a function of the nominal dollar value that is converted from traditional to Roth IRA early in retirement. The analysis starts with situations where Roth conversion is most likely to be a benefit and proceeds to scenarios where a benefit is less likely. The graphs were all generated using JRTN's Roth Analysis tool.

The first examples are from Profile 3. We focus initially on the larger profile because it is a little more interesting from a Roth conversion perspective.

Note about Asset Adjustment

Assets are adjusted for both inflation and estimated tax liability. The tax liability estimate is important, but it is also somewhat fraught. Picking a different number for this value can change the appearance of asset graphs considerably. This number is always going to be a guess because it makes assumptions about future tax rates, but intuition can help us here. Consider the first example in Figure 9. We can see that making Roth conversions seems help our overall financial situation at ages 90 and 95 so the taxes we are paying for the bulk of this conversion can't be too far from the mark. Now look at the Age 75 line, if this line remains relatively level, at least up to the "optimal conversion," then the tax adjustment factor is in the right neighborhood.

Adjusted Assets vs Annual Conversion

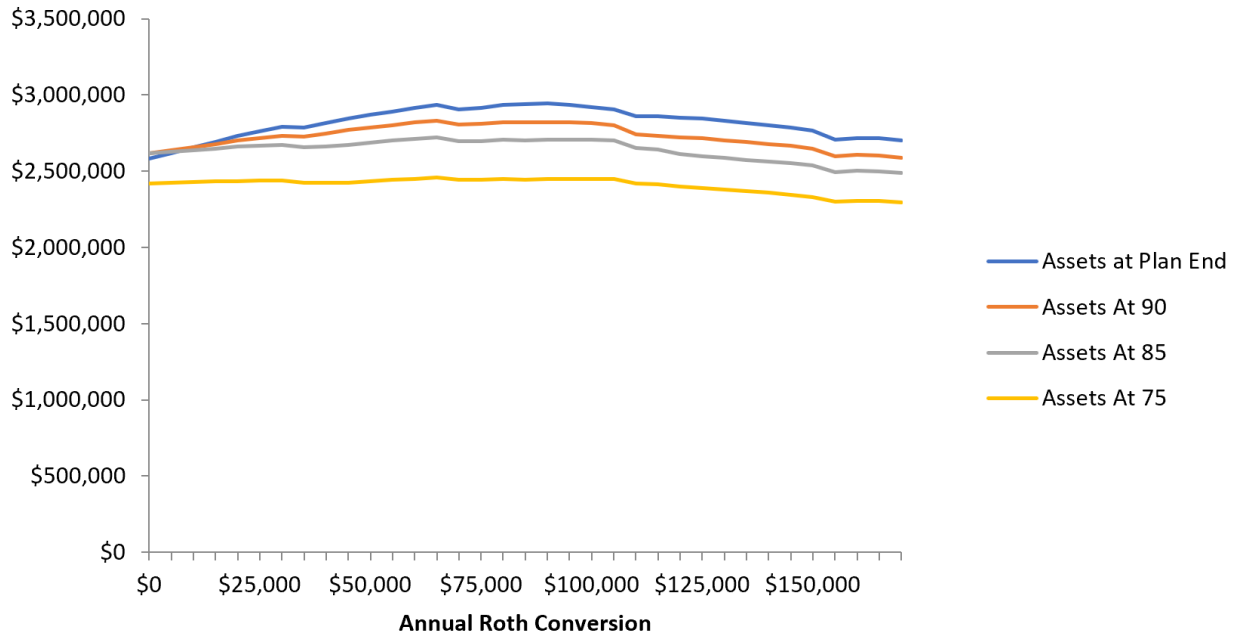


Figure 9 - Roth Conversion Impact for Profile 3

A few observations can be made about this graph:

1. The optimal conversion is something less than a complete conversion.
2. The conversion has little impact on finances until late in life. In fact, a flat horizontal curve early in retirement is a sign that you are using a reasonable factor to judge the tax liabilities remaining in the IRA. If this line trends up or down significantly, you probably have too large or too small a factor specified.
3. The data can be noisy on the way to the optimal conversion due to nonlinear impacts such as crossing IRMAA thresholds. Notice the small dip around \$70K.

The improvement due to the Roth conversion is real. Total adjusted assets at age 95 move from \$2,586K to \$2,943K at the optimal conversion of about \$90K/Year. About 14%. That is nothing to sneeze at. The savings are less measured earlier. At age 90 the swing is from \$2,619K to \$2,823 for about 8%. From a statistical perspective, the heirs are more likely to see significant savings than the retirees in this case.

Changing any of the model assumptions will change the graph. One obvious variation to consider is tax rates increasing in the future. Assume that federal tax law reverts to what we had in 2017 (pre TCJA) in 2035 and that rates for each bracket except at the bottom are increased by 2% over what they were in 2017; sounds a bit scary. This yields:

Adjusted Assets vs Annual Conversion

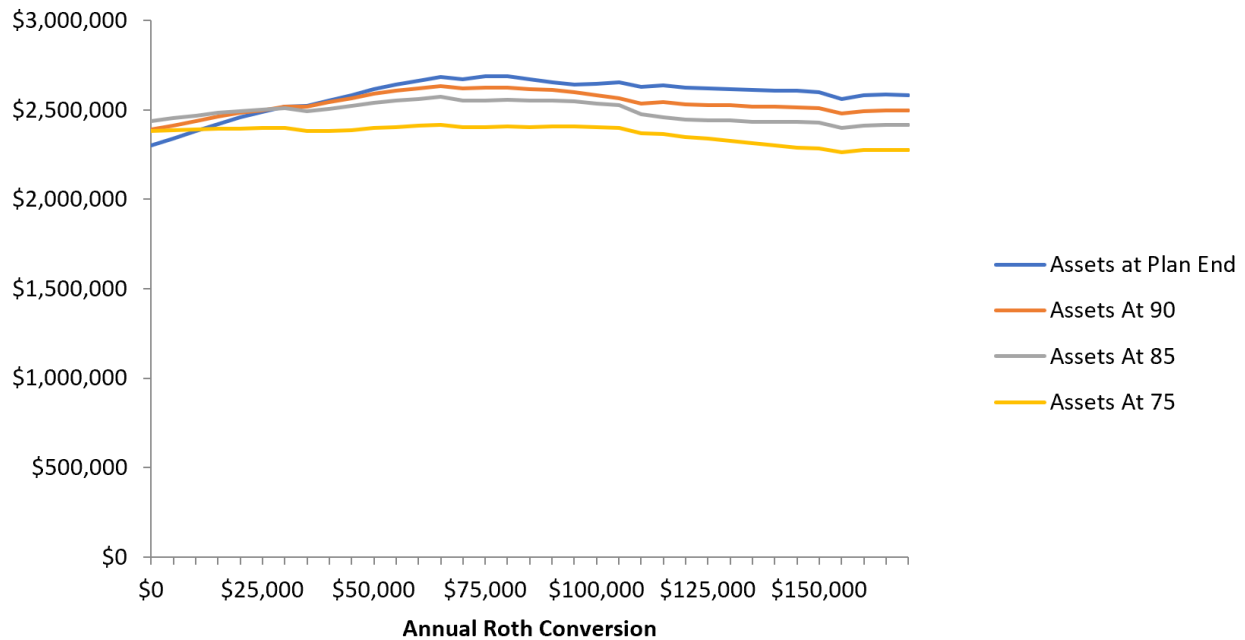


Figure 10 - Roth Conversion for Profile 3 with Higher Taxes

The results are shown in Figure 10. The numbers move lower as we would expect with more taxes. There is a bigger relative win at age 95 with assets moving from \$2,300K to 2,689K at a conversion level of \$75/Year. This is about 17%; again, what we would expect with higher taxes.

One reason why these retirees are seeing significant savings is that they are living below their means. It turns out that they can spend around \$167K/Year with no Roth conversions and still stay within their end-of-plan goal of \$1M. With a spending goal of \$165K/Year we get the following:

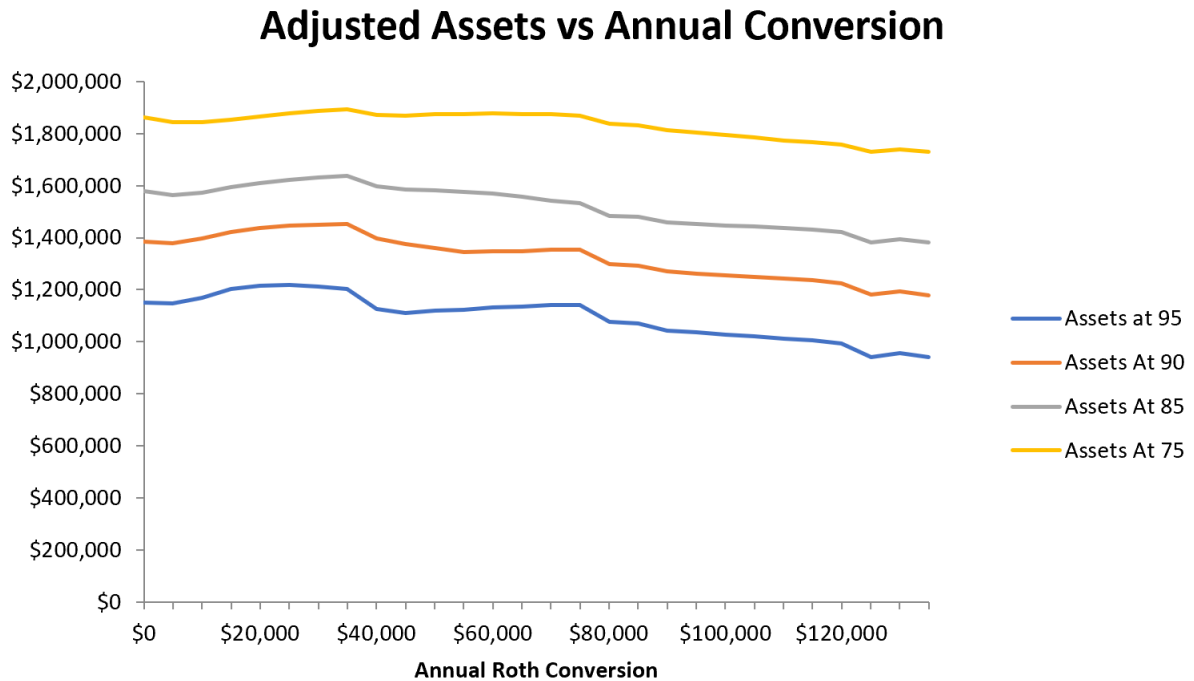


Figure 11 - Roth Conversion for Profile 3 with Higher Spending

This graph looks quite a lot different! There is no meaningful win for Roth conversions of any amount. There is a small gain initially as we go from \$1,152K to 1219K at a conversion rate of about \$25K/Year. This is about 6%. Notice also that there is a net loss for full conversion as we go from \$1,152 down to \$940. This is a loss of about 18%! It is possibly noteworthy that aggressive Roth conversion causes this plan to fail to meet the \$1.2M goal set out in the profile. This an exception to the general rule that Roth conversions probably won't hurt much and certainly a good example of why you should run your own numbers! Since there is no meaningful loss up to about a conversion rate of about \$35K/Year, retirees might reasonably elect a small Roth conversion as a hedge against unforeseen events that would argue for a Roth conversion if they were to transpire such as:

- Substantial Tax Increases
- Decrease in Spending
- Substantially higher average growth

The last parameter we will consider is real growth rate (the rate of growth after subtracting inflation). The 5% and 2% used above are pretty close to “long term conservative consensus opinions.” But that doesn't make them right. Let's consider the slightly less

happy case of 4% growth and 2.5% inflation. This is still well within the realm of possibility and various prognostications. This yields:

Adjusted Assets vs Annual Conversion

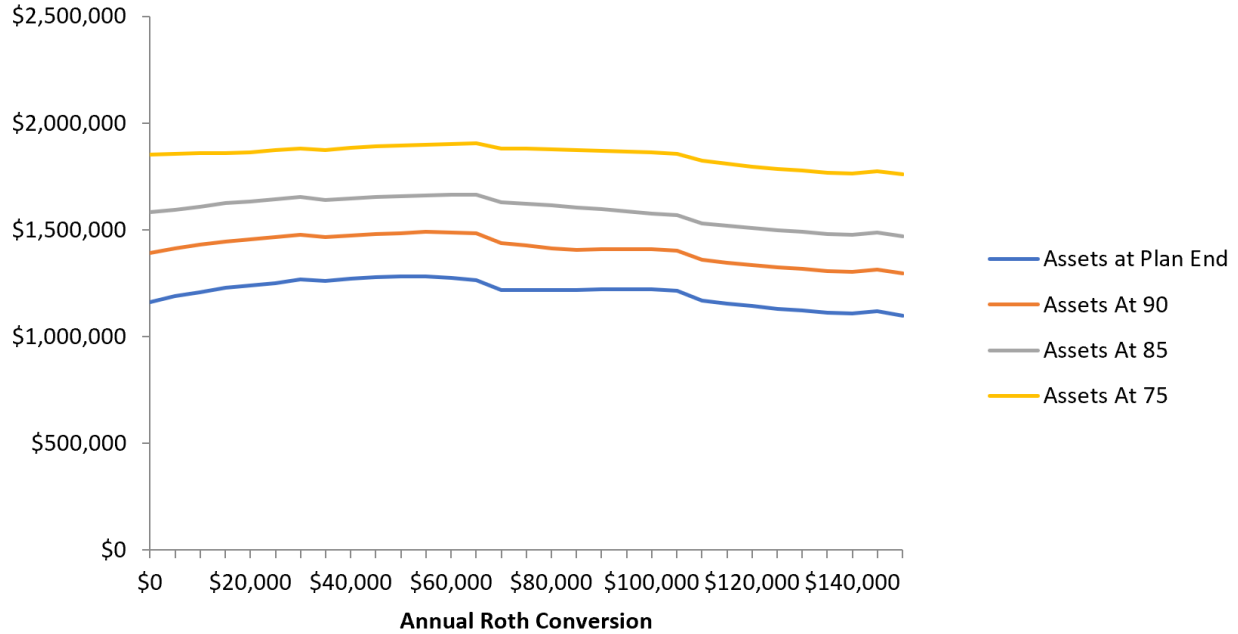


Figure 12 - Roth Conversions for Profile 3 with lower real earnings

This looks a lot like Figure 11 because spending is not covered by the earnings, leading account values to decrease over time. Like the baseline, there is still a win from the Roth conversion, but it is more modest. Assets at 95 go from \$1,161K to \$1,283K At a conversion rate of \$50K/Year. This is only about 11 percent as opposed to the 17 percent we saw for the baseline case. On the negative side, over-conversion drops assets from \$1,161K to \$1,099K for a loss of about 5%. It is noteworthy that at younger ages the potential gains are less and the potential losses more. At age 90 we see a potential gain of about 7% but also a potential loss of about 7% from over-converting

Lastly, we will briefly look at the impact of Roth Conversions on Profiles1 and 2. Profile 2 yields the following:

Adjusted Assets vs Annual Conversion

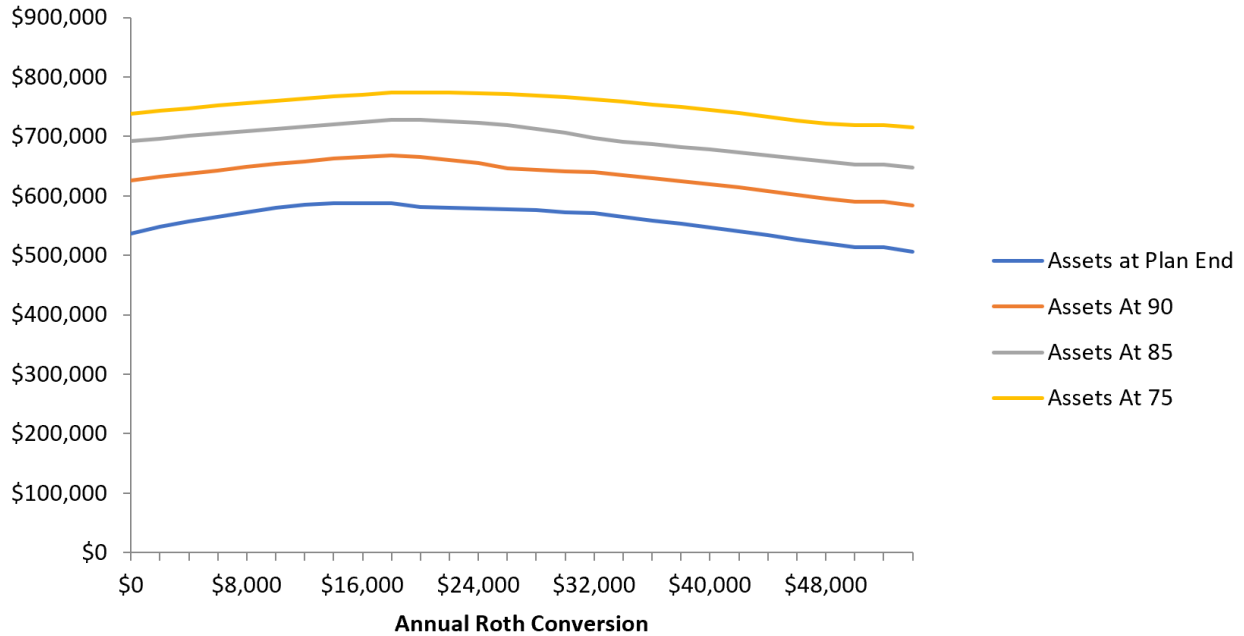


Figure 13 - Roth Conversions for Profile 2

There is a small potential win from Roth Conversions, but there is also a small potential loss. On the positive side, a Roth conversion will result in an increase in assets from \$536K to \$588K at an optimal conversion rate of about \$18K/year. This is a gain of about 10%. On the negative side, a complete conversion would result in a reduction from \$536K to \$506K at a conversion rate of \$55K/Year. This is a loss of about 6%. Here we also see the trend of lower gains and higher losses at a younger age. At age 90 the gain is about 7% and the loss about 12%.

Finally, profile 1 yields the following:

Adjusted Assets vs Annual Conversion

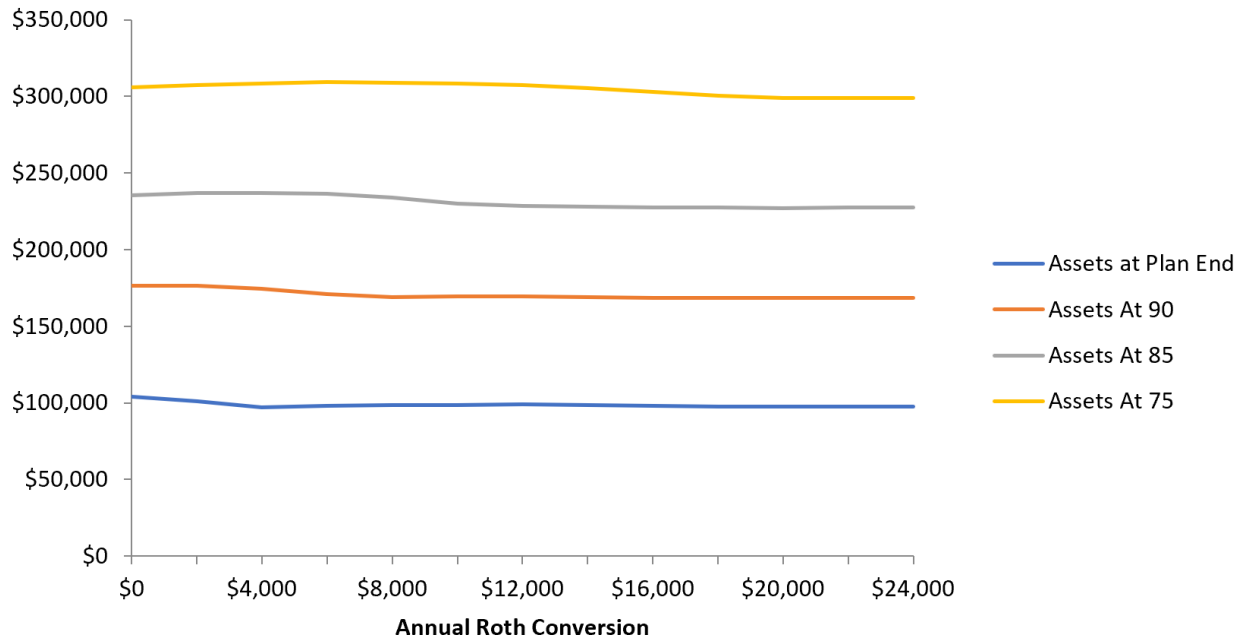


Figure 14 - Roth Conversions for Profile 1

Roth Conversion is a loss from the start.

Conclusions

Roth Conversion is going to be more compelling at higher asset levels and relatively low spending levels. It is also going to be more compelling at higher real rates of return because this is essentially the same thing as a lower spending level.

Sometimes Roth conversions can be a significant help. In many cases Roth conversions just won't make all that much difference one way or another. Usually, Roth conversions will not do substantial damage at modest levels, suggesting that they are a good vehicle for hedging against possibilities such a dramatic change in tax law or surprisingly high rates of return.

The mathematically optimal Roth conversion is quite dependent on guesses about what the future will bring. This argues for looking at different scenarios that encode different futures. It also means that it is essentially impossible to pick what will, in hindsight, have been the optimal conversion. There are simply too many unknowns.

A very aggressive Roth Conversion scheme that aims to get most of the assets converted is going to be suboptimal unless you are in a special situation where you expect your income

level to rise substantially for other reasons (such as anticipating inheriting a large traditional IRA).

The most important lesson is that you need to run your own numbers to see what the right answer is for your situation and for your sense of future financial markets, taxes, inflation, etc. Another subtle message is that since modest changes in the Roth strategy really won't make much difference in the long term, you can feel free to do some short-term optimization to avoid non-linear impacts such just crossing into the next IRMAA bracket.

7.3 Aggressive Roth Conversion can lead to surprisingly low tax rates

A plan to convert most of your qualified assets to Roth by your mid 70's will leave you in a situation where most of your liquid assets are in Roth accounts if you started with most of your assets in a traditional IRA. You are then paying income tax mostly on your external income sources such as Social Security and Pensions. (Your spendable income might be considerably higher as you draw down the Roth account in a tax-free fashion.) Rather than the scary high marginal rates we read about with large RMD's late in life, you are looking at the lowest tax rates since that summer job you had as a teenager! These low tax rates don't necessarily mean you are coming out "ahead"- In fact you are likely coming out behind by paying unnecessarily high rates during the conversion process. All the same, this might be a comforting situation to be in and it can have some influence on life choices such as what jurisdictions it makes sense to live in.

Average Tax Rate vs Year

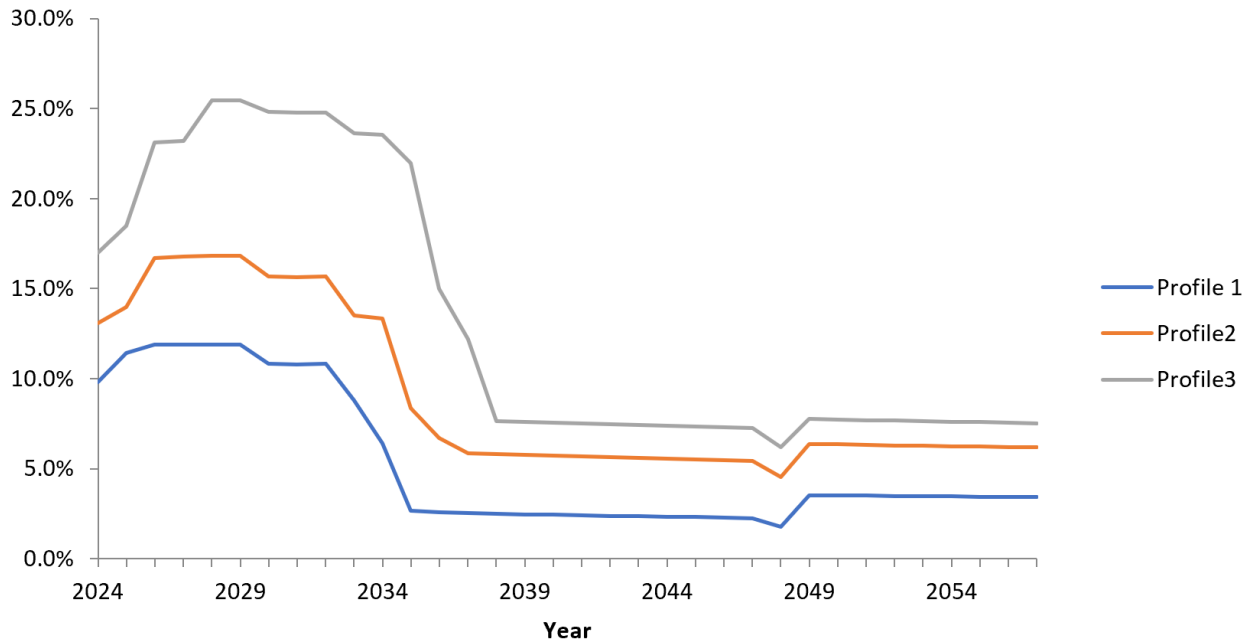


Figure 15 - Average Tax Rate over Time

Figure 15 shows the average tax rate for the 3 different profiles with Roth Conversions that are high enough to convert the entire IRA. This helps to explain why a very high Roth conversion is generally not advised. It often leads to paying the taxes eventually due on the IRA at an unnecessarily high rate.

Warning

A low tax rate is desirable but paying no taxes at all is undesirable because it means you are leaving the value of the standard deduction on the table. This is more likely to be a concern where external income sources are relatively modest. For example, if we consider Profile 1 without the pension we see the following:

Average Tax Rate vs Year

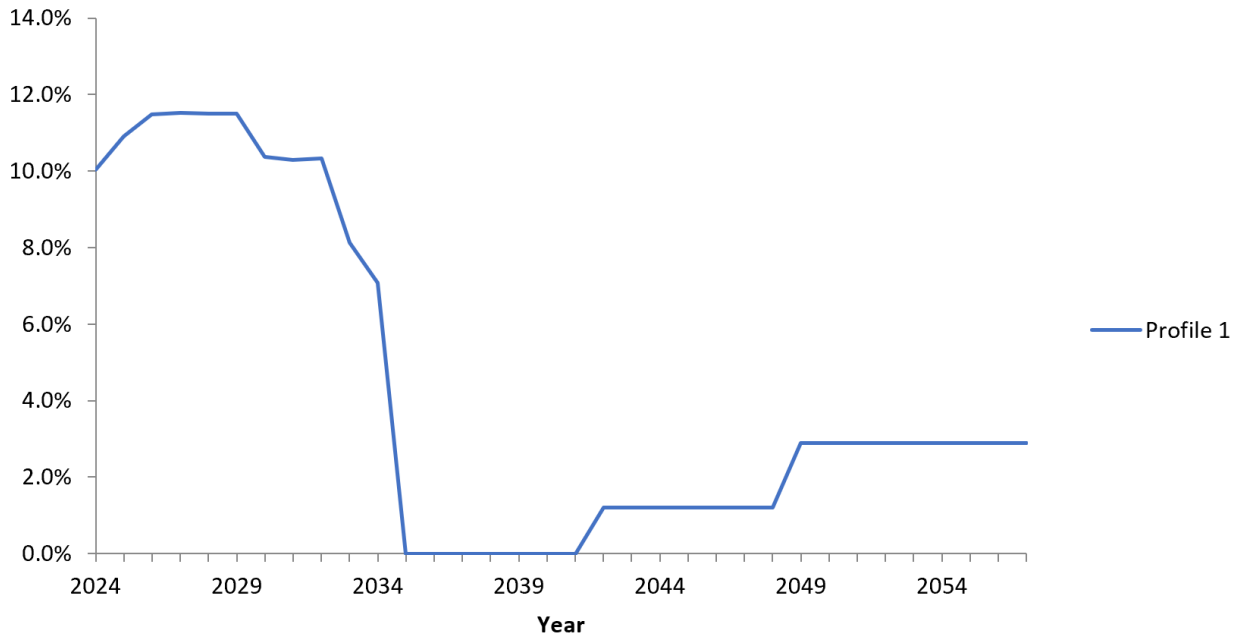


Figure 16 - Tax on Profile 1 without pension

The zero-tax years are not a positive outcome here. What that means is that some of the tax paid early in retirement to convert the Roth was completely wasted.

7.4 Inflation matters more than you might imagine

There is almost always inflation – and it compounds. When you look at the actual numbers, the dollar value of your spending 25 years from now is likely to be *much* higher than today. But this is only the most obvious impact.

Consider the relationship between rate-of-return and inflation. When the rate of return is just a couple of points higher than inflation, our portfolios are happy. When growth is near or even below inflation the situation quickly gets ugly. We want to make the best decisions about Social Security, Roth Transfers, when to retire, and what to spend. But the reality is that relatively small changes in rate-of-return vs inflation can dwarf the impact of these choices for retirees who are funding a substantial part of their spending from their savings. The scenario-based approach allows us to evaluate some of these less-pleasant futures; we don't necessarily need to plan to live these (historically unlikely to persist) scenarios, but we can gauge how well we could survive them.

One other impact of inflation is that not all tax calculations are indexed for inflation. For example:

- Net Investment Income tax cut-off
- Amount of Social Security Subject to Tax
- Many state taxes

These unindexed tax law elements have the effect of gradually pushing your taxation level up over time.

Overestimating inflation can also be a problem for your financial plan because inflation impacts the model results. A relatively high inflation rate might lead you to reduce Roth conversions because your real rate of return will be lower which reduces the “optimal conversion” value as discussed in previous sections. A lower projected inflation rate will argue the reverse.

Inflation Rate	5% Growth	7% Growth
Profile 1		
2.0%	\$55.8K	\$61.9
2.5%	\$53.8K	\$59.9
4.0%	\$48.0K	\$53.6
Profile 2		
2.0%	\$94.5K	\$108.6K
2.5%	\$90.0K	\$104.1K
4.0%	\$76.6K	\$91.0K
Profile 3		
2.0%	\$167.2K	\$201.7K
2.5%	\$157.3K	\$192.6K
4.0%	\$126.5K	\$162.5K

Table 13 - Inflation Impact on Spending Ability

Table 13 summarize potential inflation impact on the 3 different profiles. The *spending ability* is defined is the inflation adjusted after-tax spending level that results in the inflation and tax-adjusted end-of-plan balance falling (just slightly) above the minimum desired end-of-plan balance (as described in Table 12). In other words, the desired spending goes up each year to account for inflation. (It is reduced on the passing of the first partner.) This table was generated using JRTN’s “maximum spending” option.

There are a couple of things to note here. The first is that spending ability is impacted even with the *very* optimistic assumption that real earnings remain steady (2% inflation with 5% growth is the same real earning as 4% inflation and 7% growth). This is due to the inclusion of a non-inflation adjusted income source in the profiles and unindexed aspects of tax law. The second is that profiles which rely more on assets to support maximum spending are impacted more.

Relationship between Rate of Return and Inflation

Doesn't the rate of return tend to increase with higher inflation? After all, banks and other institutions tend to pay interest rates that track inflation and equity investments are "forced" to track interest bearing investments to some extent. The answer is "it depends." It is true that new interest-bearing investments will offer higher rates with higher inflation. But for existing investments this "higher rate" will come from a loss in the cash value of the investment (e.g. bonds lose value as interest rates rise and equities will tend to lose value to increase yield). Most models assume that an increase in inflation has no direct linear impact on the real rate of return. In other words, it is dangerous to assume that the rate of return will increase to compensate for higher inflation. That said, some investment approaches are more sensitive to inflation than others.

7.5 Paying more in taxes is not always worse

It seems obvious. Every dollar you pay in taxes is a dollar less to spend or invest. To the extent that some taxes are avoidable, this is true. But it turns out that it is not quite that simple. In the end, what matters is "how much you keep" not "how much you spend in taxes." You want to keep an eye on taxes, but only as a sanity check. A similar analysis process relates to tax-advantaged investments. They might make sense. But they might not too. You really must run the numbers.

Underling this is the math for Roth conversions. If you wait and pay the taxes later, you are paying taxes on a larger amount due to investment-led growth in the IRA. All things being equal the taxes will be higher. But that is OK since the growth of the IRA has also funded the increase in taxes owed.

A few examples will help here.

First consider Profile 1, which we saw earlier had little or nothing to gain from an asset perspective from Roth Conversion.

Assets and Taxes vs Annual Conversion

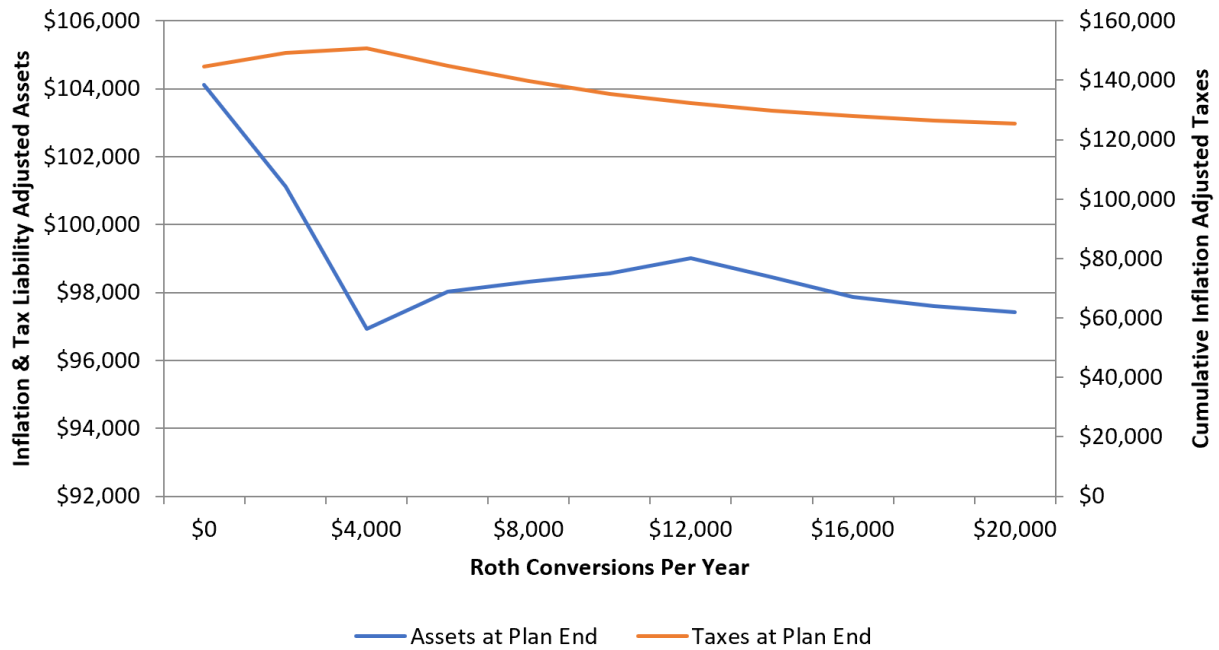


Figure 17 - Assets and Taxes vs Roth Conversion for Profile 1

Figure 17 shows how both the end-of-plan assets and the cumulative inflation-adjusted tax burden changes with increasing Roth conversions. This graph looks a little more dramatic than the one presented in Figure 14 because the vertical scales are selected to focus on the area of interest. What we see is that both the taxes and the assets decrease as we increase our Roth conversions. Our taxes have decreased from \$146K to \$123K, but we are worse off for it.

Next let's look at the other end of the spectrum with Profile 3:

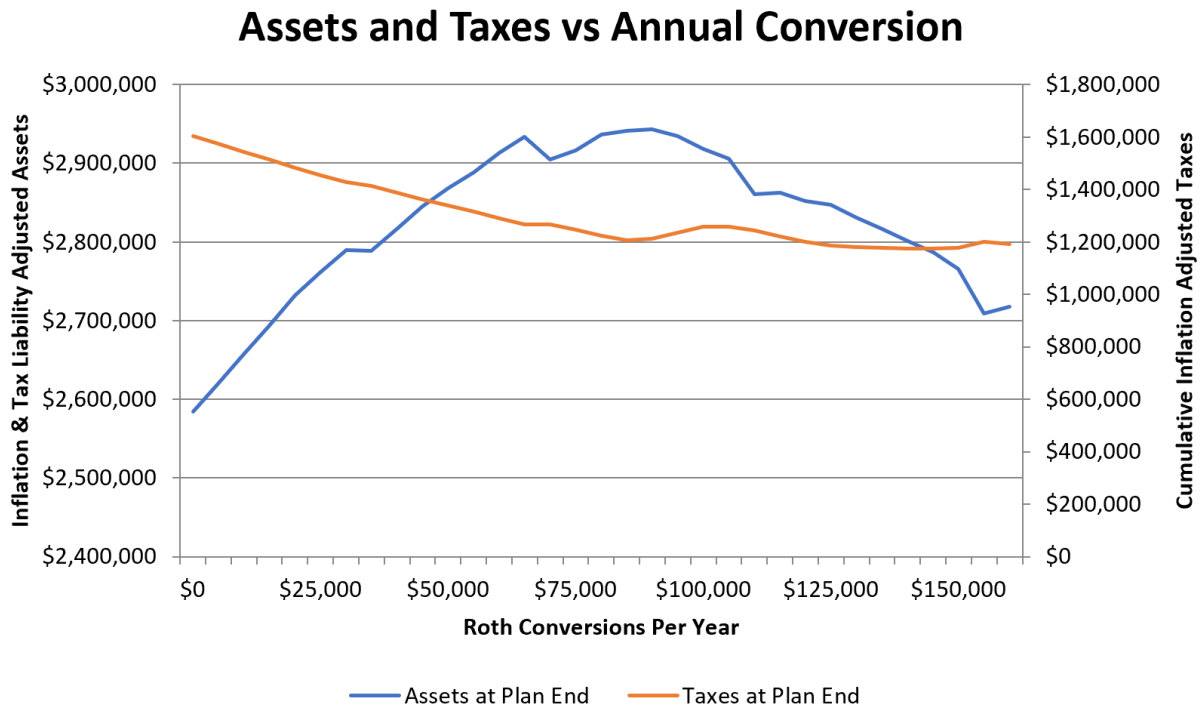


Figure 18 - Assets and Taxes vs Roth Conversion for Profile 3

The story for Figure 18 starts as our intuition would suggest. As we increase our Roth Conversions, both the tax burden and the asset picture improve. But when we get around \$90K the asset curve tops out and starts to decrease, suggesting that any conversion over that amount is counterproductive. The tax line does not follow this same trend. If we picked the point of lowest taxes around \$140K, we would again lose out. For this profile, minimizing taxes is a good thing, but it is not as good as maximizing assets. Finally we will look at a variation of this graph with an inflation rate of 3% instead of 2%:

Assets and Taxes vs Annual Conversion

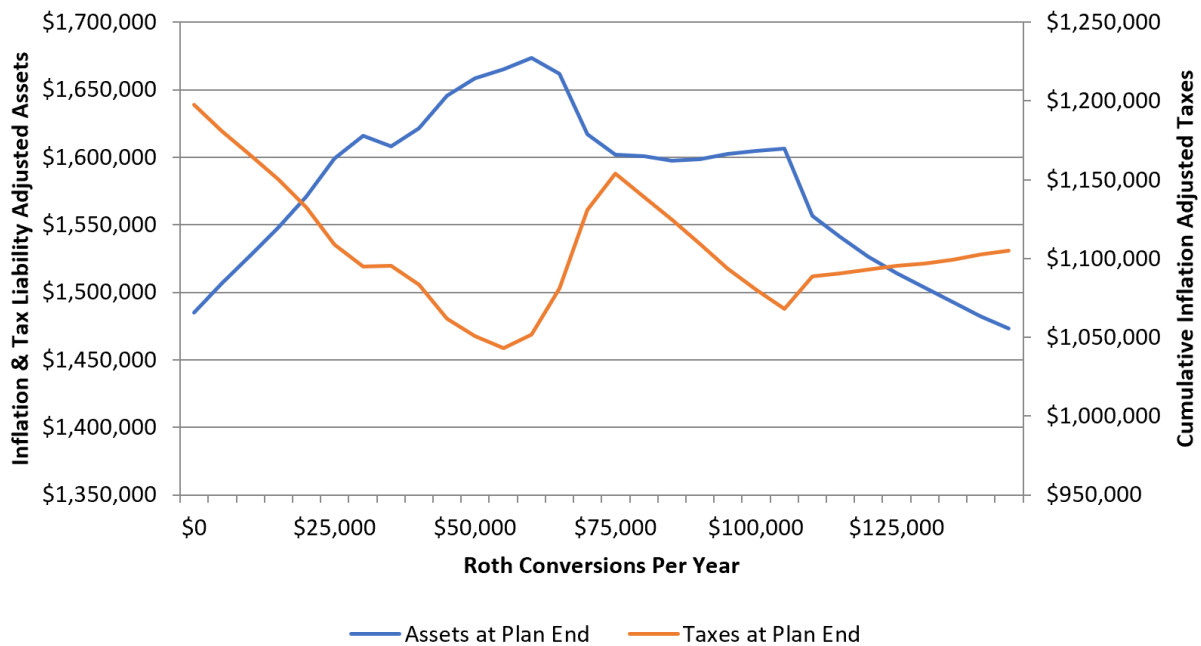


Figure 19 - Assets vs Taxes for Profile 3 at 3% Inflation

Of course the total adjusted assets are considerably less, but what is surprising is how this simple change muddies the waters for the tax payments.

7.6 Starting Social Security early might be OK or maybe not

The math is clear: if both you and your partner live into your nineties, you will come out ahead by waiting to take Social Security.

A popular way to think about Social Security commencement is in terms of the “break-even” age for Social Security. The way this is frequently calculated is to just look at the Social Security payments themselves. This will typically yield a “break-even” in your late 70’s. A more nuanced look that considers return on investments will push this out several years; the higher your estimated rate of return the further out the break-even will be. What this means is that waiting on Social Security will leave you in a better position in your 90’s. But it may have a negative or *very slight* impact well into your eighties.

It is surprising that some plausible scenarios suggest that you can come out behind by waiting on both Social Security commencements right up to the end of plan. Consider for example an of 7.4% rate of return, 3% inflation, and first partner mortality at 90. At 95, the surviving partner is still ahead if one of them had started at full retirement age instead of

waiting for age 70. At 3% growth this is no longer true. But an important point is that the magnitude of the difference is small in both cases.

Are you looking to optimize the very possible, but still less likely, situation of both partners living way into your 90's or are you looking to optimize the more likely case of one or both you passing in your 80's? It is best to look at your overall financial situation and not to focus just on the Social Security payments because this accounts for money you could be earning on your investments if you take Social Security earlier. If your retirement plan has you leaving an estate, the best measure might be to look at the value of this estate over the years with different commencement date assumptions. If, on the other hand the plan is to leave little or no estate and to have SS an important part of your income stream in late life, it may make the most sense to wait.

One way to look at this is in terms of end-of-plan account values given a specific spending plan. Another way to look at the question is to calculate the impact of Social Security commencement on the maximum spending level. This second approach is a little more flexible because it does not make a priori assumptions about what the spending level can be and because it is a little more "accessible" due to the numbers being more relatable for most of us.

SS Commencement	5% Growth	7.4% Growth
Profile 1		
62,62	\$53.7K	\$62.9K
67,62	\$55.0K	\$63.1K
70,62	\$55.8K	\$63.1K
67,67	\$56.0K	\$62.8K
70,67	\$56.0K	\$62.8K
70,70	\$55.9K	\$62.7K
Profile 2		
62,62	\$91.2K	\$110.7K
67,62	\$93.4K	\$111.3K
70,62	\$94.5K	\$111.4K
67,67	\$93.8K	\$110.8K
70,67	\$94.9K	\$110.9K
70,70	\$94.6K	\$110.4K
Profile 3		
62,62	\$164.2K	\$208.0K
67,62	\$166.5K	\$208.2K
70,62	\$167.2K	\$208.4K
67,67	\$166.8K	\$207.8K
70,67	\$167.7K	\$207.9K
70,70	\$167.5K	\$207.3K

Table 14 - Social Security Commencement Impact on Spending Ability

A lot of this is not too surprising, but bears repeating:

- The impact of future real (net) rates of return will likely dwarf your commencement decision.
- Higher rates of return make it less advantageous to wait

One result that does seem a little surprising is that starting the lower of the payments early is either optimal or so close to optimal that it might as well be optimal in most cases. Many people will find it comforting to see higher income early in retirement with a lower asset draw. Math suggests that there really isn't that much of a reason to wait unless you expect both partners to live well into the nineties.

A word of Caution

The results we see here, and every other Social Security commencement evaluation, are driven by guesses at mortality. Changing the 95 to 90 for the surviving partner will reduce the benefit of waiting while increasing 85 to 90 for the first partner passing would have the opposite effect. This should reinforce the need to run the numbers yourself and look at a few different scenarios you are concerned about.

7.7 Your Withdrawal rate may vary substantially over time

A common theme in the retirement press is to use a withdrawal rate as a vehicle for judging what your spendable income can be as discussed in 3.5. There are many variations on this, but they all amount to starting with some rate – typically ranging from 3% to 5% and then adjusting this amount over time to account for inflation and possibly other changes.

Whether your withdrawal rate stays relatively constant or changes a lot over time will depend on the details of your financial situation as well as your overall plan. For example, if you are looking to defer Social Security till 70 and you are looking to retire in your 60's then you are likely to make up the difference drawing from your assets. The draw will then decrease when you start Social Security. If on the other hand you are starting Social Security immediately and your savings are modest, you might find your withdrawal rates are indeed steady.

Withdrawal Rate vs Year

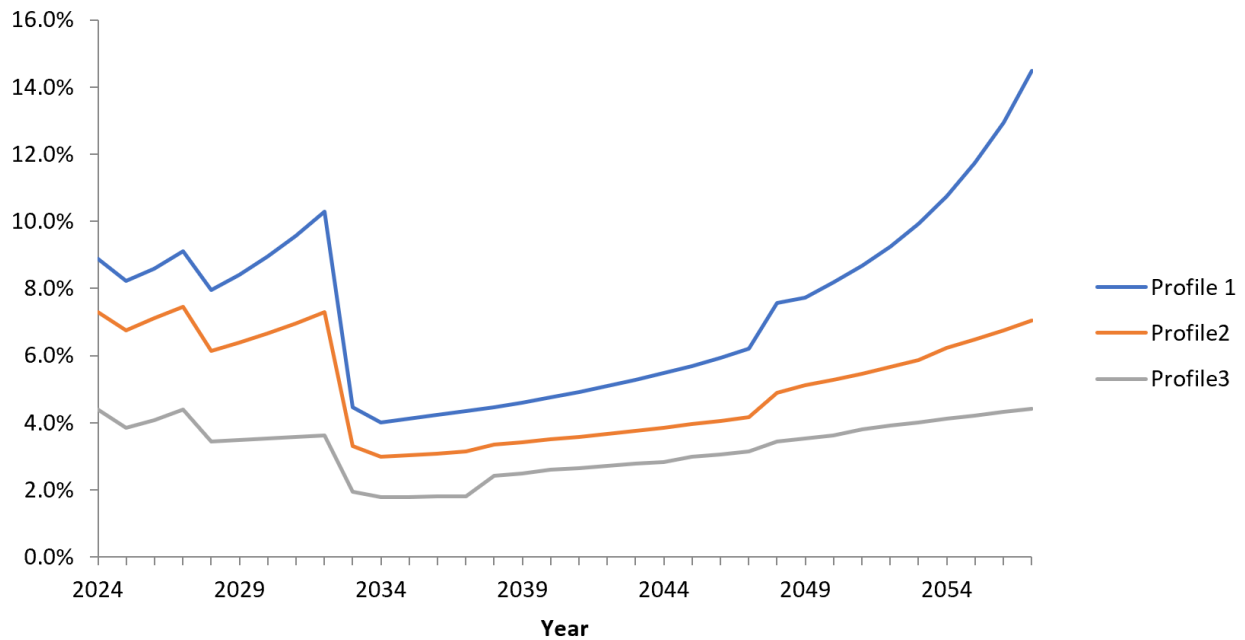


Figure 20 - Projected Withdrawal Rates

Figure 20 shows the projected withdrawal rates for the 3 different profiles. As expected, the withdrawal rates drop as Social Security starts. We also see a slight increase when the first partner passes since this tends to have a negative impact on finances.

How does this relate to the safe withdrawal rate?

Section 3.5 introduced the notion of the “safe withdrawal rate.” This is a number that is calculated at the start of retirement and then increased for inflation each year after that. The fraction of assets that are withdrawn each year thus goes up as the asset base goes down and inflation increases the dollar value of the draw. The number presented here is the *actual current* withdrawal rate. A graph that related the actual withdrawal rate to the safe withdrawal for each year would show the same sort of jaggedness.

Are RMDs or Taxes paid on RMDs a withdrawal?

If funds from an RMD are simply transferred to an unqualified account, then the transaction is not a withdrawal. By the same token, the funds used to pay the taxes don’t really constitute a withdrawal either since we are just moving money that is “tagged” for the government on to its “rightful” owner. If RMD funds are spent, then they are a withdrawal, but it seems best to think of this as a straight-forward withdrawal activity with the fact that it was associated with an RMD as incidental.

7.8 Long Term Care Insurance might not make sense

A substantial fraction of 65-year-olds in the United States will eventually need some form of Long-Term care. This is a scary prospect for people entering retirement since this care can be quite expensive. Unfortunately, LTC Insurance is also quite expensive. This insurance is most likely to make sense for individuals who have modest retirement savings and are looking to protect that savings for a partner or their estate. At lower net worth levels, it likely makes more sense just to roll the dice with an understanding that Medicaid is available as a fallback. At higher net worth levels it makes more sense to self-insure and to earmark part of the “potential estate” to LTC *if necessary*. This choice will make sense for an increasing number of people as the insurance premiums become more expensive and the typical coverage decreases.

7.9 Your marginal tax rate might be higher than you think

Federal and many state taxes are graduated so that income at progressively higher levels is taxed at a higher rate. Unfortunately, there are a number of other taxes and tax-like costs that also rise with income level:

- Federal Net Investment Income tax is a surtax on top of the investment income tax you already pay. This surtax is only levied when MAGI exceeds \$250K for joint or \$200K for individual filers. This is not indexed.
- Medicare IRMAA costs increase with income. This happens in a step-wise fashion with the first step at \$206K for joint filers and \$103K for individuals. This is indexed for inflation
- More of Social Security is taxed as income rises. In fact, a couple may have large enough Social Security payments that they pay the full 85% tax level without any other income at all. This is not indexed for inflation. If you fall in that range where more and more of Social Security is taxed, then your marginal tax rate is relatively higher. (This is the infamous “Social Security Donut that we hear about on the Internet.”)
- Some states take additional measures to capture tax at higher income levels. For example, Connecticut has a phased “recapture” of the standard deduction. If your income in the “phase-out” range, your marginal tax rate increases is higher than before or after the phase-out.
- Some states and local governments have means-testing for property tax abatement or government benefits. Often this is based on income.
- If you have wage income that income will have additional tax for FICA (Social Security).

These factors can easily add several percentage points to your effective marginal tax rate as calculated from the tax tables. Also observe that not all income sources are the same. Different types of income will have different marginal rates. An additional dollar earned as a dividend from your unqualified account may be taxed more than an additional dollar withdrawn from your IRA.

7.10 Exploring the example profiles

The profiles presented in Section 7.1 are also provided with the JRTN modeling tool. The distributed versions contain additional elements to support scenario analysis but otherwise match the profiles described here. These profiles are provided with the JRTN modeling tool in the event you would like to dig into them a little more. But as always, the recommendation is to build your own model and focus on that instead.

The scenario extensions propose variations on the profile. For example, rather than having a single spending amount or a single projected earnings level, there are several. You should be able to reproduce the numerical results presented in this chapter and then dig into the math in more detail.

8 Modeling Tools

By this point you should have a pretty good notion of what you might accomplish with a retirement modeling tool. It is time to look at different types of modeling tools and the process for selecting one that is right for you.

8.1 Modeling Tool Landscape

There are many different financial planning/modeling tools out there and, of course, you might decide to just roll your own as discussed in section 3.7. If you engage with a financial planner, they are almost certainly plugging your information into one of these tools; just as your professional tax preparer plugs your numbers into tax preparation tool. Most often this will be a commercial tool, but some commercial tools are also offered with allied advisor services, analogous to how tax preparation support is sold. Table 15 provides an overview of the modeling landscape.

Characterization	Discussion
Retirement Funding Modeling	Tools that lead with the financial model. These take a number of inputs such as expected rate of return and account balances and then generate a “plan” from these inputs. Often including Monte-Carlo simulation. Several of these tools are available in both an “individual” version and a “professional” version with the difference mostly related to pricing model.
Portfolio Modeling	<p>Tools that lead with the portfolio; often folding in other key pieces of information such as expected SS and spending needs to forecast future finances. Most brokerage firms offer something here and there are third-party tools. Usually including Monte-Carlo simulation. These tools often support aggregation across multiple brokerage firms allowing for a fairly complete view of investments.</p> <p>These tools may extend the portfolio model with relatively terse summaries of spending and external income. They are unlikely to directly support cash flows between accounts such as Roth conversions.</p>
Integrated Tools	<p>Tools that combine portfolio modeling, retirement funding models, and spending models. There will be automatic information flows between the “realms.”</p> <p>These tools will typically support “information feeds” from brokerage accounts to provide an accurate view of the assets.</p>

Financial Modeling Spreadsheets	Spreadsheets are a natural way to look at year by year finances and they have the advantage of being transparent. They are probably not going to be as adept at Monte-Carlo simulation or multi-client support. Many DIYs'ers wind up building a spreadsheet at some point in their financial journey.
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Table 15 – Tool Characterization

The purpose-built tools may be web based or run locally as installed programs. The approach is to capture a variety of inputs from the user and then to present a plan for the future that reflects these inputs. Often this future projection incorporates Monte-Carlo simulations that aim to establish the probability that the plan will “succeed.” Success is most often defined as “not running out of money” but there may be variations on this.

These probability-based projections consider past market behaviors (and possibly other events such as mortality) to generate a large number (often thousands) of different “futures” and then to evaluate the model repeatedly for these different futures. The result is a probability of success; for example, the model might claim that you will be able to spend at the desired rate for 95% of the scenarios without running out of money. The good news is that there is a substantial body of academic research and practical experience supporting this general approach. The less good news is that it tends to focus on a single set of inputs. For example, “Inflation will average 3% over the next 30 years” or “We will start Social Security draws at age 67.” These simulations will predict how likely you are to fail, but they usually don’t provide much help in understanding what that failure actually looks like, so they are a bit opaque.

We must be a little careful interpreting these results. When the tool says “95% chance of success” what it is really saying is that based on a prediction of future market volatility, there is a 95% percent chance of success if the future is similar enough to the past. The good news is that the general approach is testable by running the model at various times in the past and comparing it prediction to what actually happened. The bad news is that our future might not be that obliging.

Another approach to modeling is to focus on *scenarios*. A scenario is defined by a specific set of inputs; the same sort of inputs that the custom-built tools tend to support. Some of these inputs may be decisions such “When will I take Social Security?” Other inputs will be projections about some aspect of the future such as “what will my rate of investment return be?” or “What will inflation average?” or when will one or both partners die? The most effective scenario modeling will make it easy to compare scenarios by providing built-in mechanisms for comparing different scenarios. But of course, you could just save the results of different model executions in a manual fashion if you need to. Scenarios are

obviously useful as a decision tool. Scenarios are also useful for understanding the impact of “different futures” such as higher or lower inflation rates or rates of return. Where they really shine is in trying to understand *decisions in the context of different futures*. For example, what is the impact of different rates of return on early or late Social Security commencement?

8.2 Sourcing your Retirement Modeling Tools

Now that we know a bit about retirement modeling tools, the question is: where to get one? There are several choices, as outlined in Table 16.

Source	Discussion
Build Your Own	This is likely going to be spreadsheet based. You can start from scratch as discussed in section 3.7 or start with an existing spreadsheet and modify it to meet your needs.
Commercial Tools	There are a number of commercial tools on the market. Some of these are “web-based” and others are installable software. Some have a one-time fee and others are subscriptions.
Free Tools	There are two different sorts of free tools. The first is dedicated web-sites for financial modeling. The second is spreadsheets such as the JRTN tool described in this book.
Tool used by Financial Advisor	A financial adviser has already selected a tool. This is probably a commercial tool that they have sourced, but a few advisers create proprietary tools. You might see just the summary results from this tool, or you might have direct access to it. Some commercial tools have both an “individual” and an “advisor” model, so it is possible that you might be able to use exactly the same tool that your advisor uses on your own.
Tools offered by Brokerage Firms	Most brokerage firms offer one or more retirement planning tools. Some of these are available to non-customers. A tool provided by <i>your</i> brokerage service is going to be able to leverage knowledge of your accounts. Note that most of these will allow you to link to other brokerage firms allowing for a fairly comprehensive view of your portfolio.

Table 16 - Sourcing Retirement Tools

There is no reason to rely on a single tool. We can gain the best insights and confidence by using multiple tools and comparing the results. Try a dedicated financial modeling tool; but

also take advantage of the tools that your brokerage service provides. If you are so inclined, try using your own model – either from scratch or starting with something like the one described in the later part of this paper.

One important point is that these tools will not necessarily tell you the same thing! See (Rachel (Qianwen) Bi, 2020) for a detailed discussion on how the results from modeling tools can vary. It is one more reason to have your own model.

The Internet is your friend here. Try the following web searches:

- Retirement Planning Tools
- Retirement Calculator
- Free Retirement Planning Tools
- Retirement Tool Evaluation
- Retirement Planning Spreadsheet

You will quickly find tools as well as numerous sites that review and recommend tools. The following are representative:

Tool/Site	Discussion
https://www.honestmath.com/	A free modeling tool with an emphasis on its Monte Carlo Simulations. The model's definitions are relatively simple.
https://www.newretirement.com/	A range of web-based tools and associated advisory services. An entry level tool is free.
https://pralanaretirementcalculator.com/	This is an Excel based tool with both a paid version and a free version. The paid version incorporates scenario modeling and Monte-Carlo simulation. Lots of modeling details supported.
https://maxifiplanner.com/	A commercial planning tool marketed to both advisors and individuals.
https://www.empower.com/get-started-retire	Empower is a commercial firm with a range of offerings to individuals and advisors.
https://www.whitecoatinvestor.com/best-retirement-calculators/	This is a review of retirement calculators and related concerns
https://www.aarp.org/retirement/retirement-calculator/	A simple tool that makes assumptions based on current salary.

Tools that bill themselves as “retirement calculators” tend to be simpler with more assumptions on the tool’s part and less input on your part. They tend to be more focused on big picture questions like “can I retire without working” and a little less on nuances such as structuring Roth conversions.

This book does not try to evaluate existing tools. Rather it provides guidance for *your* tool evaluation. There are three reasons for this. The first is that any comparison and evaluation is likely to suffer errors of omission. The second is that since a substantial part of the material presented (See chapters 9 and 12) is about the open-source tool JRTN (Just Run The Numbers) developed by the author, a comparison to other tools is likely to be biased. Lastly, and most importantly, the tool needs to meet your specific requirements, and these vary substantially. An evaluation that focuses on your needs is going to be more useful to you than a general evaluation (many of these can be found on the Internet if desired).

One aspect of tool evaluation is “does the tool allow me to accurately capture my situation?” The flip side of this, as briefly discussed in section 8.6, is “how much accuracy do you really need anyway?” The answer might come down to the specific decisions you are looking to make. If you are primarily focused on “how much can I spend?” then you probably don’t need every modeling nuance such as detailed tax modeling. If you are trying to decide whether to do Roth conversions, then you need accurate tax modeling.

8.3 Evaluating Modeling Tools

Much of the material presented to this point is a discussion of modeling requirements. This section brings that material and other information together to provide an evaluation matrix. This is also where we introduce some details about the JRTN tool to kick-start your evaluation process.

Criteria	Discussion	JRTN	TOOL-1
General Considerations			
Cost	This might be an annual cost or a one-time fee.	Free	
Update Policy	Does the tool promise annual updates to address changes in tax law?	No ¹	
Local Data	Is the data stored locally on your computer?	Yes	

¹ Since JRTN is open source there can’t be any promises, but the individual user or the community are empowered to make these changes.

Criteria	Discussion	JRTN	TOOL-1
Ease of Use	The easiest to use tool is going to have guided form-based input and easy navigation of results. A less easy tool will rely on spreadsheet fields and some documentation. Ease of use is tied to the completeness of the model. The more complete the model, the more parameters there are to input and understand – making it harder to use – even with a fancy user interface.	Fair ²	
Budget Integration	Does the tool have a reasonably complete representation of a spending budget?	No	
Portfolio Integration	Does the tool have a representation of your complete portfolio?	No	
Complexity and completeness of input data	This is a general statement about the many specific types of data presented later in the table. There is no “right” or “wrong” here.	Relatively Complex	
Rate of return estimation	If the tool has a representation of your Portfolio, does it use that representation to estimate the rate of return?	N/A	
User Extensible	Is the tool extensible by the user?	Yes ³	
Full access to parameters?	This question is most relevant for a tool provided by a financial advisor. Do you have complete access to the input parameters or are some of them hidden (possibly to protect you from yourself)?	Yes	
Annual Plan Updates	How well does the tool handle updates on an annual basis? Ideally, we would be able to lock down new account values, but probably keep a notion of original plan start for indexing purposes.	Good ⁴	

² Once a spreadsheet always a spreadsheet

³ Some changes can be made at the spreadsheet level; others will require programming

⁴ The tool supports the notion of a base year used for inflation adjusted value calculations

Criteria	Discussion	JRTN	TOOL-1
Income Tax Modeling 5			
Tax Jurisdiction Change	Does the tool model changing tax jurisdictions?	Yes	
Federal Tax Fidelity	How good a job does the tool do with “non-ordinary” taxes, flexibility wrt to standard vs itemized, etc.	Good	
Hypothetical changes to Federal tax law	Does the tool have any mechanism to support hypothetical changes to tax law?	Yes	
State Tax Fidelity	You should look into how the tool handles taxes for states you are interested in.	Good ⁶	
Explicit Support for Earned Interest	Earned interest can have different tax consequences than dividends and short-term gains.	No	
Control over tax rule indexing	Does the tool provide you any input in how indexed parameters such as brackets are handled?	Yes	
Income Source and Asset Modeling			
Open Ended Account List	Will the tool allow you to add as many accounts as you would like? For example, can there be multiple unqualified accounts?	No	
Support for pension survivor options?	Pensions can generally be taken with joint, partial, or no survivor benefits.	Yes	
Annuity Income Support	Does the tool capture key elements of annuity design to model the income flow from an Annuity	No	
Annuity Purchase Decision Support	Does the tool capture the cost of establishing the annuity as well as “pre-annuitization” growth?	No	
Pension Nuance Support	Does the tool capture details such as how the pension is taxed, survivor benefits and indexing?	No	

⁵ Different types of accounts have tax consequences. These are covered in the income sourcing section

⁶ Depends on the state. Most states have relatively simple rules. For those states, income tax support is good. A few states have very complex rules – especially for high earners. In those situations, the tax law fidelity is likely to only be fair.

Criteria	Discussion	JRTN	TOOL-1
Bank Account Support	A bank account earns interest but does not throw other sorts of earnings. It could a source to draw from.	No	
Unqualified Brokerage Account	The unqualified brokerage account will generate different types of taxable income	Yes	
Roth Account Support	If it supports Roth Accounts, it should also have support for Rollovers	Yes	
Roth Withdrawal Rule support	Roth Withdrawals within 5 years of deposit are subject to tax on the earnings.	No	
IRA Account Support	There should be mechanisms for managing RMDs and any withdrawals should factor in tax calculations.	Yes	
Multiple-Life RMD	If partner ages differ by more than 10 years, different rules for RMDs are used.	No	
Inherited IRA	Support for the 10-year withdrawal rules as well as the lump sum remaining at 10 years.	No	
Support for deferred 401K Withdrawal rules	Funds in a 401K do not need to be withdrawn while the owner remains an employee	No	
HSA Account Support	For a retiree, a Health Saving Account is similar to a Roth account. When it passes to a non-spouse it is more like an unqualified account	No	
Wage Income	This should include control over Social Security taxes on the wages if it includes continued wage income in retirement.	Yes	
Social Security Account	Every retirement tool will model Social Security accounts	Yes	
Passive Income	Does the tool allow you to define a passive income stream?	Limited ⁷	

⁷ The tool allows for a specification about the fraction of Wages for which the participant owes FICA tax. A passive income stream could be represented by having this value zero, but that wouldn't work well if there was also true wage income.

Criteria	Discussion	JRTN	TOOL-1
Social Security Indexing Control	Social Security is indexed for inflation, but there are many ways to measure inflation. Can you set indexing to something different than the “inflation” parameter?	Yes	
Social Security Income implications	Social Security payments before full retirement age may be reduced by ongoing wage income	No	
One-Time Income Events	A one-time income event might be an anticipated inheritance or the sale of a business.	No	
Spousal Life Insurance	This is a special case of one-time income events.	No	
Support for Individual vs comingled assets	Does the tool try to provide an accurate view of individual vs comingled assets?	No	
Adjustments to qualified account values to estimate tax liability	The tool should be able to treat tax deferred accounts differently than other accounts. A rollup that simply adds Roth accounts to IRA accounts is not very helpful	Yes	
Can the tax adjustment parameter vary?	Are there mechanisms to use a different tax adjustment as circumstances indicate?	Yes ⁸	
Plan Phase			
Accumulation Phase Support?	Accumulation Phase support is going to focus on growth of assets. It may also try to address spending needs.	No	
Early Retirement Support	During early retirement we have a different set of rules. For example we may not be able to draw SS.	Limited	
Model Retirement	This is the period of “normal” retirement when we are considering the full range of retirement income sources	Yes	
Estate Phase Support?	Can the plan model the value of the estate for a period of time?	No	

⁸ A simple mechanism for adjusting the tax factor based on current account size is provided

Criteria	Discussion	JRTN	TOOL-1
Model Evaluation			
Concise year-by-year Report	Does the tool provide a year-by-year report of key metrics in a simple tabular form?	Yes	
Graphical presentation	Does the tool provide easy to understand graphical output?	Yes ⁹	
Multi-year rollup	Does the tool provide multi-year rollups of various results such as spending and taxes?	Yes	
Decision Support			
Multiple Model Support	Does the tool allow you to create multiple models in a straight-forward fashion. For example, by creating a copy of an existing model and then changing some parameters.	Yes	
Easy Scenario Comparison	Does the tool make it easy to compare different scenarios?	Yes	
Automated Scenario Generation	Does the tool automatically create scenarios?	Yes	
Roth Conversion Optimization	Does the tool provide direct support for optimizing Roth conversions?	Yes	
View into the data below the final results?	Does the tool provide visibility into the underlying data	Yes	
Social Security Breakeven	Will the tool project when you come out ahead by waiting on Social Security?	Yes	
Possible Social Security Changes	Does the tool allow you to model potential social security plan changes such as the hypothesized reduction in payments in the 2030's?	No	
Risk Modeling			
Monte Carlo Simulation	A Monte Carlo simulation will look at a large set of different return-on-investment scenarios (and possibly other variables)	No	

⁹ Since this is a spreadsheet, most anything can be presented graphically if desired. The tool provides for command driven generation of a few key graphs.

Criteria	Discussion	JRTN	TOOL-1
Risk Scenarios	A risk scenario is an explicit statement that projects higher risk. For example, using a low average rate of return.	Yes	
Historical (Back Testing) Based Modeling	Does the tool directly use historical rates of return observed during various periods of time in the past.	No	
Black Swan Events	A black swan event is a “bad year” with an explicit deviation from the “average rate of return.” It can accomplish much the same as the Monte Carlo simulation when a couple of bad years are incorporated early in the plan. Also Monte Carlo simulations can incorporate Black Swan events.	No	
Goal Seeking			
Level spending goal	Set a spending constant after inflation spending goal	Yes	
Time-varying spending goal	Can a spending goal be defined that changes explicitly from year to year?	No	
Annual spend reduction based on account balance goal	Use the baseline spending goal for as many years as possible and then reduce spending when account balances dictate	No	
Account Sourcing Control for draws	Control over the amount of money drawn from different accounts and the order in which it is drawn.	Limited ¹⁰	
Maximum Level-Spend identification	Calculation of the maximum level-spending amount consistent with maintaining a proscribed asset level	Yes	

¹⁰ There is control over the priority of drawing from qualified accounts vs unqualified, but behaviors to draw from Roth last and to draw proportionally from IRA's based on account size is hard-coded.

Criteria	Discussion	JRTN	TOOL-1
Maximum Reserve Level	This would identify the spending level that has the reserve topping out some number. The mechanism is the same as the Maximum Level Spend Identification. The difference is that we aiming to find the minimum spend.	No ¹¹	
Account Balance Constraints	Specify per-account balance constraints.	Limited ¹²	
Configurable Widow/Widower spending goal?	Specify in relative terms what happens to the spending goal when the first partner passes.	Yes	
One-Time spending event	Planned events such as the purchase of a house or motor home	No	
Roth Conversion Optimization	Does the tool provide integrated mechanisms to help you optimize your Roth Conversion	Yes	
Roth Conversion Support	Can Roth conversions be integrated into the goal statement? How flexible are the “conversion guidelines?”	Good	
Support for saving	In the event that external income sources exceed the spending goal, is money moved to savings?	Yes	
Incorporate limits on taxable income?	It is sometimes possible and useful to limit reported income. This would impact what accounts to draw from.	No	
Charitable Giving	Can Charitable Giving goals be incorporated into the model? This is most important starting at age 70 ½ when these contributions can be made directly from an IRA	No	

Table 17 - Retirement Tool Evaluation Matrix

¹¹ The tool’s “minimum reserve value” could be replaced with this maximum value but the tool can not calculate both values in an integrated fashion.

¹² A limit can be specified for the unqualified account

8.4 Contrasting Scenario Modeling and Monte Carlo Modeling

The big difference is in how these approaches look at the future. Looking first at investment earnings potential, the Scenario Modeling looks at the future in terms of “optimistic” cases, “pessimistic” cases, and “likely” cases. The Monte Carlo model projects what the future will bring by more directly extrapolating the past and then putting probability bars around this. They accomplish much the same thing, but the additional math surrounding the Monte Carlo approach might lead to a bit more confidence in the “likely” case. Where these approaches start to differ in their view of the future is when we consider all of the other things that might vary such as tax law or a decision to move to a state with different tax laws.

Another important difference is in how these tools approach the decisions that lie in the future such as when to take Social Security, stop working, or do Roth conversions. The Monte Carlo methods execute their financial models thousands or tens of thousands of times. This takes some time, so these tools are less likely to directly support directly varying these scenarios because of the large number of permutations involved in scenario variation.

One final aspect of scenario modeling is worth noting. There are multiple “worse cases.” This is especially true in the context of longevity. There is of course the worst case of both partners living well past the plan and running out of money. Another worst case is when one partner passes prematurely. This impacts what the best decision would have been for taking social security, but possibly more importantly, it can have significant negative income tax implications for the surviving spouse. We want to understand the various worst cases, but we also want to understand more typical cases. Scenario modeling makes it easier to wrap your mind around the different futures.

Scenario modeling and Monte Carlo methods are not necessarily mutually exclusive. It is possible to define a modest number of different scenarios and then run Monte Carlo simulations on each. What we have is a spectrum running from a single scenario through a few explicit scenarios and ultimately to large numbers of scenarios generated in an automated manner and used in an exploratory fashion.

8.5 Spreadsheets vs Purpose-built Tools

Spreadsheets and purpose-built tools have contrasting advantages and disadvantages. Most people building their own tool are going to wind up using a spreadsheet because this is going to be less work than trying to code something from scratch. The big advantage of the spreadsheet is that it comes to you as a complete framework with embedded mechanisms for the necessary math and relationships. Another advantage of a

spreadsheet is that the model is going to be visible and open to review. You don't need to take some programmer's word for the behavior.

Spreadsheets are not particularly adept at representing combinations of different sorts of data in an open-ended fashion because the data needs to be "flattened out." One winds up with either many related tables in the spreadsheet (or set of related spreadsheets), a very large number of columns, or both. All that extra structure then needs to be embedded into the spreadsheet rules. This is a bit awkward. For example, if the goal was to have a tool that supports an open-ended number of accounts of varied types, it would be a bit ugly to capture this in a spreadsheet (but of course not impossible). The representation as a collection of data objects in a traditional programming language would be more natural.

Spreadsheets don't have as much flexibility for defining user input mechanisms and results reporting as a custom software solution. It is impossible to match the "fancy UI" and graphical feedback possible with a dedicated solution.

A pure spreadsheet approach is not going to have the same flexibility for implementing goal-seeking behavior. Goal seeking in the context of a spreadsheet is likely to require some programming, resulting in what is effectively a hybrid solution like we see with JRTN. Most "serious" spreadsheet-based retirement model will probably include some code.

Lastly it is worth noting that Spreadsheets are not just for do-it-yourselfers. There are a number of commercial offerings based on spreadsheets.

8.6 Completeness, Predictive Power, and Ease of Use

Earlier sections have discussed different aspects of completeness including support for different types of asset and income sources and the richness of the tax modeling. A complete model will provide an accurate view of the future once possible uncontrolled external events are locked in. (e.g. guessed at for modeling purposes). That accuracy is helpful in some cases and less so in others. It depends on what you are trying to accomplish with the model. Certain decisions such as Roth conversions benefit from improved accuracy. Others such as "can I retire now" benefit less.

However accurate your model is, the predictive power is limited by the substantial number of external variables in play. A highly accurate model might still be useful for certain decisions since the decisions are largely independent of specific details of the future. For example, while we can conclude that a Roth conversion is likely a positive thing, it is impossible to accurately predict *exactly* how much it will help. Maybe a lot, but possibly hardly at all. At a more pragmatic level, these decisions need to be made, and you might as well have the best information available to support them.

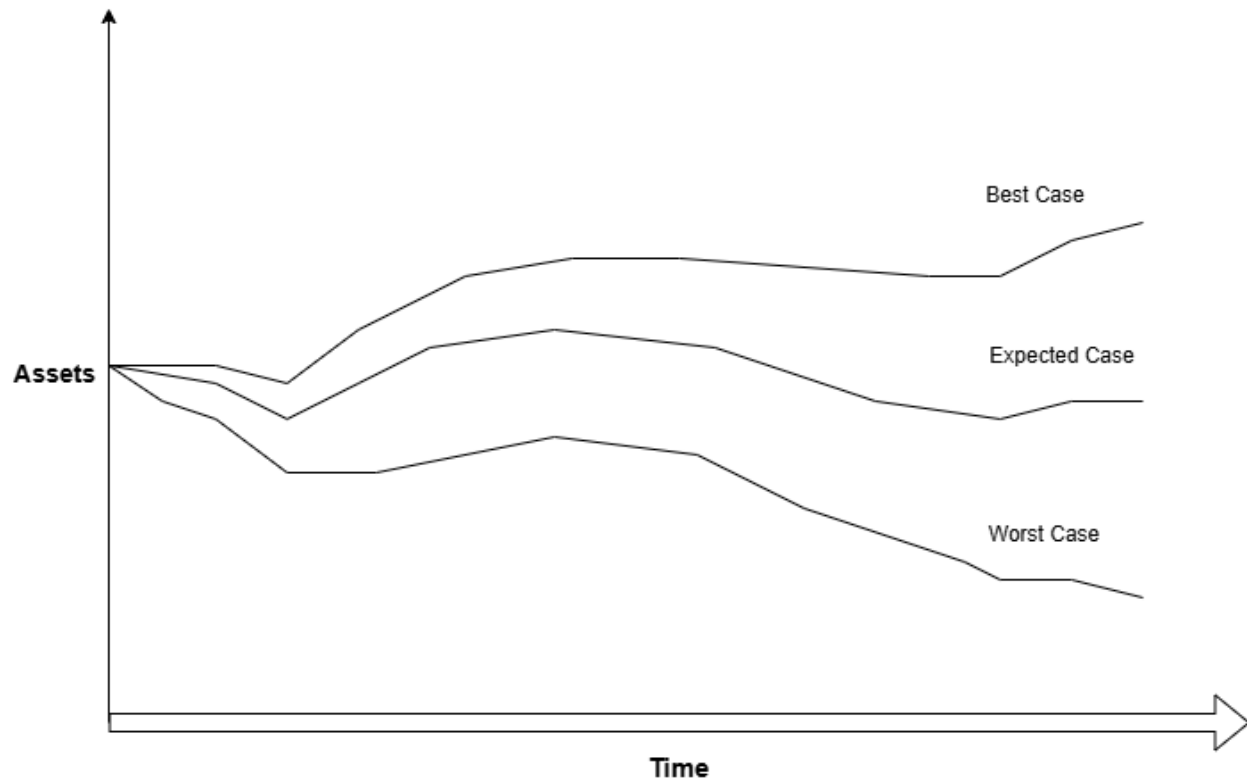


Figure 21 - The Cone of Uncertainty

Figure 21 shows this in a graphical fashion. In this case we are showing what total assets look like over time. The expected case might be the result of a detailed model. The best case and worst cases are likely to follow the same general shape, but they diverge more and more over time. Some modeling tools will try to project what these best cases and worst cases might look like. The Monte Carlo implementations do this by establishing probabilities. For example, there might be a 95% chance that we will be better than the worst case. Alternatively, the best and worst cases might be defined as the “likely worst case and likely best case with, for example, with a 90% probability that we wind up somewhere between the two curves. This is great; but even if the modeling tool you are using doesn’t try to model this, you should be aware that these curves exist.

Every planning process shares this same general aspect. It is impossible to completely predict the future. In the software engineering classic “Software Estimation: Demystifying the Black Art”, Steve McConnell called this the “Cone of Uncertainty.” (McConnell, 2006) We borrow that terminology here.

It is tempting to focus on the relationship between the “expected line” and the “worst case line.” We see lots of examples of this in real life with new airliners and nuclear power plants being years late and billions over budget. But that is dangerous. If you wind up always

comparing your plan to a real-life that went worse, then you have a systematic error in your planning approach that consistently yields overly optimistic plans.

It's just a model

After all this discussion about modeling, it is a little disconcerting to realize that the future won't follow the script. It is best to think of these models, especially ones that go 30 years into the future, as feasibility studies rather than operational plans.

Ease of Use

Model accuracy comes at a cost. The more accurate the model is, the more information is needed as input to the model. This invariably makes the modeling tool harder to use than it would have been if it had not tried to model a particular aspect of spending, income, assets, or taxes. The authors of the HonestMath modeling tool (Honest Math User's Guide) characterize this as "getting lost in the weeds."

Tool authors can invest effort to make the capture of the data required for detailed analysis less painful, but at the end of the day entering, and more importantly, thinking about, a large number of parameters is going to be more difficult than a small number of parameters.

8.7 Model Visibility for Problem Solving

Much of this book deals with answering "what if" questions such as "what if my return on investments in 4% instead of 5%?" There is another sort of question, the "why" question. Why did the model make this prediction? These "why" questions will tend to arise more naturally if you are looking at difference scenarios: "Why is this scenario different in this way from that scenario?" Let's reconsider the assets and taxes graph presented for Profile3 at 3% inflation:

Assets and Taxes vs Annual Conversion

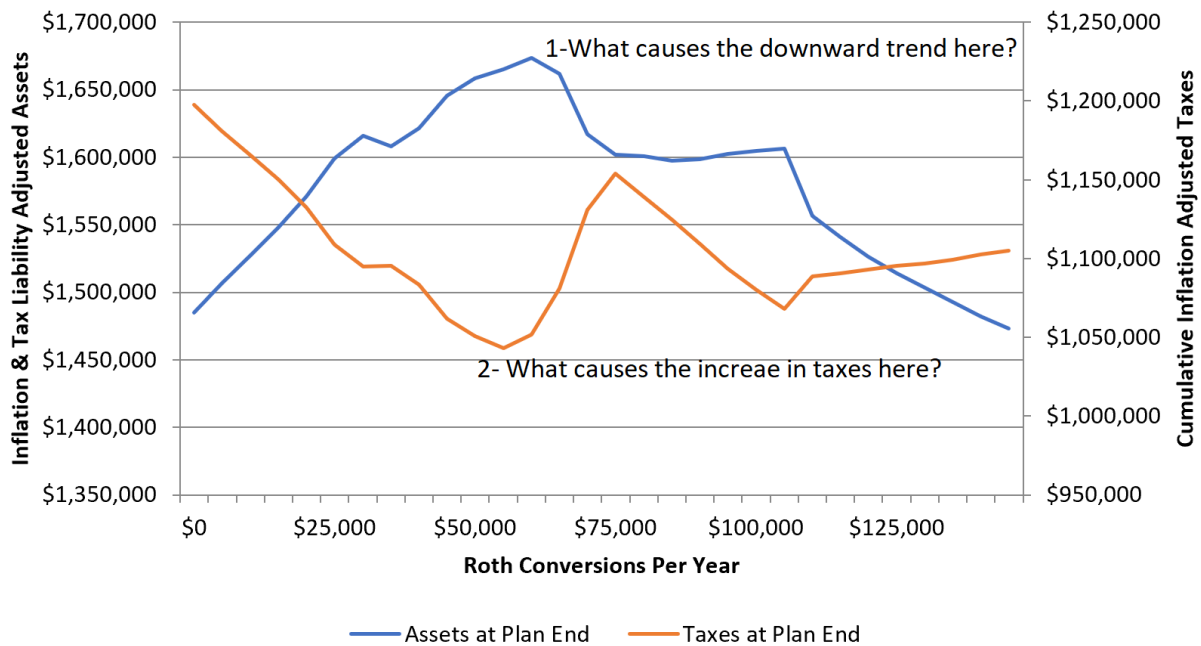


Figure 22 - Roth Conversion Questions

Figure 22 shows this same graph for the case of 5% growth and 3% inflation, but this time annotated with a couple of questions. Recall that this graph shows us summary results at age 95 for a range of different conversion values. Each point on the X axis represents a different scenario with a different Roth conversion value. This graph holds everything else constant, so we **know** that the difference in outcome has something to do with the taxes we are paying.

To answer these questions, you will need to dig into the taxes being paid on a year-by-year basis, and in order to dig into that, you will want to know the components of the taxes.

“Why” questions can arise even in the context of a single scenario. Most financial models are going to lead you to a few summary punch lines. For example:

- How much can I spend?
- How much will I have left?
- How much will we pay in taxes?
- What should my Roth conversion be?
- How likely is the plan to “fail.”

These summary results can naturally lead you to question how the tool arrived at its conclusion.

In both the “single” scenario situation and when comparing scenarios, what you need is access to the next level of data: the cash flows and positions on a year-by-year basis. Having data visualization available for this more detailed data is the next step and is a big help. The exact data you need depends on the question you are trying to answer.

Answering “why” questions is not strictly necessary to use a modeling tool effectively, but it is helpful because it will lead to a better understanding of retirement finances and to fewer surprises.

9 JRTN User's Guide

JRTN is an open-source retirement modeling tool implemented using Microsoft Excel. This chapter provides a detailed review of the tool from a user perspective. The tool is implemented as a series of Worksheets and some automation via Visual Basic for Applications (VBA).

An important and apparently unusual aspect of the tool is the automated generation of scenarios via the permutation of parameters such as rate of return, inflation, and others.

9.1 Overview and Motivation

Like many other DIY's, I created my own spreadsheet to model retirement income. Since I am a programmer at heart, I couldn't resist adding a bunch of automation to the initial worksheet. The result is a workbook that might be the start of your own "DIY" spreadsheet model or used as is. Many Excel automation puzzles were solved along the way; but in the end, both the spreadsheet mechanics and the automation are straight-forward.

There are two big advantages to spreadsheet model. The first is that the arithmetic of the model is on full display. The second is that it is generally straight-forward to extend the model.

The focus is on individuals in or approaching retirement where the financial situation entering retirement is more-or-less known. It is intended to help answer questions about Social Security draw date, Roth Conversions, how much you can afford to spend, etc.

9.2 Worksheet Roadmap

The workbook contains several different worksheets. The most important is the **Model** worksheet that models retirement income cashflow on a year-by-year basis. This worksheet follows the general form presented in sections 3.6 and 3.7. There are hundreds of columns and a dozen or so parameter tables. This worksheet is the core of JRTN.

The **StateTaxInfo** worksheet captures tax law details for each state. Information in this sheet is copied to the **Model** worksheet for two states (current residence and a potential move) via automation. Changes may be required to this sheet to capture local income tax rules.

Two auxiliary worksheets support scenario analysis. The **FactorTable** worksheet identifies values for different parameters on the **Model** worksheet. Parameters may have multiple possible values. For example, we might define possible growth rates of 3%, 5% and 8%. It also provides a mechanism for grouping to help manage the total number of permutations. The **FactorTable** worksheet is used to generate the **Scenarios** worksheet. The **Scenarios**

worksheet defines each scenario by capturing specific values of parameters in a set of columns. The Scenarios worksheet is then used to record summary information from the solution of that scenario. For example, assets remaining at various ages, cumulative taxes paid, etc.

These 4 worksheets may be copied and renamed as desired. For example, when you run the scenarios, you specify which **Model** worksheet to use. This is useful for testing, debugging, and experimentation. There are a few other functional worksheets that cannot be renamed:

- Controls – This is used to configure a few calculation-behavior controls. For example, how close the algorithm aims to get to the desired annual spending value. Controls are also provided to enable different logging activities.
- Tools – This worksheet provides access to a number of tools for maintenance and analysis purposes.
- Baselines – A worksheet that captures “baseline” values to support break-even analysis of Social Security commencement. This is used as a scratchpad during scenario execution from the **Scenarios** worksheet.
- Various “log file” Worksheets. These created when needed; they are not present in the distribution version of JRTN.

The following worksheets are strictly documentation and do not have any functional role:

- RawStateInfo
- Overview – this contains a very brief description of the tool and a copyright notice. This book came into being as this overview became unwieldy.

Additional worksheets may be created by user activities. These are essentially “reports” or other output:

- Roth Conversion Impact. This worksheet documents the “legacy” value of your assets for the full range of Roth conversions starting at zero and ending with the IRA exhausted at the end of the conversion process.
- Profile worksheets. A profile worksheet captures all of the “retiree specific” variables related to a plan, including the secondary input tables on the Model worksheet, the entire FactorTable, and the State Tax localization table.
- Scenario Comparison worksheets. (TBD)
- Income Source Graph (TBD)

9.3 Getting Started

JRTN is provided with “sample” retiree data that corresponds roughly to the “average” (mean) situation as reported by various sources on the Internet. This can be used to make an initial judgement as to whether the tool might be useful.

- Try changing parameters on the *Model* worksheet and executing **Solve Model**
- Generate and run scenarios using **Create Scenarios** and **Run Scenarios** on the *Scenarios* worksheet.

Since everyone’s situation is different, the first step to using the tool is to provide information about your specific situation. The recommended approach is to start with the *Model* worksheet and then move on to multiple-scenario analysis. The following is a summary of what is needed to create a *Model* worksheet specialized to your situation:

1. Update values in the “Fixed Parameters” section on the Model Worksheet:
 - 1.1. Starting account values
 - 1.2. Partner Birthdays
 - 1.3. Pension and Work values (If Any)
 - 1.4. Pension Start Years
 - 1.5. Work Stop Years
 - 1.6. Estimated Fed deduction (for a return to pre-TCJA taxes)
 - 1.7. Plan Start Year
 - 1.8. Plan End Age
 - 1.9. RMD Age’s
 - 1.10. FICA factors
 - 1.11. Pension control variables
2. Update the “Social Security vs Age” table (from your SS statement or account) on the Model Worksheet.
3. Update values in the “Variable Parameters” section on the Model Worksheet:
 - 3.1. Investment rate of return
 - 3.2. Declared income on Non-Qualified Brokerage account
 - 3.3. Federal inflation indexing factor
 - 3.4. Inflation Rate
 - 3.5. IRA Value weighting Factor
 - 3.6. Unqualified account weighting factor
 - 3.7. Plan Age 1
 - 3.8. Plan Age 2
 - 3.9. Unqualified Growth rate factor
 - 3.10. Last Year in State1

- 3.11. Post 2025 Federal Tax Scheme
- 3.12. Social Security Commencements
- 3.13. Percent of Unqualified account that is unrecognized
- 4. Update Values in the “Solution Control” table on the Model Worksheet:
 - 4.1. Target Spend Value
 - 4.2. Qualified Fraction
 - 4.3. Min Unqualified Balance
 - 4.4. Minimum Total Adjusted Balance
 - 4.5. Single Fraction
 - 4.6. Roth rollover target value
 - 4.7. First Roth Rollover Year
 - 4.8. Last Roth Rollover Year
- 5. Review the StateTaxInfo table for your state. Update if necessary. See the StateTaxInfo worksheet discussion for more details. For most states, nothing will be required, but if you live in a state that has local income tax variations, you will probably need to tweak this a little. Changes are most likely needed to the Local Adjustments table at the bottom of the spreadsheet.
- 6. Select your current and potential future states of residence
- 7. Use the **Solve Model** button to adjust the draw values and Roth conversions. You should see the numbers in the spreadsheet rapidly change with the end-result being that the “Adjusted After Tax Spending” matches the request that you entered into the spending controls.

Note for Single Users:

Single users should set the “Birthday 2” field on the *Model* worksheet to NONE and set the “Single Fraction” to 1.0 in the spending adjustment table of the *Model* worksheet. This is all that should be necessary; however, you might decide to also zero out some of the miscellaneous “Partner 2” values such as the starting IRA value for clarity sake.

You are now ready to experiment a bit. Try changing one or more of the parameters in the “Variable Controls” or in the “Spending Controls” and then use the **Solve Model** button to recalculate the worksheet. This makes it easy to examine different scenarios, but it is a little painful to compare them.

The next step is to look at automated scenario execution:

- 1. Update the *FactorTable* worksheet to correspond to your finances:
- 2. Create Scenarios corresponding to the updated FactorTable:
 - 2.1. Setup the scenario definitions by using the **Create Scenarios** button on the scenarios Worksheet

- 2.2. Execute the scenarios using the **Run Scenarios** button on the Scenarios worksheet
- 2.3. Focus on a specific group using the **Visibility** button on the Scenarios worksheet
- 2.4. Compare the scenarios in the group. If the group is large, you probably want to use the Excel column filters that were set up when you ran the Visibility command.

Next, you can look at tuning the model to answer your questions by creating new groups or modifying the existing ones, changing various parameters such as rate-of-return, inflation, and future taxes to better match your own view of the future.

You can also export the reports that are available to help you understand the results these are available via the Tools worksheet:

1. Detailed Roth Conversion Impact
2. Scenario Comparison (TBD)
3. Income Source

These reports provide both tabular output and graphs.

9.4 The Model Worksheet

The *Model* worksheet consists of the main calculation table at the top and then several control tables at the bottom. The main calculation table consists of several groups of columns. (roughly, from left to right):

1. Columns to provide year and age information.
2. Columns that identify external sources of income such as pensions, work, and Social Security.
3. Columns that identify “draws” from accounts.
4. Columns that identify taxable investment expenses. This is income being thrown by investment accounts that is not directly incorporated into spending. Examples would be 1099 income from after-tax accounts or the portion of the qualified account RMD’s not needed to support spending needs.
5. Columns that represent accounts. To keep things as simple as possible there is a single after-tax investment account and a single Roth account (rather than one for each partner or even multiple accounts per partner). It is necessary to maintain separate qualified accounts for each partner to properly manage RMDs.
6. Many columns support tax calculations. This includes the effect of income on Medicare premiums – which is treated like just another tax.
7. The goal column: After-Tax, Inflation-Adjusted Spending Capacity.
8. A few summary columns
9. Columns to support break-even analysis for Social Security

The income sources come into play and then go away at different years as defined by control parameters below the calculation table and tax law. These income sources contribute to spendable income. External income sources other than Social Security roll up to the *External Income Before SS* column. We need to treat SS income independently due to the complex tax rules surrounding it. The *External Income Before SS* column is a "handoff point" to down-stream calculations. It should be easy to add additional sources, such as an annuity or passive income sources, if desired.

Like any spreadsheet, the behavior of the *Model* worksheet is defined by the relationships between cells on the worksheet. A lot of this is the flow of information from column to column for a particular year and from year to year for account balances. The behavior is also controlled by parameters present in the "Fixed Controls" and "Variable Controls" sections of the spreadsheet and the Social Security and tax tables. Some of these controls provide "top of column" data such as starting balances for investment accounts; others such as the inflation rate control calculations throughout the spreadsheet. Since it is all exposed by the *Model* worksheet it is completely visible making it open to review and reasonably open to extension.

The *Model* worksheet can be used in a manual fashion by adjusting the Roth rollover and draw columns to achieve the desired outcomes for the account balances and spendable income. But this quickly grows old; goal-seeking automation is provided to calculate the draws required to reach a certain spending level. This automation is conceptually similar to what the Excel Goal seeker does. This automation also sets the Roth conversions based on the Roth conversion rule specified.

Note: There is no automation associated with the definition of the *Model* worksheet. For example, changing the starting value for an account or the amount drawn from an account for a particular year will flow through the spreadsheet using normal spreadsheet mechanics; there are many cell references and formulas, but no VBA automation is involved here. It is just a spreadsheet.

The behavior of the "spending automation" access via **Solve Model** is controlled by the **Solution Controls** table present on the *Model* worksheet. This table is only used by the automation – it is not referenced directly by any of the *Model* worksheet cells. In addition to the controls provided by this table there are a few "hard coded" behaviors:

- Funds are never withdrawn from a Roth or traditional IRA prior to Age 59 ½.
- Once funds can be withdrawn from an IRA without penalty the algorithm takes some of required funds from the IRA and other funds from the unqualified account based on the *Qualified Draw* fraction solution control parameter.

- Once we are in the RMD domain, the code first tries to satisfy spending needs via the RMD itself.
- If the IRA is emptied, the algorithm moves first to the unqualified account and lastly to the Roth account.
- With the exception of RMD calculations, we draw from the two IRA's in proportion to their size. (This might be sub-optimal if there is a significant difference in age)

Changing the solution controls will not *directly* impact the spreadsheet; rather they change what happens the next time you solve the model. **Note:** this "model solution calculation" is, by necessity, based on iteration and heuristics. See section 12.3 and section 12.5 for a detailed discussion about how the heuristics work and what might go wrong.

The automation makes it easy to see the behavior of tweaking a parameter while holding others constant. For example, to change the anticipated inflation rate and re-run the cash flow projection.

The results of the calculations are summarized in the "Rollup" table immediately below the main calculation table. All these numbers are interesting, but the one with the most consequence is the **Total Adjusted Realized Value**. This is the sum of the inflation-adjusted after-tax money made available for spending over the entire period and value of the accounts at the end of the period. This account value is adjusted for inflation and for the estimated remaining tax liability on (non-Roth) qualified accounts and unqualified accounts.

Optimization Goals

The Solution controls support optimization goals:

- Identify the maximum possible spending amount
- Identify the optimal Roth Conversion
- Identify the maximum Roth Conversion (This is the conversion amount that empties the IRA during the conversion period specified.)

When the automation encounters an optimization request, it iterates through the "normal" spending adjustment (setting draws and Roth conversion per year) several times to find the desired optimal value.

Note about Tax Calculations

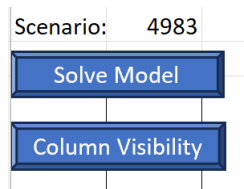
The tax calculations provided by JRTN are only an approximation of the actual tax liability. This is true for both state and federal taxes, but it is maybe "more true" for state taxes because of the wide variations in tax law between states and the difficulty of generalizing

these rules in a manageable fashion with a spreadsheet. Many states have straight-forward rules, but the complex situations can get *quite* complex. For example, it seems that every discussion of Connecticut state taxes starts with a statement to this effect. The complex situations usually incorporate some sort of needs-testing and it turns out that there are many different ways to fold “need” into tax law. If you live in one of these “complex law” jurisdictions you may try tweaking parameters such as standard deductions or the taxability of certain income streams to try to get closer to your actual situation

The “good news” is that there is not much point in trying to capture every nuance of federal or state tax rules because they change! We might have it right for the next couple of years, but it is almost certain to be wrong later. JRTN is taking an approximation of today’s tax rules and then running them out for about 30 years. We know perfectly well that these laws will change but we don’t know when or how. Extrapolating a precise view of today’s tax law 30 years is just not going to be that much better than extrapolating an approximation.

9.4.1 Model Worksheet User Interface

The *Model* worksheet provides the following command buttons in the upper left:



The **Solve Model** button will cause the automation to update the spreadsheet to reflect the current control tables. If the Solution Controls table has a request for spending or Roth optimization, this may take a moment or two; otherwise, it should be nearly instantaneous.

The **Visibility** Button brings up:

Model Column Visibility

Tax Bracket Definitions

Medicare RMMB Brackets

Intermediate Nominal Values

Flags & Miscellaneous Per-Year Values

Intermediate Tax Inputs

Down Stream Values

Sums Over Time

Baseline Comparision

Partner Sum Display

Show only Sums

Individual Values Only

Show both Sums and Individual Values

OK Unhide All Cancel

This allows you to hide many of the columns of the worksheet. The default shown here will hide all but key inputs and results. Note: columns “A” through “G” are reused by various control tables at the bottom of the worksheet.

9.5 Model Worksheet Reference

This information can be categorized as follows:

- Some of the information is “input” to the model and is expected to change from scenario to scenario
- Some information is “input” that is expected to remain constant for a retiree
- Some information is calculated or located based on input information
- Some information is constant is and captured from external sources

Factor	Discussion
Model Solution Parameters	
Target Spend Value	This is the inflation-adjusted spending that you plan for.
Qualified Fraction	This is how much of the draw to take from the Qualified account (as opposed to the unqualified account)
Min Unqualified Balance	This is the minimum unqualified balance. When the balance dips to this the spending algorithm will stop taking draw from the qualified account
Min Total Adjusted Balance	This is a goal for the entire plan, but it is not enforced. Instead, attention is called when we fail to meet this goal. When spending is calculated via Solve Model on the <i>Model Worksheet</i> a pop-up is used. When spending is calculated via the <i>Scenarios</i> worksheet, cell highlighting is used.
Single Spend Fraction	This controls what the spending transitions to when the first partner passes.
Roth Conversion Target Value	This is the baseline amount to use for Roth Rollovers. The exact amount of the Rollover will be a function of the Roth Strategy.
First Roth Rollover Year	This first year to do a Roth Rollover
Last Roth Rollover Year	The last year to do a Roth Rollover
Roth Strategy	Selects from a set of Roth Strategies as documented on FactorTable worksheet. For example, we might use a simple flat rate or possibly try to avoid one of the Medicare brackets.
Spending Calculation Precision	How close to get to the target spending value.
Annualized Excess Spending Precision for Max Spending Calculation	How close to try to ultimate maximum spending value.
Roth Calculation Mode	Specifies how to calculate the Roth Conversion. This will have one of the following values: <ul style="list-style-type: none"> • Explicit – Use the Roth Target value • Zero – Use zero instead of the Target • Optimize – Find the optimal conversion • Half-Optimize – Use ½ of the calculated optimal value • Maximize – Find the maximum conversion
Spending Calculation Mode	This may have the following values: <ul style="list-style-type: none"> • Explicit • Maximize

Factor	Discussion
First Retirement Year	This is the first year where the model solution automation will adjust draws or savings to result in a specific spending level.
Variable Parameters	
Investment Growth Rate	This is the projected average before inflation growth rate
Declared Income on non-qualified accounts	This is an estimate of how large your short-term 10-99 income will be as a fraction of account size. The value will vary depending on your investment mix.
Federal Inflation Indexing factor	This is a number that estimates federal indexing of social security, tax brackets, etc. with respect to the inflation number. For example, a value of 0.9 will index Social Security, etc by $0.9 * \text{Inflation Rate}$. Historically federal indexing has not quite kept up with inflation
Inflation Rate	This is the projected average inflation rate. This is used to adjust future account values and spending back to start-of-plan values.
IRA Valuation Weighting Factors	These factors are used to calculate the “effective value” of the qualified accounts. There are two parts to this. The first is a fixed factor that is always present and the second is a variable portion that is scaled based on IRA assets. The first factor should correspond roughly to your base tax rate if you didn’t have an IRA. The sum of the two should be approximately what your rate would be early in a Roth conversion scheme.
UnQualified Account Value Weighting Factor	This is used to calculate the “effective value” of the after-tax account. It is intended to take into account tax owed on capital gains. For funds likely to pass into an estate this can be 1.0 due to the step up in basis value that happens at death. This does not play any direct role in spending calculations.
Plan Age 1	Estimate of when first partner passes
Plan Age 2	Estimate of when second partner passes

Factor	Discussion
Unqualified Growth Rate Factor	This is used to estimate the growth rate of the unqualified account. It is a multiplier for the Investment Growth Rate. It might be lower to account for a tax-efficient investment scheme that expected to grow slower than qualified accounts.
Last Year In State 1	This is the last year that you plan to live in the first state. This is used to select the state tax rules in effect.
Federal Tax Scheme	This is a guess at how federal taxes will work after the 2017 TCJA law expires. This is used to calculate the tax rule and the tax column in the calculated parameters section. This should be a selection from the scheme table on the <i>FactorTable</i> worksheet. The different values capture whether we are continuing with the basic TCJA income definition rules and a set of different possible tax rates. For example TCJA-Pessimistic guesses that
Social Security Commencements	This is the plan for starting Social Security. The values should correspond to age values in the Social Security table near the bottom of the <i>Model</i> worksheet. This is a single parameter with 2 ages because that works a little better for multiple scenario modeling.
Percent of Unqualified Account that is Unrecognized	This is used for calculating the tax impact of spending funds from the unqualified account.
Reference Column in "Baselines" for Adjusted Total Value	The reference columns are used for calculating "breakeven" dates for commencing social security. These values are generated and filled in automatically by the scenario analysis and are only relevant for Scenario groups that focus on these concerns. The Model spreadsheet has two columns over near the right-hand side that compare against these <i>Baseline</i> worksheet columns. A negative value here means that this scenario is a baseline scenario.
Reference Column in "Baselines" for Adjusted SS Value	

Factor	Discussion
Fixed Parameters	
Workbook Data	This is documentation that indicates whether the specific data present in the workbook is confidential or generic. It is not used in any calculations, but it is set to “generic” when the workbook is made ready for distribution.
2017 Federal Personal Deduction	This is a capture of the 2017 Personal Deduction. This is used to support calculations that hypothesize a return to pre-TCJA tax law (or something similar)
Standard Deduction (Plan Start Year)	This captures the Federal Standard deduction for the start of plan year
Start of Plan Part B Premium	This captures the Medicare Part B Premium for the start of plan year
After Tax (unqualified) Brokerage Start Balance	This personal information captures the starting unqualified account(s) balance.
IRA Starting Balance 1	This personal information captures the starting IRA Balance(s) for partner 1
IRA Starting Balance 2	This personal information captures the starting IRA Balance(s) for partner 1
Roth Start Balance	This personal information captures the starting combined Roth balances for partner 1 and 2.
Est 2026 Deductions Before Income Tax	This personal information captures the estimated 2026 deductions before incorporating state income tax.
Working Income 1	This is annual wage income that we expect partner 1 to make.
Last Year Working 1	This is the last year that we expect partner 1 to work.
Working Income 2	This is annual wage income that we expect partner 2 to make.
Last Year Working 2	This is the last year that we expect partner 2 to work.
Pension 1	This is the annual value of pension 1
Pension Start 1	This is the year we expect pension 1 to start
Pension 2	This is the annual value of pension 2
Pension Start 2	This is the year we expect pension 2 to start
Birthday 1	Partner 1’s Birthday
Birthday 2	Partner 2’s Birthday. Use NONE for a single model.
Plan Start Year	This is the first year of the plan

Factor	Discussion
Baseline Year for Inflation Indexing	This is the year that we use for Inflation Indexing. If you are just getting started with JRTN, it is probably the same as the Plan Start Year. If you are looking to use JRTN year after year it may represent an earlier year.
FICA factor for income 1	The portion of Partner 1's income that is subject to both parts of FICA. Wage income may be from "independent" employment or not. Independent workers owe both parts of the Social Security tax
FICA factor for income 2	The portion of Partner 2's income that is subject to both parts of FICA.
Pension 1 Index fraction	The degree to which Partner 1's pension is indexed. A factor of 1.0 will index pensions to match federal indexing. A factor of 2 will have no indexing.
Pension 2 Index fraction	The degree to which Partner 2's pension is indexed.
Pension 1 Survivorship	A number specifying the value of Pension 1 after Partner 1 passes.
Pension 2 Survivorship	A number specifying the value of Pension 1 after Partner 1 passes.
Calculated Parameters	
Estimated 2026 Federal Personal Exemption	This is calculated by adjusting the 2017 personal exemption to 2026 (this 2026 value is then further adjusted for subsequent years)
Social Security "1" as of Plan Start Year	This is calculated based on the social security table lower in Model worksheet, the Social Security starting age, and the participant's age. This the starting value of SS in "plan start year dollars." It is the same information that the Social Security administration provides.
Social Security "2" as of Plan Start Year	Starting Social Security value for participant 2.
Federal Indexing Rate	This is the product of the inflation rate and the Federal inflation rate indexing factors described above.
Calendar Year SS 1 Starts	This is the year participant 1 starts social security. It is calculated from participant's birthday and commencement age.
RMD Age 1	Age when RMD must start. If partner 1's Birthday falls after Jan 1 1960, this is calculated as 75. Otherwise it is 73.

Factor	Discussion
RMD Age 2	Age when RMD must start. If partner 2's Birthday falls after Jan 1, 1960, this is calculated as 75. Otherwise it is 73.
Calendar Month SS 1 Starts	This is the month participant 1 starts social security. It is calculated from participant's birthday and commencement age.
Calendar Year SS 2 Starts	This is the year participant 2 starts social security.
Calendar Month SS 2 Starts	This is the month participant 2 starts social security.
Plan End Age	This is calculated as the second of the partner plan ages described above
Post 2025 Federal Taxable Income Rule	This specifies whether we are following "TCJA" rules or not for income calculation. It is calculated from the tax scheme parameter described above.
Post 2025 Tax Scenario Column	This identifies the column from the Potential <i>Future Tax Rate Scenarios</i> table lower in the Model worksheet. This selects the tax rate that will be applied starting in 2026.
Unqualified Account Growth Rate	This is calculated from the <i>Investment Growth Rate</i> and the <i>UnQualified Account Value Weighting Factor</i>
Social Security Commencement 1	These are calculated from the Social Security Commencements parameter
Social Security Commencement 2	
State Tax Calculation Parameters	
State	Identifies "State 1" and "State 2"
Standard Single Deduction/Exemption	The value of the standard deduction/exemption for Singles.
Standard Joint Deduction/Exemption	The value of the standard deduction/exemption for Couples.
Individual Retirement Income Exemption	Additional individual exemption. This is applied to individuals 65 and older.
Individual Credit	This is the individual credit. Taxes are reduced by this credit.
Pension Income Taxed	Is Pension income taxed?
IRA Taxed	Is income from retirement accounts taxed?
Wage & Passive Income Taxed	Is "normal" income from wage and passive income taxed?
% SS Taxed	What percentage of Social Security is taxed
DIV-INT Taxed	Are dividends and interest taxed
CAP Gains Taxed	Are capital gains taxed?
Indexed for Inflation	Are brackets and deductions indexed for inflation

Factor	Discussion
State Tax Table 1	This captures brackets for State 1. A very large number is used to indicate the top end.
State Tax Table 2	This captures brackets for State 2. A very large number is used to indicate the top end.
Federal Tax Rates	
TCJA Rates	These are the rates for 2024 and 2025
Post TCJA Rates	These are the rates in effect after 2025. This column is populated based on the contents of the <i>Potential Future Tax Rate Scenarios</i> table and the tax scheme selection rules described above.
Potential Future Tax Rate Scenarios	These columns identify different possible tax rates. The values here can be changed to match your range of guesses about what the future holds for federal income tax.
Medicare IRMAA factors & Costs	This table captures Medicare costs. These are effectively an element of the federal tax scheme.
Estimated Social Security Payments	
Annual values	These values come from your social security statement or account – possibly after consideration that your “working” plans might be different than what the SS Administration is assuming.
RMD Table	
Age	Single-life RMD value

Table 18 - Modeling Parameters

9.6 StateTaxInfo Worksheet

This worksheet is used to create the “state 1” and “state 2” income tax definition sections of the Model worksheet. There are 3 different tables on this worksheet:

1. Baseline income bracket definitions
2. Tax rule definitions (for example, is Social Security taxed?)
3. Local Income tax rate tweaks. This is a mechanism for accounting for local income taxes that can happen in several states. For example, different counties in Maryland have different “adders” to the base state income tax. If you live in Maryland you need to enter a value here to reflect the county you live in.

Information about a state’s income tax rules is loaded from the stateTaxInfo sheet to the model worksheet whenever the state is changed on the model worksheet. This includes “policy” information such standard deductions and what income is taxed, as well as tax tables used for states that have a progressive taxation scheme.

The information on this worksheet is collected from a variety of sources summarized on the *RawStateTaxInfo* worksheet. It is a good idea to verify details for your specific situation by consulting official tax documents (typically the individual tax form and its associated instructions).

9.7 Scenario Modeling

The automation provided on the Model worksheet is helpful, but it becomes awkward to compare different situations such as different social security commencements or different future rates of return.

Scenario modeling addresses this by running the model many times (most likely several thousand) with different sets of parameters and then using simple spreadsheet mechanics to review the results. Scenario modeling makes it easy to compare different predictions about the future and different decisions you might make. For example, to compare the financial impact of starting Social Security early or waiting. What makes the spreadsheet model particularly attractive for this sort of evaluation is that it becomes easy to fold in other parameters as:

- Mortality of first partner
- Investment income returns
- Inflation
- Different future Income tax levels
- Expectations about how well SS Cost of Living adjustments cover inflation

With a spreadsheet, this is a simple matter of applying filters to a column.

The following is an outline of how to work with scenarios:

1. Verify that the desired set of Factors are specified in FactorTable.
2. Create the Scenarios using the *Create Scenarios* button.
3. Run the scenarios.
4. Select the desired Visibility. This is a simple utility to hide input and results columns that are of less interest. This also defines filters for the input columns and sets a filter on the group column to limit the rows displayed to the selected group.
5. Use the input parameter filters to "tour" the data as discussed in Section 9.8.2
6. Since this is "just a spreadsheet" you might also want to use sorting or filters on one or more of the results columns.

If you want to dig into a specific scenario, re-execute just that one scenario. This will leave the Model worksheet loaded with the parameters for that scenario. You may also decide to tweak the FactorTable to change parameter values, add new choices, etc.

9.8 The Scenario Worksheet

The Scenario Worksheet is a single table with two sets of columns:

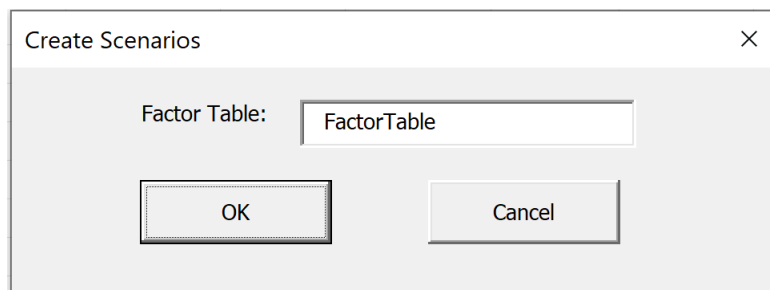
1. Scenario Definition Columns. These columns contain parameters that are copied to the Model worksheet prior to running a scenario.
2. Scenario Results Columns. These columns are copied back from the Model worksheet after a scenario is run.

9.8.1 The Scenario Worksheet User Interface

The *Scenarios* Worksheet provides the following buttons in the upper left corner:



The **Create Scenarios** button brings up:



This is used to rebuild the Scenario worksheet from a FactorTable worksheet.

The **Run Scenarios** button brings up:

Run Scenarios

What Scenarios to run

All

Group:

One Scenario:

All, Restart At:

All, Except:

Model Worksheet Name:

OK Cancel

Status: Pending

This is used to run all the scenarios or a subset of the scenarios. You select the scenarios you want to run and the Model worksheet to use. Then “OK” to initiate the calculations. The following steps are performed for each selected scenario:

1. Copy control parameters to their "home" on the *Model* worksheet.
2. Execute the "Solve Model" logic associated with the updated Model worksheet.
3. Copy result values back to the *Scenarios* worksheet.

The Model worksheet will remain populated with the last scenario that was run, so if you want to dig into a scenario, run just that one and then move back to the Model worksheet to examine it in more detail.

The **What Scenarios to Run** section allows you to run a subset of the scenarios if desired. This is particularly important if you have defined a group to focus on Roth or Spending optimization because optimization is much more time consuming than a simple scenario execution.

Two different sorts of optimization activities might occur for a scenario:

- Find the maximum spending level
- Find the optimal Roth Conversion

If both are active for a scenario, the logic will first calculate the maximum spending value using the nominal Roth conversion value and then use this spending level for the Roth optimization.

NOTE:

It often does not make sense to do both maximum spending evaluation and Roth Conversion optimization since the optimal Roth Conversion is usually going to be nothing at all at the maximum spending level. The exception will be in circumstances where a very high end-of-plan residual value is requested from the model. The reason for this is that the high-spending plans have you drawing down the IRA fast enough to support spending that RMD's do not become a big issue.

Roth optimization uses the nominal Roth conversion value as a jumping off point. Roth optimization will be most computationally efficient if this nominal value is at least in the general neighborhood of the anticipated optimal value.

At the bottom of the Scenario worksheet a summary is provided:

Summary Statistics		
	Counts	Percent
Insufficient Funds	102	3.3%
Failed to meet Reserve	776	25.1%
Total Failed	878	28.4%

This counts the number of scenarios that fail outright or fail to maintain the desired minimum balance. Maximum spending scenarios are excluded because these will never fail on either basis. This is roughly analogous to the failure statistics that one can get from a Monte Carlo simulation. Your expectations for this will depend on the extent to which your scenarios pursue negative scenarios or require optimistic real rates of return.

The fact that the scenarios failed is reflected in the body of the Scenario worksheet:

- Scenarios with insufficient reserve are flagged red (you could also use column filters to look for these scenarios directly)
- Scenarios with insufficient funds are flagged red and the results fields are left unchanged

The ErrorLog provides a little additional information in the form of the row number where the failure was first observed.

The **Visibility** Button brings up:

Scenario Visibility

Hide Unvaried Input Parameters

Hide Utility Columns

Results to Show

Nominal Tax and Account Totals

Adjusted Tax and Account Totals

Tax Totals

Asset Totals

Social Security Totals

Realized Value Totals

Taxes on Unqualified Accounts

Rollups

Roth Totals

Break Even

Group: All

OK Cancel

This controls the visibility of input and results columns. It also creates filters for the input columns and adjusts the “group” column filter to match the selected group (controlling row visibility)

9.8.2 Understanding Scenario Results

A challenge with using automatically generated scenarios is that there can be a lot of data to look at. Permutations of the FactorTable worksheet quickly lead to thousands of different scenarios with each scenario being a row in the Scenario table. There are also quite a lot of different results data that you might look at. It can get a little overwhelming – it is easy for your thoughts to drift off in the direction of “can’t I just have my financial planner make sense of all this?”

But don’t despair, the following is an outline of how to proceed:

1. Use Visibility controls to focus on a single group at a time. This will typically reduce the row count from “several thousand” to “several hundred.” You will generally also use this to hide input parameter columns that don’t happen to change for the current group.
2. Decide what results data you are most interested in at the moment. A good place to start is often the adjusted account values near retirement, especially if spending behavior is consistent across the scenarios in the group. You might decide to use Excel controls to hide the other output columns.
3. Eyeball the data to get a general sense how much it varies across the scenarios. You might sort the results column to make this clearer.
4. Use Filters to lock down a few of the input parameters to allow you to focus on others. The natural limit here is to have just a single input parameter varying and to focus on a single result value. All the sudden the data is easy to see!
5. Use column filters to understand the impact of different input parameters.

Likely vs Unlikely Scenarios

Each scenario parameter has a range of “feasible” values and then a much smaller range of likely values and you can often identify a “most likely” case. For example, the Federal Reserve has a target for inflation of 2%. This suggests that the most likely long term inflation value is something in that general vicinity. All the same, it is risky not to consider what your finances would look like with 4% inflation. A similar thought process can be applied to rates of return, longevity, and any other external variable.

This suggests another strategy for working with scenarios. Use the large pool of potential scenarios to identify a handful of relatively more likely scenarios to focus on.

9.9 The FactorTable Worksheet

The *FactorTable* worksheet provides the input for scenario creation. Each type of factor, such as “inflation rate” or “rate of return” in the FactorTable worksheet corresponds to a control column in the *Scenarios* worksheet, and in turn, to a control on the model worksheet. Sets of factors may be combined into groups. The purpose of the group is to manage the total number of scenarios created to a reasonable number.

The FactorTable has the following columns of data:

Data	Description
Group Name	This will have the name of a group or it will be empty signifying data that is uses identically in all groups.
Data Type	This is used for applying cell formats as scenarios are created in the Scenario worksheet

Name Reference	This is an Excel Name associated with a field on the Model Worksheet.
Block Type	This identifies the parameter block on the Model worksheet. This will be either AdjustParam for the solution control parameters or VariableParam for the typically variable parameters.
Column	This identifies the column that this control parameter will wind on in on the Scenario worksheet. This is an index into the control columns starting at column "C"
Ref Column	This is used for Dependent Variables. It is a statement that this set of parameters are dependent on the value of the data in the referenced column.
BE Info	This is used to identify data that is used for Break Even analysis. In the current version of JRTN it is either empty or has the string SSBE.
Remaining columns	These contain a set of one or more parameters. If this is a dependent parameter (the Ref Column is not empty) then there will be pairs of parameters where the first field is the parameter to populate and the second is the parameter value to match in the Ref Column.

Table 19 - Factor Table Definition

Within a group a particular factor may be:

1. Constant. For this group a particular factor does not vary at all. Constant data might be explicitly part of the group or it might be data that is not associated with a group (the group field is empty)
2. Independently Varying. There are a set of parameters values for the group. For example, 3 different rates of return.
3. Dependently Varying. These parameter values are tied to some other varying parameters in the group. For example, you might tie Social Security commencement to the "start of retirement" year. The purpose of this dependent mechanism is to remove scenarios that are not of interest. This reduces the computation cost for updating the scenario worksheet and makes the results easier to understand.

The FactorTable can be changed in the following ways without any impact on the VBA automation:

- The value associated with specific factors can be changed. For example, you can change the target spending amounts.
- The number of factors on a line can be changed (the automation just looks for the last factor value on a row)

- New groups can be defined
- New Factors can be added. Adding a new factor type is slightly more involved, but it does not require any automation changes. This is discussed in Section 12.2.

If you are going to be actively working with the FactorTable worksheet, it is helpful to understand the logic which maps this worksheet to the scenario worksheet; the following is a summary:

1. Clear the existing *Scenarios* worksheet
2. Clear the *Baselines* worksheet
3. For each Group:
 - 3.1. Create the baseline scenario for the group by using the first factor column from the factor table for each factor. For factors that are not part of this group use the first factor from the first row of the *FactorTable* worksheet corresponding to this factor.
 - 3.2. For each factor row with this group name:
 - 3.2.1. Record the start row and current stop row for this group in the *Scenarios* worksheet. This identifies the *incoming block*.
 - 3.2.2. For the 2nd and subsequent factors on the factor row:
 - 3.2.2.1. Create a new block of rows in the *Scenarios* worksheet by copying the entire incoming block
 - 3.2.2.2. For each row in the newly created block:
 - 3.2.2.2.1. Change the factor value to match the current factor
 - 3.2.2.2.2. Update any dependent parameter definitions

This logic allows us to have groups that focus on different aspects of the model while allowing for some variation in other parameters. For example, a group that explores Roth Conversion may have 2 or 3 inflation values whereas a group that focuses more on earnings and inflation might look at a larger number of different inflation values.

The number of scenarios for a group is the product of the factor count for the FactorTable rows for that group. This number can grow quite large, but it is far smaller than the number of permutations suggested by considering all the multiple-factor rows without grouping - which can easily grow to many millions of different scenarios.

Groups can be used for two different ends. The first is to explore a range of scenarios. When you use groups in this fashion, each group will have several varying parameters. This may yield many scenarios in a group. The other use of a group is to probe the impact of a single parameter in detail. In this case you have just one varying parameter, but that parameter might have a larger number of variations, and those variations might be carefully

aligned with some question you are trying to answer. Section 10.6 provides an example of using a group in this fashion.

A group may be commented out by prepending each instance of the group name in the factor table with a “#” character. These groups will be skipped when regenerating the Scenario table.

Note:

The group structure for Roth Conversion optimization requires the Roth Optimization mode to be the *first* varying parameter in the group. Social Security Breakeven analysis, on the other hand, requires that the corresponding parameters be *last* in the FactorTable as described in Sections 10 and 10.5.

Social Security Break-Even

The tool provides for break-even evaluations for Social Security: When does delayed Social Security break even compared with an early start? This is measured both in terms of the Social Security payments themselves as well as the Inflation-Adjusted Total Realized Value.

The Break-even calculation uses tagging in the FactorTable worksheet to identify the factors to consider for the break-even evaluation. This needs to be the *last* varying factor of a particular group. The baseline itself is based on the first parameter on this line. This results in a set of baselines. For example, we find the following near the bottom of the factor table in the distribution version of JRTN:

ModelSSCommencements	VariableParam	23	SSBE	66.83,66.83	70,66.83	70,70
----------------------	---------------	----	------	-------------	----------	-------

This will result in a set of baseline scenarios that all have commencement at age 66.83,66.83 with each of the other varying parameters changing. For example, we might have varied tax law, first partner mortality, inflation, rate of return etc. This is quite powerful because it shows how the breakeven year changes with the other circumstances. The baseline comparison then will compare a scenario with 70,66.83 to the scenario that is identical in all respects except for having a commencement at 66.83,66.83.

The baseline for the breakeven analysis is going to depend on your circumstances and other factors such as your plans to work longer. For example, if you need to work till 65 when you can start to collect a private pension, there is little point in calculating a breakeven using Age 62. The baseline should be the earliest age you can imagine collecting Social Security given your situation.

Using Scenarios Effectively

The key to working with scenarios is to manage the explosion in the number of scenarios as we allow more and more parameters to vary - while still having access to the “important” parameters. Generally, this means defining a Group that focuses on a single question or future prediction and selecting a few key parameters to vary as part of this group.

Since scenario execution can be time consuming, it may make sense to focus on a single group at a time. If you guessed that a particular parameter was important, but it proves to be only secondary, then reduce the number of factors for this parameter, possibly to a single factor. As you refine your model, and as you use your model over a period of years, you may settle on the value of certain parameters. You can then update the model to lock in these parameters. Some possible examples include:

- Social Security Commencement
- IRA Tax Factor
- Tax Jurisdiction

Chapter 10 provides a few examples of using JRTN to help answer specific questions. This will provide some guidance. Also, the Sample Profiles that are provided with the tool have a set of groups defined (each profile has the same structure, the only difference is in some of the dollar values associated with parameters).

9.10 Controls Worksheet

The Controls Worksheet defines a handful of global controls.

Logging Control	
Row Iteration Summary Log	This log is intended to help debug and optimize the heuristics. This will have one entry for each plan year for each scenario.
Model Solution Core Calculation Log	This log documents the behavior of the Core Model Solution heuristic. It is quite detailed and therefore only available when spending is set via the <i>Model</i> worksheet
Performance Summary Log	This is a lightweight log with one entry per “Run Scenarios” request. It summarizes performance across all of the scenarios executed.

Roth Optimization Log	This log is intended to help debug and optimize the Roth optimization heuristic. It will have one entry for scenario summarizing the initial guess and the results.
Spending Calculation	
Set-Spend Precision	This is a dollar value that specifies how close to get to the target spending value.
Max-Spend Precision	This is a dollar value that specifies how close to try to ultimate maximum spending value. This should be substantially larger than the set spend precision
Roth Optimization Increment	The Roth optimization mechanism uses evenly spaced steps up or down
Execution Time Estimation	
Time Per Model Solution Core	The average time in seconds to execute a single Model Solution Core request. For scenarios that don't involve optimization there is one model solution core request per scenario.
Roth Optimization Factor	The typical number of model Solution Core requests needed to find the optimal Roth Conversion.
Roth Max Factor	The typical number of Model Solution Core requests needed to find the maximum Roth Conversion.
Max Spend Factor	The typical number of Model Solution Core requests needed to find the maximum spending level.

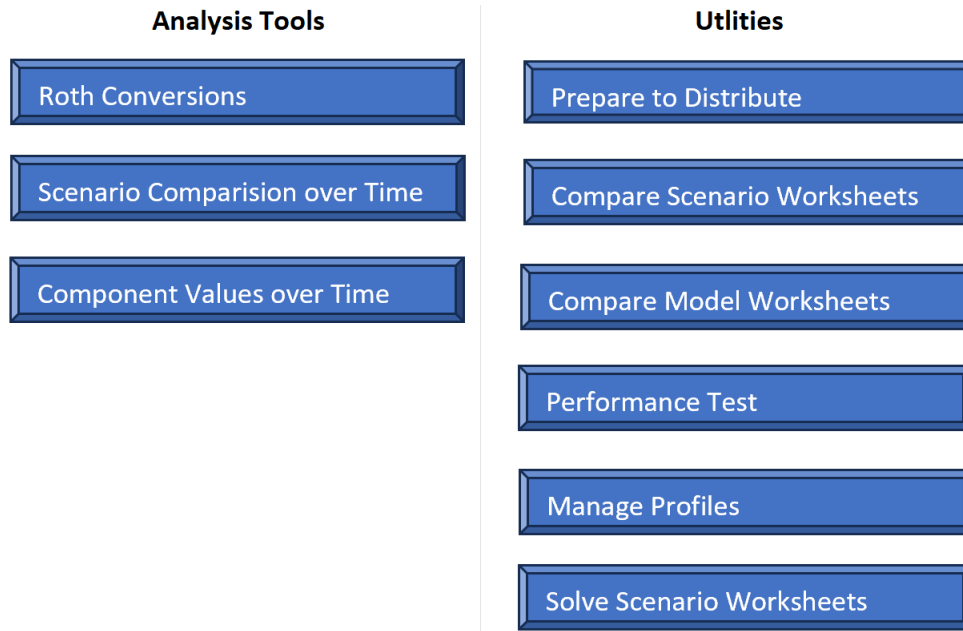
When a log is enabled, an appropriately named worksheet is created and subsequently populated. With the exception of the performance log, you will generally want these turned off.

Model Solution controls impact both the execution time and the accuracy of the results.

The Execution time parameters are used to help calculate the time remaining when executing "Run Scenarios" operations. Once you have a representative set of scenarios defined, you can review the Performance log for information to set these parameters more accurately for your environment.

9.11 The Tools Worksheet

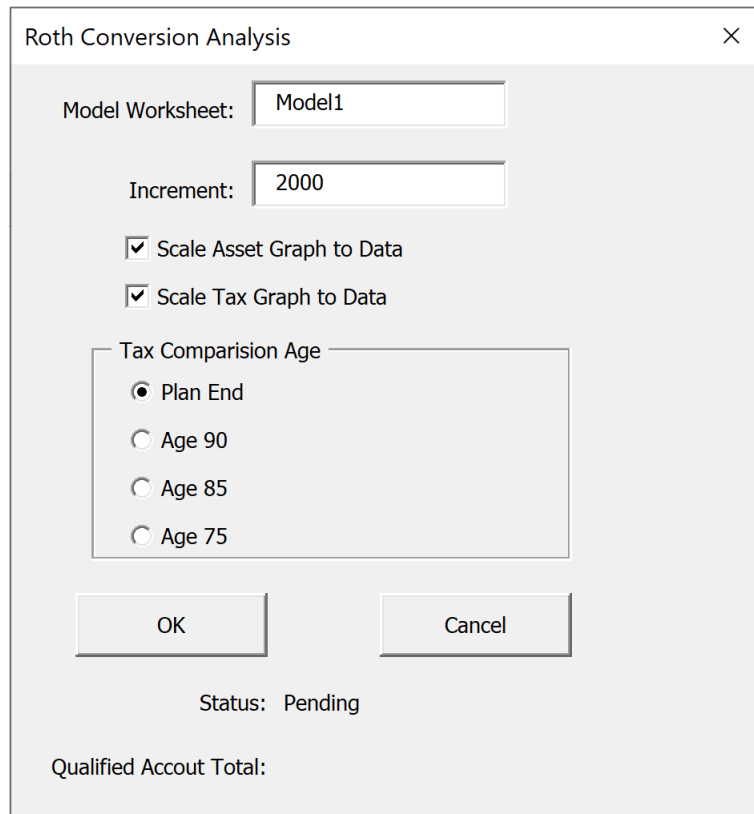
The *Tools* worksheet provides the following:



Unlike other worksheets, this worksheet is there just to provide access to automation. There is no data associated with this worksheet. Each of these buttons brings up a form. The first set of tools enable you to explore your model in additional ways. The second set of tools are more likely to be used by someone making changes to JRTN or using a single instance of JRTN to work with multiple retirement situations. These forms are described in the following sections.

9.11.1 Roth Conversion Analysis

The **Roth Conversions** button brings up:



The screenshot shows a dialog box titled "Roth Conversion Analysis" with a close button (X) in the top right corner. The dialog contains the following fields and options:

- Model Worksheet:
- Increment:
- Scale Asset Graph to Data
- Scale Tax Graph to Data
- Tax Comparison Age:
 - Plan End
 - Age 90
 - Age 85
 - Age 75
- OK button
- Cancel button
- Status: Pending
- Qualified Account Total: (empty field)

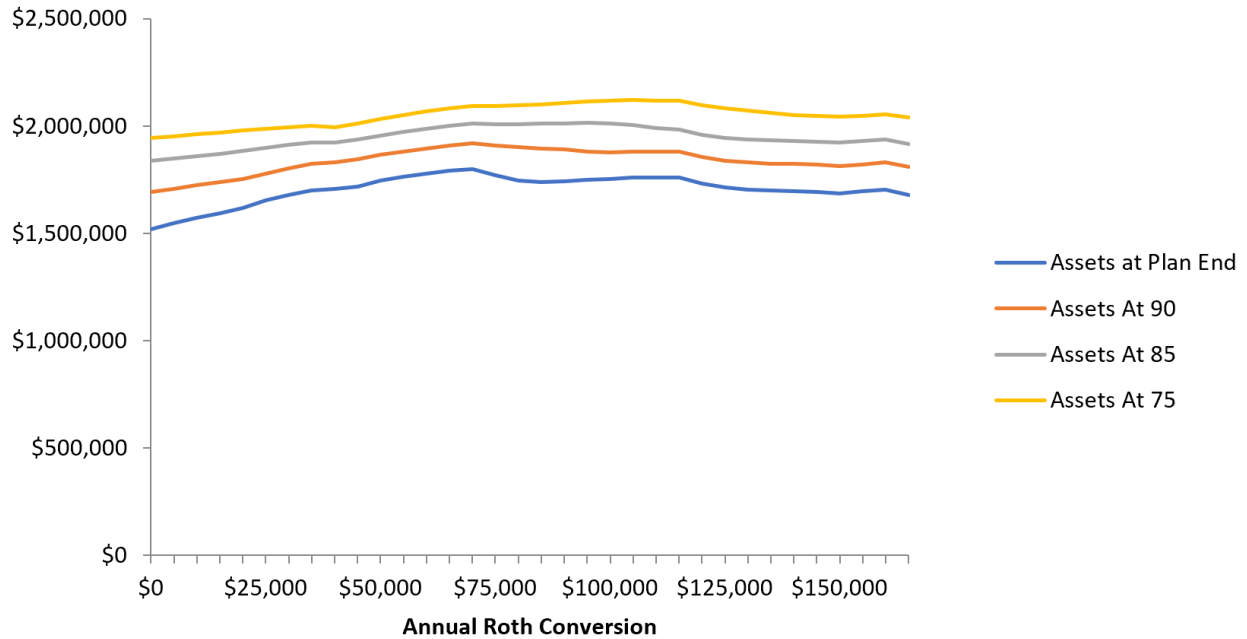
This tool executes a Roth Conversion repeatedly with increasing conversion amounts until the IRA accounts are empty at the end of the conversion process. Increment specifies how much the Roth Conversion is increased each time. Progress is reported on the form as the computations proceed. The execution may be canceled if desired.

Two different graphs are generated. The first is the "Assets vs Conversion Amount" graph as show in Figure 9 on Page 71. The second graph is a comparison of total tax burden and assets as show in Figure 17 on Page 82. This graph is created for a single Age as selected on this form.

This fills in data on a Worksheet named "RothProfileScenario#" where 'Scenario#' is the scenario number associated with the Model worksheet (Cell B1 on the Model Worksheet). The worksheet is created if necessary.

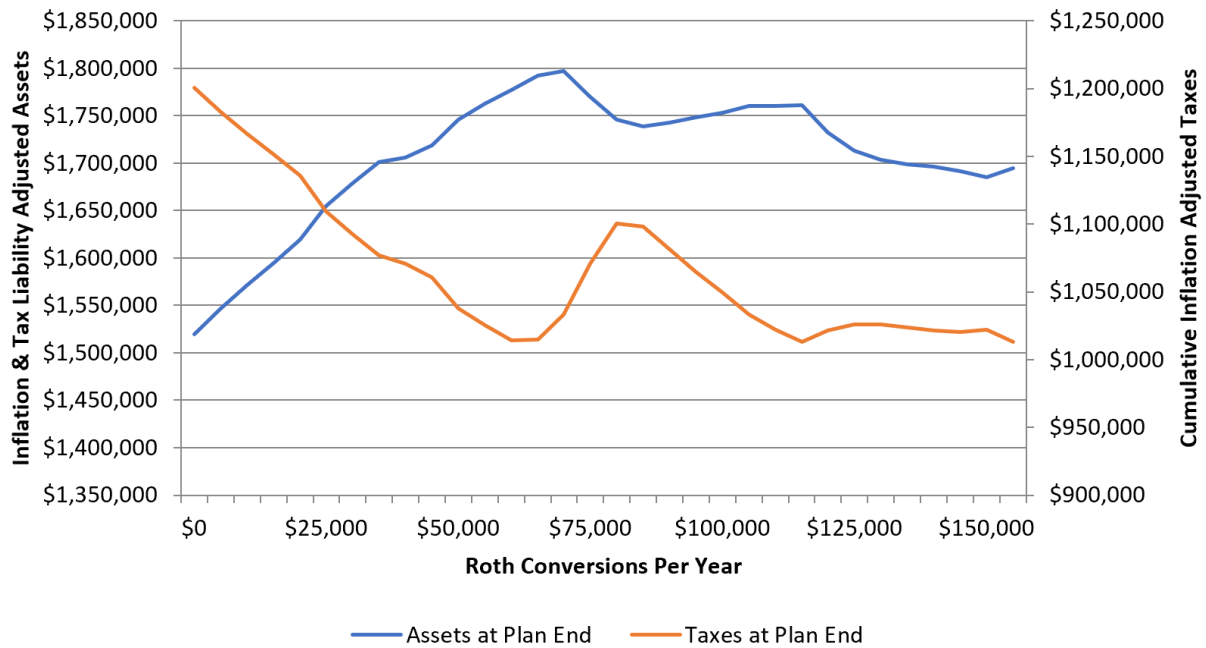
Two different graphs are created. The first is “asset value vs conversion amount.” The second graph relates account values and total taxes. The following are sample outputs for Scenario 1 of Profile3:

Adjusted Assets vs Annual Conversion



These curves are for 5% growth and 3% inflation for Profile 3. No real surprises here. We see more assets at an optimal Roth conversion, and we see a more pronounced impact later in life due to high RMDs. The asset & tax graph is a little less obvious:

Assets and Taxes vs Annual Conversion



The Assets line is just a repeat of one of the curves from the previous graph. We see taxes decline and assets increase in parallel at first (note that this is not always the case!) but after that the tax line provides questionable guidance. It suggests you do a complete Roth conversion, but that is not going to be the optimal choice in terms of what the retiree actually keeps.

9.11.2 Scenario Comparison Graphs

The **Scenario Comparison Over Time** button brings up:

Compare Scenarios over Time

Use Same Scenario Worksheet

	Scenario Number	Scenario Worksheet	Optional Scenario Name
Scenario 1:	1	Scenarios1	
Scenario 2:	2		
Scenario 3:			
Scenario 4:			

Report Worksheet Name: Compare Scenarios

Report Adjusted Values
 Scale to Data

Data to Report

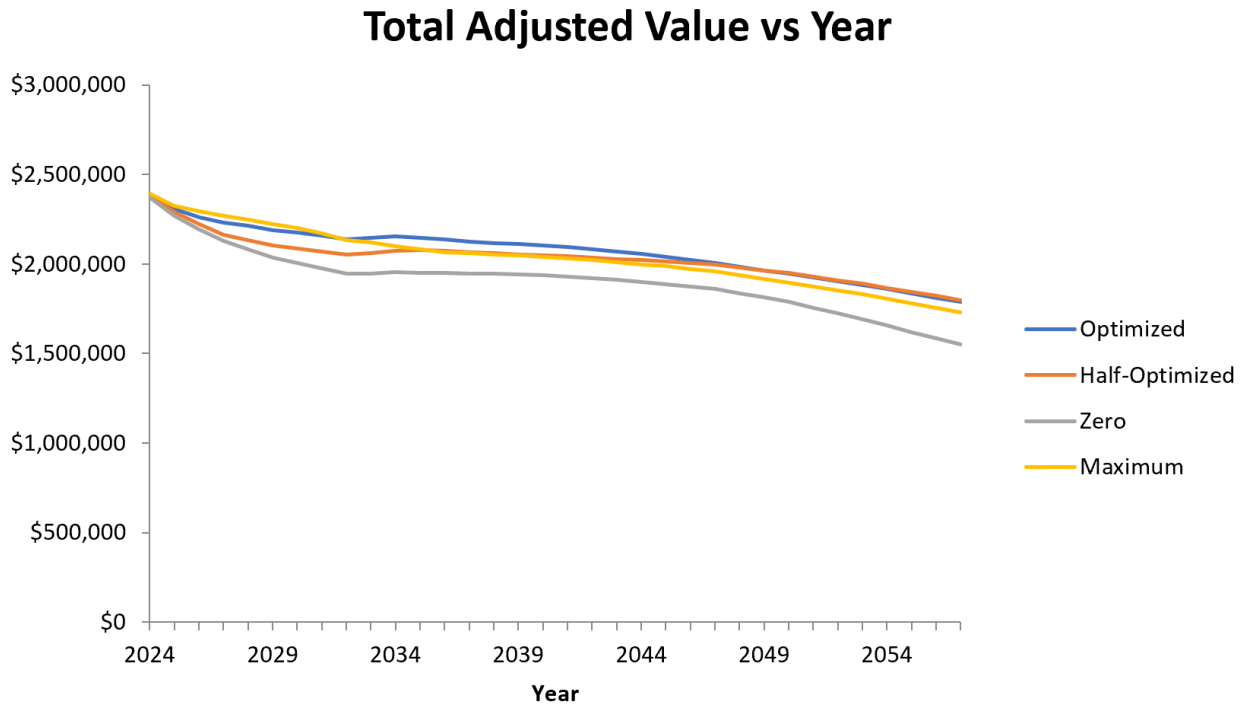
Total Account Value Unqualified Account Value Withdrawal Rate
 Total Taxes Investment Taxes Marginal Tax Rate
 Roth Account Value Sum of Taxes to Date Average Tax Rate
 Qualified Accounts Value Qualified Account Withdrawals

OK Cancel

This captures data over time from several different scenarios and then presents a line graph comparing the data. The first set of data items are dollar values that may be reported as either adjusted or nominal values (except for sum of taxes to date which is only meaningful in adjusted terms). The remaining values are percentages. This is the same sort of analysis one can do directly with the Scenario worksheet but with a more detailed view of how the data is changing over time since the Scenario worksheet presents snapshots at just a few points in time.

Scenarios are identified by scenario number and an optional name to be presented on the graph. The tool can also be used to compare data from different scenario worksheets. This might be used, for example, to compare plans that have been updated for a new year.

The Report name is the name of the Worksheet to be used. This will be created if necessary. The following is an example output:



This shows the total adjusted account values for 4 different Roth conversion schemes for sample profile 3. The results should not be a surprise. For Profile 3, zero conversion is noticeably sub-optimal. A full conversion is also sub-optimal in a marginal fashion. There is little difference between the calculated optimal conversion and an amount of half that much.

Two versions of the graph are created. The top one uses an absolute zero-based scale, the other uses auto-scaling. In many cases these will be the same.

9.11.3 Composite Data Presentations

Many key outputs of the model are the sum of sub-components. For example, the net worth modeled by tool is the sum of the various accounts that are tracked. The composite data reports present this sort of data as area graphs to make it easier to understand how the component parts relate to the total and how the relationship changes over time. The **Component Values Over Time** button will present the following form:

Data Components [X]

Model Worksheet:

Report Worksheet Name:

Report Adjusted Values

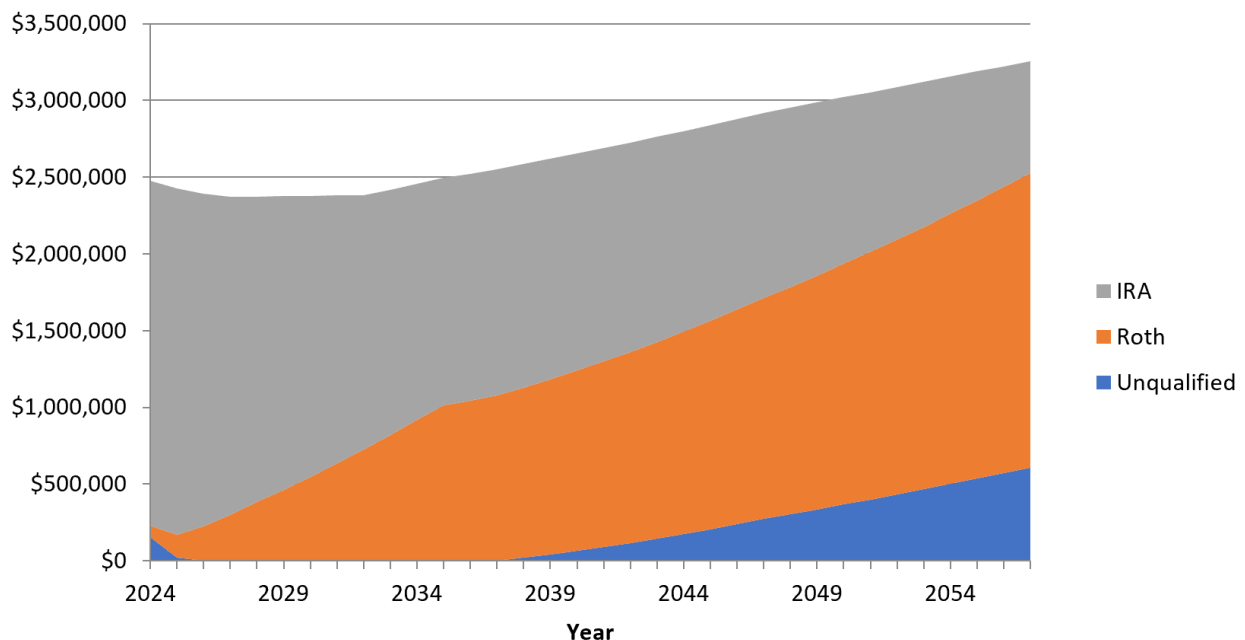
Data to Present

Account Values Tax Components by Tax Type
 Income Sources Fed Taxable Income Elements
 State Taxable Income Elements

OK Cancel

This will create a new sheet with the requested name or reuse the sheet if it already exists. The sheet will be populated with data values for each year and two graphs, an absolute area graph and a percentage area graph. The following is an example for sample Profile 3 and a \$70K Roth conversion:

Adjusted Account Components for Scenario 1



We first see the unqualified account spent down. Then the Roth account grows with Roth conversions as the IRA shrinks. We also see the RMD's exceeding spending needs starting

at around 2038 resulting in funds accumulating in an unqualified account. This is a hint that we might do better with a higher Roth conversion amount.

Understanding Taxes

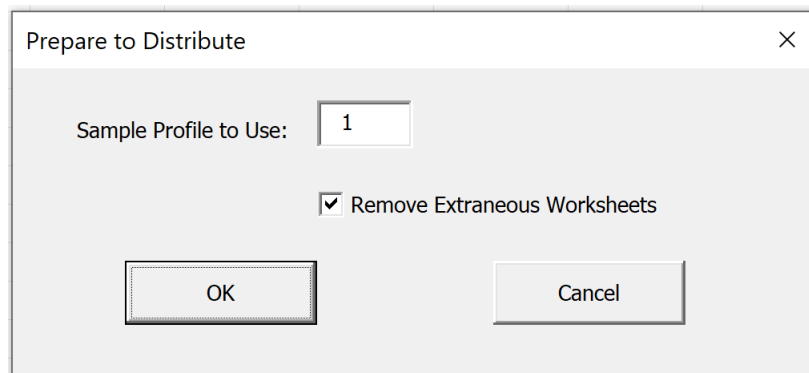
The three tax-related graphs will help you understand the projected tax situation, but even with three graphs this is still an incomplete picture because it focuses on the income part of the tax calculation and because it does not try to close the loop by associating a specific income element with the complete tax consequences of the income. Consider an extra dollar of dividend income from an unqualified account. This might have the following impacts on tax calculations:

- An increase in ordinary taxes
- An increase in Net Investment Income (NII) surtax
- An increase in the Medicare IRMAA tax

It is probably possible to develop some sort of “income to tax mapping” presentation, but it would only be approximate, and it doesn’t seem that it would add that much value over looking at “tax elements” and “taxable income elements” separately.

9.11.4 Prepare to Distribute

The **Prepare to Distribute** Button brings up:



Prepare to Distribute

Sample Profile to Use: 1

Remove Extraneous Worksheets

OK Cancel

This is a utility to remove any personal data from the workbook and more generally to clean it up in preparation for distribution. This does the following:

1. Loads one of the SampleProfiles. This updates the Model worksheet and the FactorTable worksheet.
2. Updates the Scenario worksheet to reflect updated Factor table. This also clears the Scenario worksheet results

3. Optionally removes the logging worksheets and any other worksheets found. There are two exceptions to this: worksheets named *ModelSave* and *FactorTableSave* are left untouched. (this is to support debugging the mechanism)
4. Clears the utility worksheet used for break-even analysis
5. Runs the model worksheet with the updated values

WARNING:

Since this will clear personal financial information, you will probably want to execute this on a copy of your active workbook! Also note that you will need to have a FactorTable worksheet that is compatible with the SampleProfile definition.

9.11.5 Compare Scenario Worksheets

The **Compare Scenario Worksheets** button brings up:

Compare Scenario Worksheets

Target Sheet:

Baseline Sheet:

Dollar Compare Mode

Only Dollar Value:

Also Dollar Percentage: (0.001 == %0.1)

Percent Precision: (0.001 == %0.1)

Compare Definition Columns

Compare Results Columns

Compare Row Iteration Counts

Compare Max Spend Iterations

Log Errors

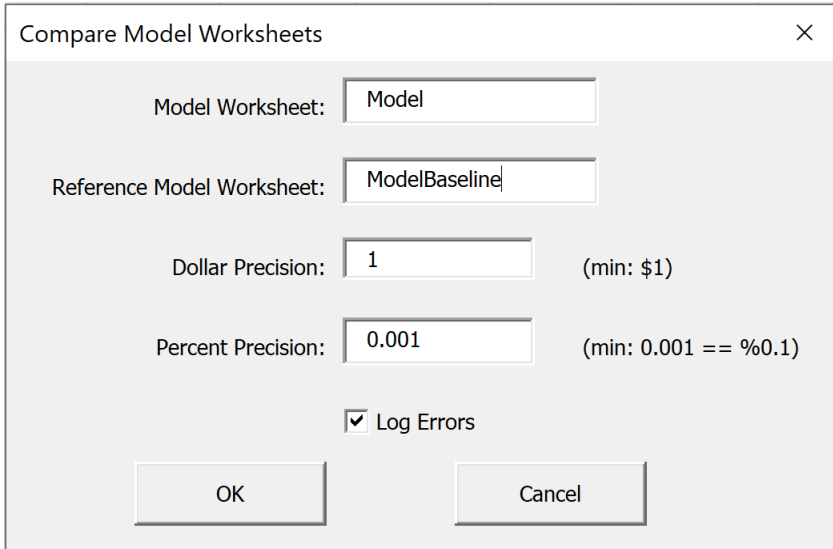
Maximum Error Count:

This is a development tool used to detect regressions. It compares two Scenario worksheets. This is useful for detecting unexpected changes in the Scenario worksheet. Some changes do not involve changing the way calculations are done or extending the

scope of calculations (for example adding support for multiple state tax definitions). In these cases, we can test against actual dollar values to high precision. Other changes are expected to change results values. For example, tuning of convergence heuristics. In those cases, we need to look for just approximate matches.

9.11.6 Compare Model Worksheets

The **Compare Model Worksheets** button brings up:



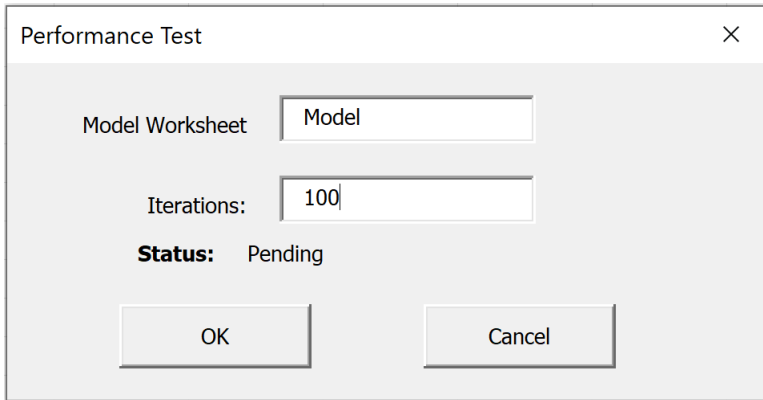
The dialog box titled "Compare Model Worksheets" contains the following fields and controls:

- Model Worksheet:
- Reference Model Worksheet:
- Dollar Precision: (min: \$1)
- Percent Precision: (min: 0.001 == %0.1)
- Log Errors
- OK button
- Cancel button

This is a development tool to help identify regression defects resulting from changes to code or to the structure of the Model worksheet. This compares a few key columns of two different Model worksheets.

9.11.7 Performance Test

The **Performance Test** button brings up:



The dialog box titled "Performance Test" contains the following fields and controls:

- Model Worksheet:
- Iterations:
- Status: Pending
- OK button
- Cancel button

This will execute the “Solve Model” logic repeatedly and then report the results to the PerfLog. This can be useful for understanding performance behaviors because it eliminates some of the “noise” associated with running scenarios (copying data back and forth and different sorts of optimization).

9.11.8 Profile Management

A profile is a compact representation of the “retiree varying” data values:

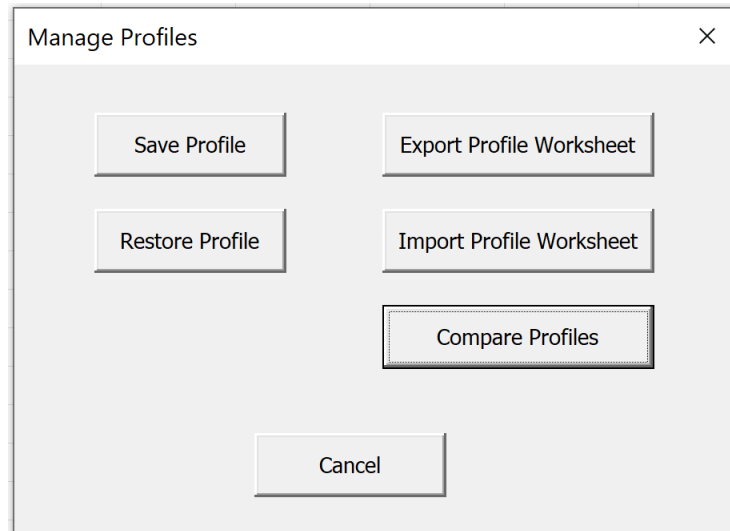
- All of the ‘parameter’ tables present on the Model Worksheet:
 - Solution Control Table
 - Variable Parameters
 - Fixed Parameters
 - State Identification
 - Social Security Values
 - Future Income Tax Possibilities
- The Factor Table’s Factor values
- The state tax income tax localization values from the StateTaxInfo Worksheet

Note that there are several tables on the Model worksheet are not included in the Profile because they will not change from person to person or are derived from other parameters:

- Calculated Parameters
- Federal tax rates
- Medicare IRMAA values
- Worksheet Reference Info
- State Tax Details
- RMD Factors

Profiles provide a robust mechanism for moving data between versions of JRTN. They may also be useful in other contexts. For the author it has been useful for managing the profiles introduced in Table 12 on Page 68 in support of some of the examples presented in earlier chapters. Profiles are also used to prepare the workbook for distribution.

The **Manage Profiles** button brings up:

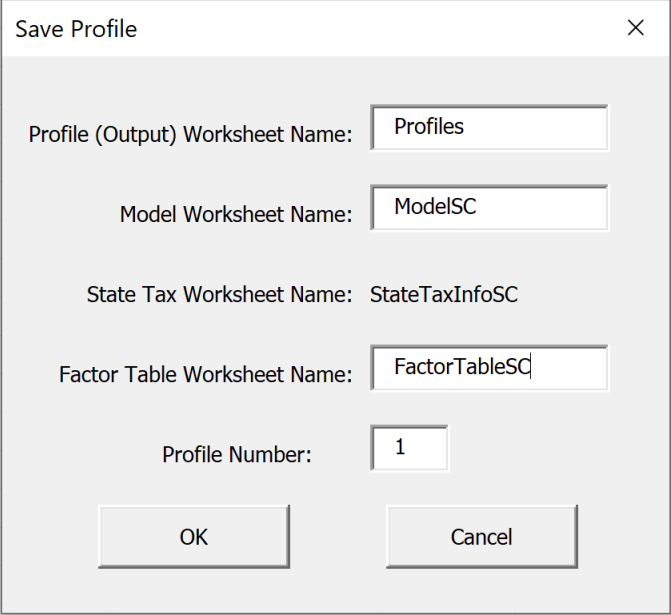


This supports the creation of Profile Worksheets and the restoration of the values in a Profile Worksheet to the Model, FactorTable, and StateTaxInfo Worksheets. It also allows Profile Worksheets to be exported to CSV files and imported back from CSV files. A mechanism to compare saved profiles is also provided.

A Profile worksheet may contain one or more profiles. The Profile worksheet has three columns that act as a key for the data and then a column for each profile. Since they share the keys, all of the profiles stored in the Profile worksheet must correspond to the same set of parameters:

- Same set of captured tables (changing this would require changes to code)
- The same set of parameters in each table
- Exactly the same structure for the Factor Table – Same rows (group, parameter name) and the same list of parameters

The **Save Profile** button brings up:



Save Profile

Profile (Output) Worksheet Name: Profiles

Model Worksheet Name: ModelSC

State Tax Worksheet Name: StateTaxInfoSC

Factor Table Worksheet Name: FactorTableSC

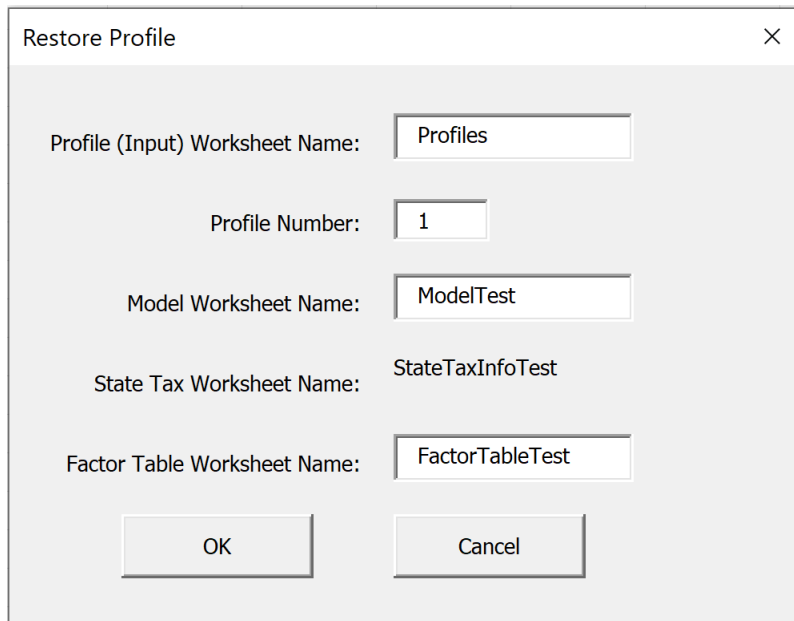
Profile Number: 1

OK Cancel

Enter the name of the Profile Worksheet to be created and, if necessary, change the input Worksheet names. The State Tax sheet is identified from the Model worksheet.

The save mechanism will issue an error and stop processing if a profile is being added to an existing Profile worksheet and it detects that the profile being created does not match the existing profile structure. This might happen as a result of an implementation change. For example if a new parameter or parameter table is added, or as a result of the user changing the structure of the Factor Table Worksheet.

The **Restore Profile** button brings up:



Restore Profile

Profile (Input) Worksheet Name: Profiles

Profile Number: 1

Model Worksheet Name: ModelTest

State Tax Worksheet Name: StateTaxInfoTest

Factor Table Worksheet Name: FactorTableTest

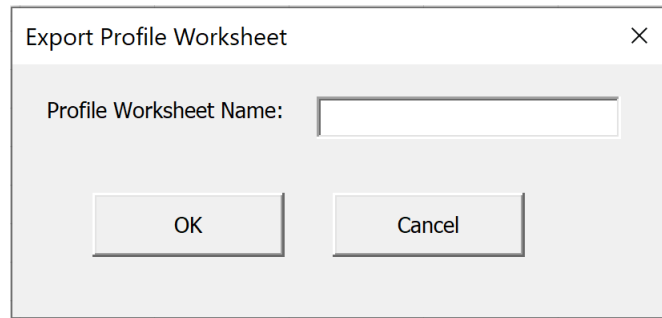
OK Cancel

This is used to copy a profile definition from a profile worksheet back to the Model, FactorTable, and State Tax Info worksheets.

Enter the name of an existing Profile Worksheet to read from. Also enter the names of the Model and Factor Table worksheets. The State Tax Info worksheet name will be populated from the Model worksheet. If this is not the tax info worksheet you want changed, cancel out of this form and update the Model worksheet. Various cells in the Model, State Tax Info, and Factor Table Worksheets will be overwritten with data from the Profile Worksheet.

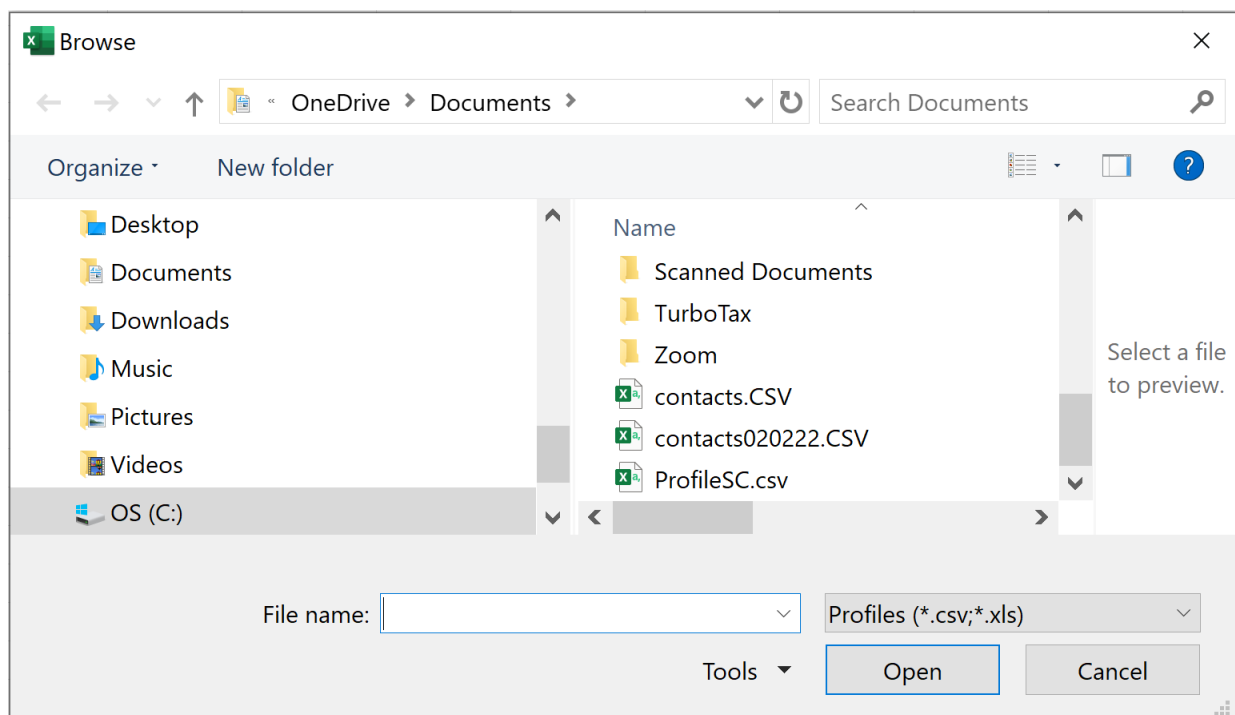
The import process tries to be as forgiving as possible; it notes discrepancies between the profile and the worksheet structures such as missing profile data or extra profile data, but generally continues on to fill in what it can.

The **Export Profile** button brings up:



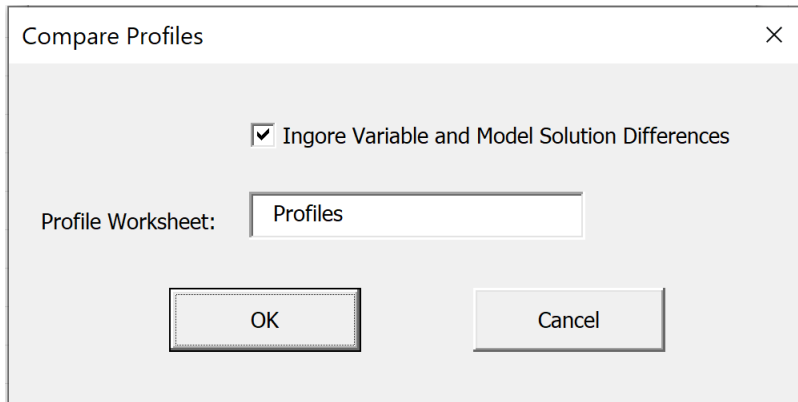
Enter the name of the profile worksheet you want to export. A CSV file will be created in the same directory as the workbook with the worksheet name.

The **Import Profile** button brings up the file finder dialog showing something like:



Use this to select a Profile CSV file. The Profile will be imported as a new worksheet in your workbook.

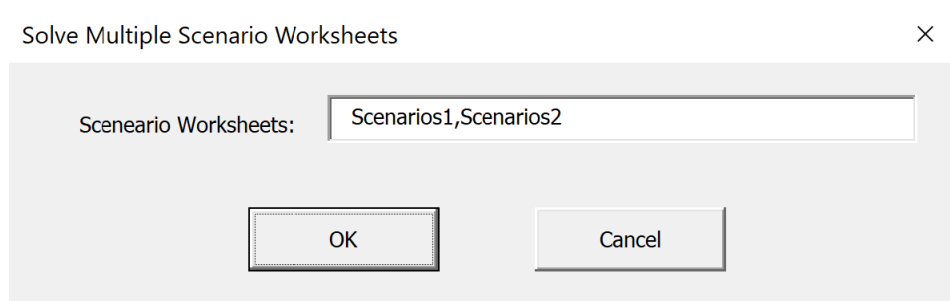
The **Compare Profiles** Button brings up the following:



This is used to compare the profiles saved in a multiple-profile worksheet. Profile lines that have identical contents for each profile are hidden. This has been useful to the author in developing the examples used in Section 6. It might not be useful to others.

9.11.9 Execute Multiple Scenarios Worksheets

The **Solve Multiple Scenario Worksheets** button brings up:



This allows for multiple scenario worksheets to be executed in their entirety. The Run Scenarios form (the same form displayed when you execute scenarios from the Scenarios worksheet) will be displayed for each scenario worksheet in turn to provide progress indication and allow the operation to be canceled if desired. This has been useful to the author in developing the examples used in Section 6 and elsewhere. It might not be useful to others.

9.12 It's a New Year

JRTN should be updated each year to reflect your current finances as well as changes in tax law. JRTN uses two start dates:

- The current (plan start) year
- The baseline year for inflation impact and spending

The current year is used to extrapolate values that we know today out into the future based on a configured growth rate. For example, each year the Social Security administration updates their estimate of what your payments will be in *today's dollars*. Likewise, the IRS updates tax brackets. The tool uses today's values to predict future values. When you first develop your plan these two dates are the same, but as time goes on, we may want the baseline year to remain the same for inflation and the plan start-year to move forward. At the start of a new year you have a choice: you can keep these two the same or you can allow them to diverge.

The following is a New Year's checklist for JRTN:

Data	Action
Account Totals	Update to reflect your end-of-year status
Plan Start Year	Increment the plan start year
Baseline Year	If you decide to change this you should review your spending plans and update them in the FactorTable if necessary
Social Security	Update the estimated payment table if you are not yet collecting. If you are collecting already, then update the actual payment value. Also if you are collecting on one of the accounts you can update the factor table to eliminate other choices. If you are collecting on both, you can update the factor table to eliminate all SS variations.
Pensions	Update to incorporate any changes to adjusted pensions
Spending	Update to reflect any changes in amounts or intentions.
IRMAA Factors	Update the factors you expect for the first two years of the plan. This is only needed if you will be taking Medicare during either of these years.
Federal Brackets	Update to reflect new year's brackets
Federal Deduction	Update to reflect new Federal Deduction
IRMAA Brackets	Update to reflect bracket changes
State Tax Brackets	Update to reflect bracket changes
Tax Law Changes	Reflect new tax laws into implementation. In some cases, this can be done with configuration, but since the scope of tax law changes is unpredictable, it could conceivably require "development"

Table 20 - New Year's Checklist

You should probably save a copy of the Model worksheet and possibly the entire workbook as a backup before proceeding. Once you have the new configuration in place, you should execute your scenarios and compare with what you had before. The Compare Scenario data tool described in section 9.11.2 can be helpful here; for example, compare the total account value over time for “last year’s model” and “this year’s model.” The numbers won’t match exactly, but there should generally be no big surprises.

10 Using JRTN to answer Questions and Solve Problems

Earlier sections of this book described questions that your model might answer as well as some possible outcomes. Both of those presentations were provided in a modeling tool independent fashion. There was also a brief discussion in section 8.7 about problem solving, answering a different sort of question: why is the model telling me this? This chapter explains how to use JRTN to answer these questions for yourself.

A common theme for many of these questions is to compare a set of related scenarios. This is done by crafting a group that focuses on one or more questions in the FactorTable worksheet, running all of the associated scenarios, and then comparing the results of the scenario execution. A few examples are provided here to show the way, but the approach is applicable to almost any question you might attempt to answer with JRTN.

This will provide some additional insight into the value of the Scenario based model and to the use of spreadsheets that makes lots of intermediate calculation results available.

10.1 Can I afford to retire?

JRTN addresses the “income” side of this question. JRTN provides two complimentary mechanisms for making this assessment:

- Explicit spending requests for scenarios
- Maximum spending calculation

The explicit spending request says, “I want to spend this much.” When a scenario is formulated in this fashion there is a chance it may fail – you either fail to meet your reserve or you run out of money completely. Failing occasionally is OK if these failures are associated with unlikely situations such as an average rate of return below the average inflation rate. The maximum spending calculation takes the opposite approach; given a particular set of parameters, how much can we spend each year? This will never fail in the sense of running out of money because spending is simply reduced until the model succeeds.

10.2 When can I afford to retire?

This is a variation on the previous question which addressed what retirement looks like if you retire now. It is also useful to compare scenarios where you retire sometime in the future. From a modeling perspective, that is when we start meeting spending needs largely from fixed income sources and assets.

Several things happen as you wait to retire:

- You may continue to save for retirement
- You postpone drawing from assets allowing them to continue to grow
- The assets are now used to support a smaller number of anticipated retirement years.
- Fixed income streams such as Social Security, Pensions, and Annuities increase their annual payout

The closer to retirement you are the less important the incremental savings is; the other factors will completely dominate the model. JRTN provides several mechanisms for modeling this transition from working to retirement. The most important of these is the *Retirement Year* spending control. Prior to the retirement year, JRTN does not try to support any specific spending level via draws on your assets. In addition to that important control, you can align other income sources such as pensions, social security commencement to provide a view of the transition years.

The easiest way to assess this with JRTN is to create a scenario group that focuses on the question. For example:

Group	Name Reference	Block Type	Column	Ref Column						
ExploreRetirementStart	ModelFirstRetirementYear	AdjustParam	30		2025	2027	2029			
ExploreRetirementStart	ModelSpendingMode	AdjustParam	28		Maximize					
ExploreRetirementStart	ModelGrowthRate	VariableParam	3		5.0%	7.4%				
ExploreRetirementStart	ModelInflation	VariableParam	6		2.00%	3.00%				
ExploreRetirementStart	ModelSSCommencements	VariableParam	23	30	70,62	2025	70,64	2027	70,66	2029

Figure 23 - Retirement Start Group Definition

This group definition looks at 3 potential retirement years and several combinations of rate of return and inflation. It uses JRTN’s dependent variable mechanism to tie the social security commencement for retiree 2 to the retirement year. This results in the following data being populated to the Scenario worksheet for Profile 1:

	Scenario	Investment Growth Rate	Inflation	SS Ages	First Year of Retirement	Max Possible Spend to 95
ExploreRetirementStart	109	5.0%	2.0%	70,62	2025	\$59,608
ExploreRetirementStart	110	5.0%	2.0%	70,64	2027	\$65,376
ExploreRetirementStart	111	5.0%	2.0%	70,66	2029	\$72,041
ExploreRetirementStart	112	7.4%	2.0%	70,62	2025	\$67,066
ExploreRetirementStart	113	7.4%	2.0%	70,64	2027	\$75,771
ExploreRetirementStart	114	7.4%	2.0%	70,66	2029	\$85,230
ExploreRetirementStart	115	5.0%	3.0%	70,62	2025	\$55,628
ExploreRetirementStart	116	5.0%	3.0%	70,64	2027	\$60,355
ExploreRetirementStart	117	5.0%	3.0%	70,66	2029	\$65,853
ExploreRetirementStart	118	7.4%	3.0%	70,62	2025	\$63,116
ExploreRetirementStart	119	7.4%	3.0%	70,64	2027	\$70,083
ExploreRetirementStart	120	7.4%	3.0%	70,66	2029	\$78,124

Figure 24 - Retirement Start Results

Two things are immediately clear from Figure 24. The first is that waiting 4 years has a big impact on spendable income over the remaining course of retirement. The second is that the real rate of return (Investment growth minus inflation) also has an enormous impact. It is best to think of the question more along the lines of “assuming a real rate of return of X, when can I retire?” The good news for the hypothetical retirees in Profile 1 is that they can retire in 2025 even with the relatively conservative assumption of 2% real growth.

10.3 Social Security Commencement

JRTN provides two mechanisms for evaluating Social Security Commencement:

- Scenario Comparison
- Break-even year calculation

For the scenario comparison we might look at comparing the spendable income that results from different commencement decisions at different rates of return. We would start by creating a FactorTable group focused on these variables:

Group	Parameter						
MaxSpending	Spending Calculation Mode	Maximize					
MaxSpending	Investment Growth Rate	5.0%	7.4%				
MaxSpending	Inflation	2.00%					
MaxSpending	Qualified Account Value Weight	.16,.11					
MaxSpending	Leave State 1 Year	2026	2060				
MaxSpending	Social Security Commencement	62,62	67,62	70,62	67,67	70,67	70,70
MaxSpending	Roth Rollover		\$0				

Figure 25 - Group definition to support SS Decision

This will result in 24 different scenarios to compare that will look like this after using the **Visibility** button to focus on the MaxSpending group and hiding some less interesting columns:

<div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">Create Scenarios</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">Run Scenarios</div> <div style="border: 1px solid black; padding: 2px;">Visibility</div>						Scenario	Investment Growth Rate	Leave State 1 Year	SS Ages	Adjusted Total Account Values At Plan Age	Max Possible Spend to 95
MaxSpending	493	5.0%	2026	62,62	\$1,002,159	\$171,071					
MaxSpending	494	7.4%	2026	62,62	\$1,000,596	\$216,608					
MaxSpending	495	5.0%	2060	62,62	\$1,011,084	\$164,248					
MaxSpending	496	7.4%	2060	62,62	\$1,004,120	\$207,915					

Figure 26 - Max Spending Results

Figure 26 shows the first 4 lines of the MaxSpending results. 24 Scenarios is a bit much to wrap your head around so let's filter the growth-rate and the move-to-a-different-tax-jurisdiction out of the picture so we can focus on the Social Security commencement, yielding:

<div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">Create Scenarios</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;">Run Scenarios</div> <div style="border: 1px solid black; padding: 2px;">Visibility</div>						Scenario	Investment Growth Rate	Leave State 1 Year	SS Ages	Adjusted Total Account Values At Plan Age	Max Possible Spend to 95
MaxSpending	495	5.0%	2060	62,62	\$1,011,084	\$164,248					
MaxSpending	499	5.0%	2060	67,62	\$1,012,636	\$166,522					
MaxSpending	503	5.0%	2060	70,62	\$1,031,172	\$167,162					
MaxSpending	507	5.0%	2060	67,67	\$1,005,800	\$166,758					
MaxSpending	511	5.0%	2060	70,67	\$1,011,704	\$167,670					
MaxSpending	515	5.0%	2060	70,70	\$1,011,687	\$167,470					

Figure 27 - Filtered Results

The results here are a little surprising. The first surprise is that there isn't that much difference between any of these. The second surprise is that starting the lower of the two payments early is an OK approach. There are lots of other parameters that may influence this outcome. The most important are probably mortality assumptions. Additional scenarios can be developed to explore these other variables. If you are going to compare a substantial number of parameters it makes more sense to focus on adjusted total value because this is much more efficiently calculated. Adjusted total value and max spending are really just two sides of the same coin.

JRTN also provides a direct reading on the “break-even” year. This is the year that a given scenario becomes “better” than the baseline of starting SS early. The breakeven calculation will yield different results for different situations. For example, a change in the real (inflation adjusted) rate of return will change the breakeven year. JRTN accommodates this by working with multiple baselines, one for each unique set of “other variables.”

10.4 Does it make sense to move to a lower tax jurisdiction?

Moving to a lower tax jurisdiction may change your spending needs. For example, states with lower income taxes often have higher property taxes or other expenses such as property insurance. What we need to do is to compare “higher state income tax with lower expenses” to “lower state income tax with higher expenses.

Consider a concrete example of a possible move from Massachusetts to New Hampshire for the couple represented by Profile 3. A financially conservative guess is that spending might grow by up by \$15K to account for higher property tax and higher Medicare costs associated with a preemptive move from Medicare Advantage to a Medicare supplement plan.

The best way to evaluate this is with a set of scenarios. The following is from the FactorTable for Profile 3:

Group	Parameter				
ExploreSpend	Leave State 1 Year	2026	2060		
ExploreSpend	Single Income Fraction	80%	70%		
ExploreSpend	Target Spend	\$150,000	\$135,000	\$90,000	
ExploreSpend	Federal Tax Model	PostTCJAHistoric	TCJAPessimistic		
ExploreSpend	Social Security Commencement	70,67	70,68	67,70	70,68

Figure 28 - Group Definition to support Move Decision

As shown, this will result in a total of 96 different scenarios (2 X 2 X 3 X 2 X 4). For our decision purposes we can focus on just the *Leave State 1 Year* and the *Target Spend* amounts of \$150K and \$135K. This is easily done by using Excel filters to hold other values constant in the Scenario worksheet.

The results of this are something like:

	Scenario	Year	Target Spend	Adjusted Total Account Values At Plan Age
ExploreSpend	3067	2026	\$150,000	\$2,233,869
ExploreSpend	3068	2060	\$150,000	\$1,821,580
ExploreSpend	3071	2026	\$135,000	\$3,125,720
ExploreSpend	3072	2060	\$135,000	\$2,755,837

Figure 29 - Scenario Results for Move Decision

The numbers we want to compare here are the first one and the last one. These represent moving at \$150K expense or staying put at \$135K expense. This is interesting! What we see is that moving to NH is a loss if we assume \$15K higher expenses but a win with no change in expenses. Obviously, there is a break-even point somewhere in-between. This could be explored by updating the Factor Table with target spend of \$140K and \$145K. Note that you don't need a fancy tool to come to the same general conclusion. Let's assume this couple averages \$200K of MA reportable income. The 5% MA tax rate suggests that a spending increase of more than \$10K or so is going to be a net loss.

10.5 Roth Conversion Optimization

JRTN provides 3 different mechanisms to support your Roth conversion planning process:

1. Define scenarios with different conversion values and different "Roth Conversion Control Parameters"
2. Algorithmically locate the optimal and maximal conversions using the Roth Optimization mode setting on the Model worksheet
3. Exhaustively evaluate the full range of conversion possibilities for a given scenario using the **Profile Roth Conversions** button on the **Tools** worksheet. This includes the presentation of a graph like the one shown in Figure 9 on page 71.

These three mechanisms complement each other with different strengths and weaknesses.

Defining different conversion values for different scenarios is a good mechanism for looking at the behavior of Roth conversions across many different possible future scenarios and decisions that you might make such as when to start a pension or Social Security. This is also a good way to sanity-check groups of scenarios that focus primarily on other aspects. For example, you might have a group of scenarios focused on different rate of return and inflation scenarios. Adding two Roth variations provides a richer view. But this

mechanism does not provide a good a few of the *sensitivity* of the results to different conversion levels nor does it provide direct help in finding the best conversion level.

Automatic Roth Conversion is controlled via the “Roth Conversion Mode” solution control and the corresponding values in the Factor Table worksheet.

NOTE:

The ultimate impact of the Roth Conversion is going to be impacted by the nominal value of the Roth Conversion as well as by the conversion controls:

- The start and stop years
- Bracket Avoidance
- Behavior or Roth conversions once RMD’s have started

In the interests of expediency – both to manage compute cost and to manage the complexity of the resulting data, the optimization procedure does not try to optimize all of this. Instead, it focuses on just the nominal conversion amount. It uses the specified start and stop years and it ignores any bracket avoidance guidance. The conversion amount is reduced by the RMD, once RMDs start.

A couple of the Roth Conversion Optimization choices relate back to the optimal conversion amount:

- Use ½ the optimization value
- Use ¾ of the optimization value

The purpose of these is to help you to assess how *sensitive* your finances are to approaching the optimal conversion amount. In the interest of performance optimization, the implementation of assumes that the optimization scenario has already been run. This means that the Roth Conversion rule should be the *last* varying parameter of a group that includes Roth Optimization and that the Optimize choice should precede the options mentioned above that reference it and the RothConvMode must be the first varying parameter in the group. For example, we find this near the top of the FactorTable provided in the distribution:

ModelRothConvMode	AdjustParam	27	Optimize	HalfOptimized	3QOptimized
-------------------	-------------	----	----------	---------------	-------------

In addition to these 3 “optimization” related controls there are two additional values that are independent of the optimization:

- Explicit – Use the Roth Conversion value specified in the control table
- Maximum – This is the value that “empties” the IRA over the specified years

- Zero – No Optimization

The Roth Conversion Profile is accessed via the Tools worksheet. It provides a graph of account value at specific ages such as 85,90, and 95 vs the Roth conversion amount. It is helpful in understanding how important Roth conversions are at different points of time in the future it is also helpful in understanding the “quality” of the relationship. This is discussed in more detail in section 0

The following is a suggested plan of attack for Roth Conversions using JRTN:

1. Focus first on the non-Roth aspects of the plan by defining a FactorTable that captures a range of variables relevant for your circumstances
2. Pick out a few (1-3) “focus scenarios” (your most likely rate of return, inflation, etc)
3. Use the Roth Conversion Profile for each focus scenario to get a sense of where you want to be
4. Add a set of optimization scenarios that capture important variables such as rate of return, taxation, etc. Review the results for any surprises.
5. Develop scenario group with a range of different conversion values and other variables. Again, review for surprise.
6. Define the conversion plan. The goal here is to optimize the “likely” cases while holding the others to “Good Enough.”

Note:

As discussed in Section 5.4, some financial situations will suggest a meaningful optimal Roth conversion and others won't. As you dig into this you will find that your finances probably put you in one of three situations:

1. The Optimal Roth Conversion is zero.
2. Your resulting account value varies chaotically as the Roth conversion amount increases.
3. There is a meaningful optimal value

If it looks like you are in the chaotic range, you might still opt for some Roth conversions to hedge against events such as a big increase in tax rates or unexpected income.

The Roth Conversion profile is a useful tool to help you understand this aspect of Roth Conversions. Pick a few “likely” scenarios and examine the Roth profile graphs.

Why no Roth Break-Even?

A few financial writers have discussed the notion of a break-even year when you come out ahead by doing a Roth Conversion. JRTN does not include such a notion because the focus

on “tax adjusted” value suggests that there is no meaningful change in asset value as a result a sensible Roth Conversion. If there is a significant tax-adjusted value in your accounts after doing a Roth conversion, then you are probably using an incorrect tax adjustment parameter or a grossly sub-optimal conversion scheme.

10.6 Why does the Model behave this way?

We will try to answer the two questions posed in Figure 25 on page 156:

1. Why do assets trend down as we increase Roth conversions after about
2. What is the cause for the bump in total taxes paid starting at about \$55K Conversion

We will start by creating a small group that we use to probe changes in Roth conversion keeping everything else constant. Roth conversion values for this group are taken from interesting break-points on Figure 22. The factor table entries for this group look like this:

Group	Parameter						
ProbeRoth	Investment Growth Rate	5.0%					
ProbeRoth	Inflation	3.00%					
ProbeRoth	Plan Age 1	85					
ProbeRoth	Qualified Account Value Weight	.15,.09					
ProbeRoth	Leave State 1 Year	2060					
ProbeRoth	Federal Tax Model	TCJAHistoric					
ProbeRoth	Roth Strategy	ReduceByRMDOnly					
ProbeRoth	Social Security Commencement	70,62					
ProbeRoth	Roth Rollover	\$0	\$55,000	\$60,000	\$75,000	105000	\$155,000

Figure 30 - Factor table for Roth Conversion Questions

Notice that the only factor changing here is the Roth Rollover value itself. For the first question let’s start by looking at how account value changes over time for three key points: zero conversion, optimal conversion, and complete conversion. The Scenario Comparison over-time tool is used to create a graphical representation of this.

Total Adjusted Value vs Year

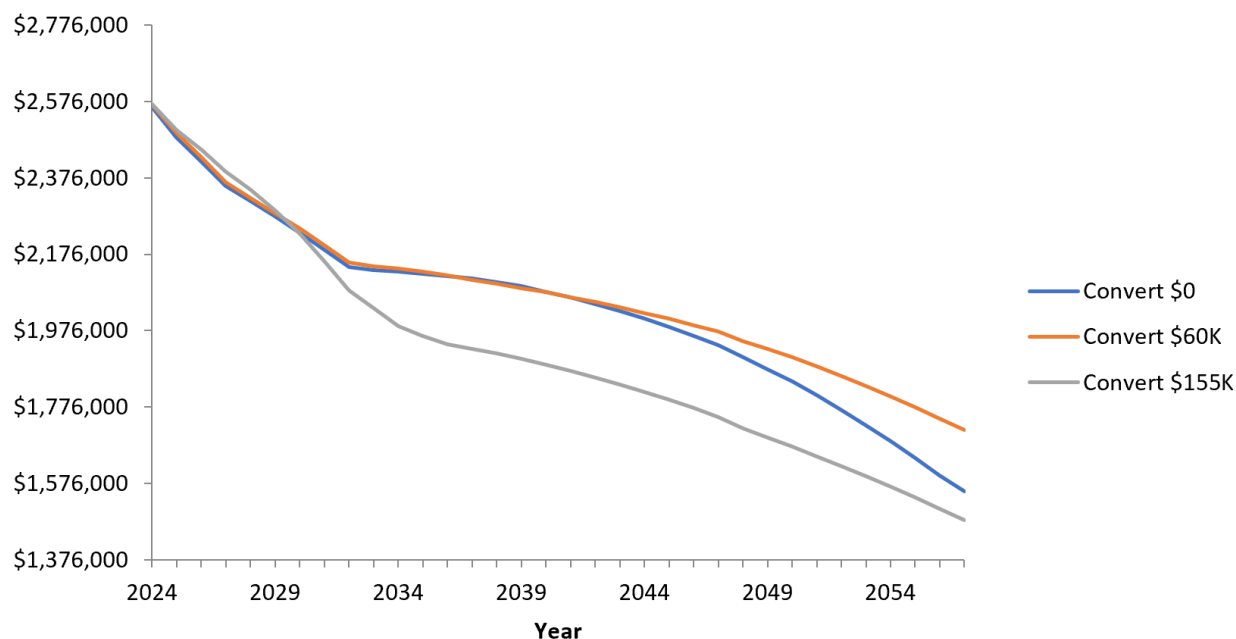


Figure 31 - Assets over time for Conversion Scenarios

Recall that the JRTN's adjusted value of an unqualified (IRA) account adjusts for inflation as well as for the taxes eventually due on the account. What we see is that the zero conversion and the optimal conversion curves are closely aligned out until the point where RMD's start. This is reassuring because it means we have a good value for tax adjustment factor. The question at hand is what happens with the \$155K conversion curve? The graph explains most of the story, we see a substantially lower value for this curve at the time the conversion completes in 2035. This lower value appears to account for most of the difference at the end of the plan. This value is low in 2035 because we paid more tax than necessary on the conversion. Since the only thing that is different between these scenarios is the Roth conversion decision, we know that this is the end result of taxes. Let's look at the average tax rate over time to get a clearer picture about what is going on here.

Average Tax Rate vs Year

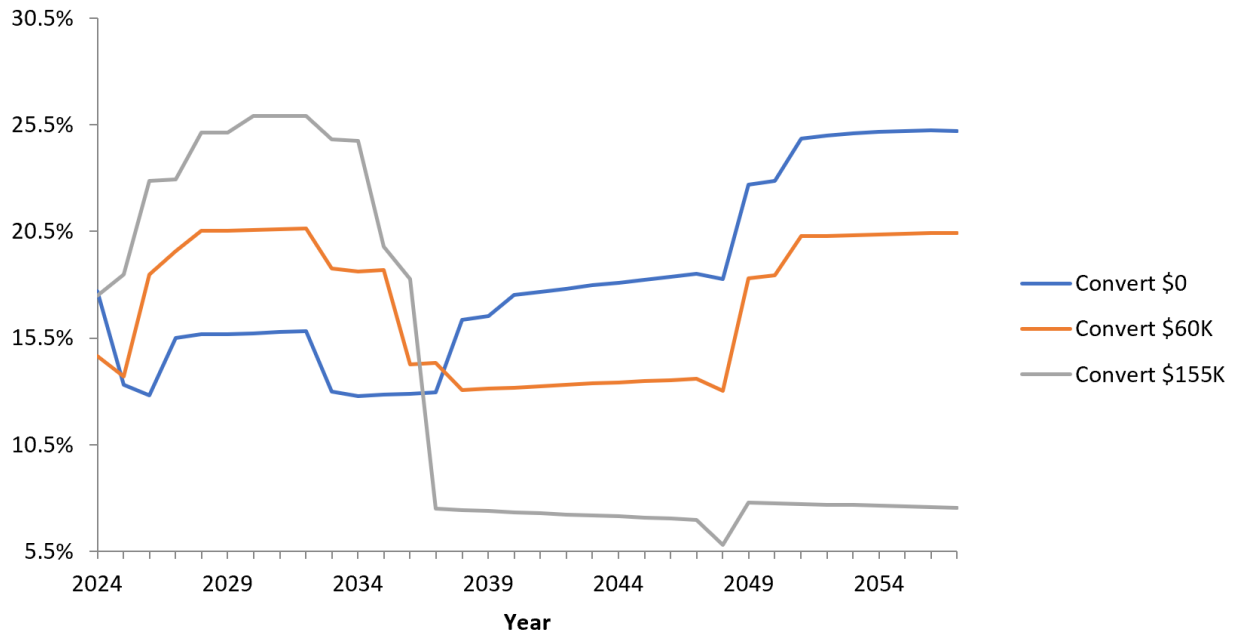


Figure 32 - Average Tax Rate over Time for Roth Conversion Questions

Figure 32 makes it pretty clear what is happening. The higher average tax rate as the Roth Conversion is executed causes us to draw down the adjusted value faster than necessary. The give-away is tax rates that change a lot over time. The zero conversion has rates climbing high late in life. The complete conversion on the other hand, has rates drop to almost zero. The optimal solution in the middle has the steadiest rates. This also suggests that there is room for further optimization by bringing up the rates in the middle so that we can reduce them a bit at the ends.

For the second question we will use this same group of scenarios but will focus on conversion rates that are more interesting for the tax curve.

Total Adjusted Tax vs Year

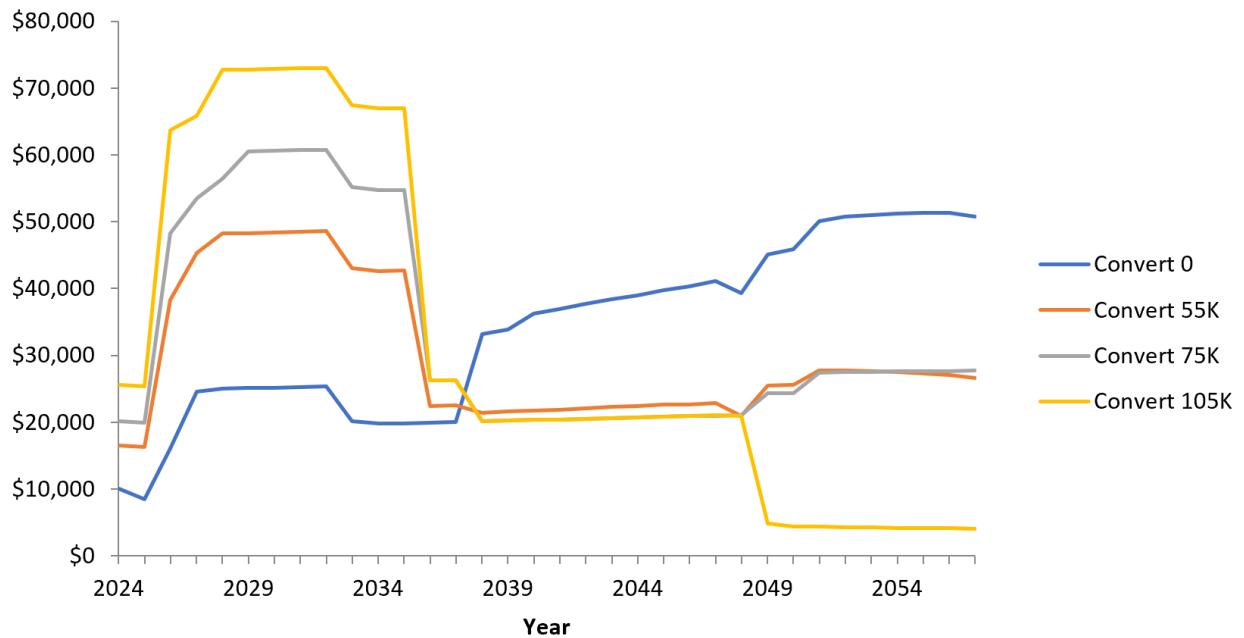


Figure 33 - Taxes over time for several Roth Conversions

Figure 33 provides a pretty good clue about what is happening. Look at the lines for the \$55K conversion and the \$75K conversion. They are virtually identical beyond about 2037, but the \$75K conversion had us paying more tax during the Roth conversion. Clearly the total tax payment over time will be higher for \$75K, but what is actually going on here? Lets look next at the IRA withdrawals over time for these same 4 scenarios:

Adjusted Qualified Withdrawals vs Year

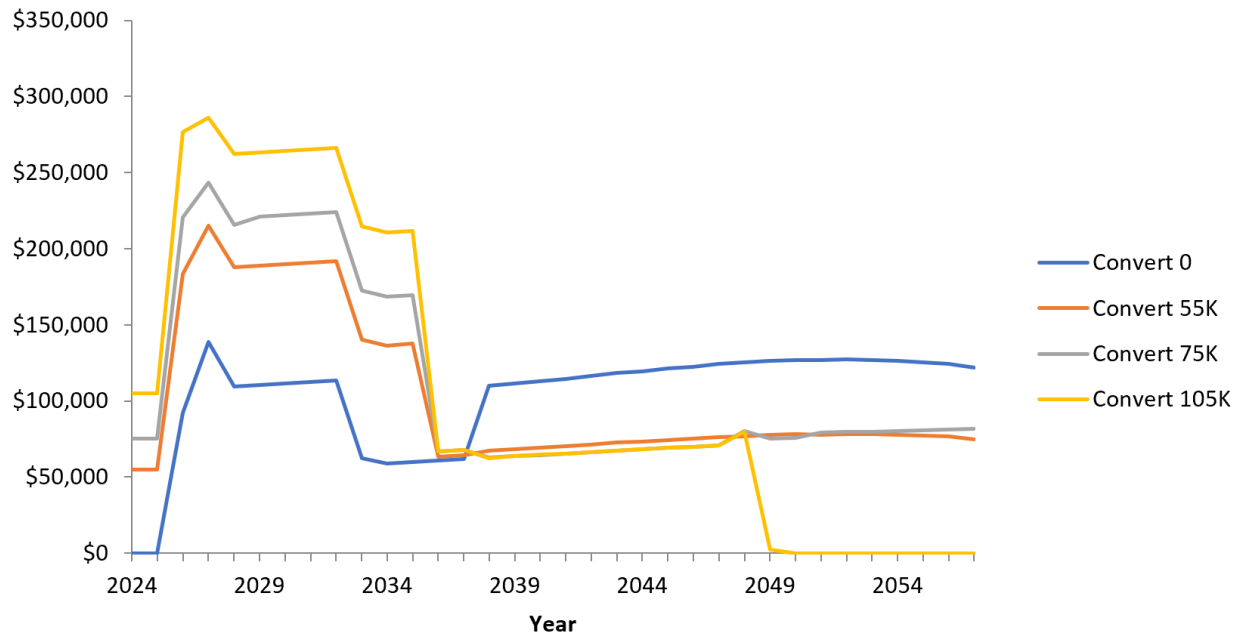


Figure 34 - Qualified withdrawals for different conversion levels

Figure 34 looks a lot like Figure 33 but it nails down what is happening. It turns out that once we get to a Roth conversion of about \$55, we have depleted the IRA enough that our subsequent withdrawals are controlled by our spending needs and not by RMD's. We can also see why taxes drop precipitously for the \$105K withdrawal case as the IRA is depleted.

A note on income sourcing

Once the RMD no longer covers the spending needs, there is a choice to make. One can take the RMD and draw spending from other accounts or use the IRA as the preferred source. The first choice lowers the taxes now and leaves the estate with a higher tax burden. The behavior of JRTN is to always prefer sourcing from IRA to Roth accounts as this is aligned with most professional guidance. Making JRTN more flexible in this regard is one of many potential enhancements, but of course every enhancement like this makes it just a little more complicated.

11 Elaboration

11.1 Limitations and Assumptions

1. The Tax model does not include (in a fingers-crossed sort of way) AMT
2. Roth withdrawals are not subject to tax (We do not try to properly handle Roth withdrawals before the 5 year window)
3. The federal tax model uses the standard deduction for TCJA and it uses an estimation of itemized deductions for non-TCJA tax calculation.
4. The underlying assumption is that nothing dramatic happens with Social Security with respect to individuals nearing retirement now.
5. Identical Federal indexing of brackets, Social Security, etc is assumed
6. Federal taxes pose a special challenge because of how up-in-the-air they are. We therefore treat them as another "future unknown" with a range of different possibilities. Since the ways that our congress may manipulate taxes is completely open-ended it is unlikely that any of the scenarios accurately predicts the future, but it does seem likely that the range of overall tax impacts is probably covered by the different scenarios here. If desired, projected rates be changed on the *Model worksheet*.
7. Some states have complex tax rules. For example, some states have a means-tested phase-out of standard deductions. States may also make the taxation of certain types of income contingent on overall income level. There are numerous special cases related to pension handling. For example, MA generally taxes pensions, but it exempts in-state government pensions and it exempts the first 20K of NYS pension income because that is how much NYS exempts MA pensions. States may also have income tax rules that vary from locale to locale within the state. The JRTN tool does not try to capture all these details, but it does allow you to get "close" for each state. Some states have tax laws that are the process of changing in a defined way. The tool does not try to incorporate these future tax laws.

11.2 Error Handling

The model solution calculations rely on heuristics to find the solution. For the spending calculation, the heuristic is to guess at the specific value of the draws needed to achieve the spending goal and then to adjust these guesses up and down until we are close to the spending goal. For the Max Spending calculation, the heuristic is to guess at a spending amount that will yield the desired legacy account value, run the entire spending calculation (e.g. for all years) for this amount, and then adjust it up or down as needed. For the Roth Optimization, the heuristic is to try to locate the Roth conversion that results in the highest

“end of plan” value. There are several different things that can potentially go wrong with these:

1. There may be no solution. For example, there may simply be insufficient resources to support a desired level of spending.
2. The heuristics might not find an answer. There is a hardcoded limit on the number of times we will loop looking for an answer, if we exceed that, the calculation is canceled. The challenge is that the relationship between the input variables we are adjusting and the output variable we are observing may be non-linear.

Note: The Max Spend Heuristic is particularly challenging. What we have seen is that a change of \$200 for annual spending can swing the annual excess from -\$2000 to +\$2000. This is likely due to Medicare calculations that have a “one dollar too much” model. The Max Spending heuristic addresses this by successively reducing the magnitude of the change in spending and then simply giving up after the annual excess has flipped from positive to negative 4 times.

3. The calculations might erroneously lead to accounts having invalid (e.g. negative) values. There are checks in the code to try to avoid these situations, but it is always possible we need one more.
4. A Visual Basic operation might throw a fatal error. Typically, this is an overflow or an underflow.

If one of the first 3 types of errors occurs while executing the spending adjustment from the model worksheet, a popup will be displayed, and calculation will cease. The behavior when executing scenarios is different. The condition will be logged on the ErrorLog worksheet and calculation for this specific scenario will be canceled, but the automation will continue to calculate other scenarios.

This all sounds a little scary; however, none of these issues have been seen in recent incarnations of heuristics even as the heuristics are “pushed” to support optimization.

11.3 Execution Time

Execution time is a function of how much you ask the automation to do and how efficiently the automation does this work. A modest amount of effort has been invested in code efficiency, but this is only interesting to the programmers in the audience. Implementation optimization is discussed in the context of the overall implementation in section 12.11.

There are however, several things that the *user* can do to impact execution time:

1. Limit the total number of scenarios with careful use of grouping. The key here is to be careful both about the number of varying parameters in a group and how many different

choices there are. Also throw out scenarios you have already locked in either in point of fact (you have started SS) or in terms of your plan “I have already decided to wait on the higher SS value.)

2. Focus on one group at time. The user interface allows you to execute just one group or all groups of scenarios. Obviously, it takes much less time to execute one group.
3. Avoid repeated running of Optimization scenarios. This is best accomplished by grouping all of the Roth Optimization requests into a single group and then grouping the max spending calculations into a different group. Once you do this you can use the “All except” mode for selecting the scenarios to run.
4. Try adjusting the convergence criteria specified on the controls worksheet.
5. Minimize the use of “tax bracket tested” Roth conversion rules since these require additional iterations.
6. Be careful about the size of the group that includes Roth conversion optimization or Max Spending optimizations since the “Set Spending calculation will be done a number of times to find the optimal values are found.
7. Having multiple workbooks open can negatively impact performance. This is discussed in more detail in Section 12.13 on Page 185.

A substantial part of the execution cost is incurred by the underlying Excel engine and the associated cost of transiting data between VBA and workbook. The good news is that the Excel execution engine is multi-threaded to take advantage of multiple processors. The bad news is that the singly threaded VBA environment still tends to throttle performance.

Summary execution time statistics are captured on the PerfLog worksheet. The key number as it relates to computer performance is the “average time per row iteration.” This is around 0.014 seconds on an aging laptop with the following specifics:

- Intel(R) Core(TM) i7-7700HQ (4 Core, 8 hyper-thread) @ 2.8 GHZ
- 16 GB Ram

This is essentially the “inner” loop. There is probably not a lot that can be done to speed it up from a coding perspective, but a faster processor always helps. More cores likely won’t help much since Excel on seems to drive this computer to only about 40% total CPU usage with several of the 8 threads being relatively underused. This is probably a reflection of the fact that quite a lot of processing is being done by the singly-threaded VBA engine.

11.4 Possible Enhancements

1. Better support for early retirement. This includes accounting for different health insurance concerns (ACA tends to be needs-tested, but with different rules than Medicare).

2. Support for (late) accumulation-phase users. The trick here would be to find something useful that is “not too complicated.” At the minimum we would want to establish a mechanism for adding to various accounts, but it likely doesn’t make sense to try to do complete spendable income modeling at this phase. This is related to providing better support for answering the question “when can I retire?”
3. HSA account support.
4. Joint-Life RMD rules.
5. Add mechanism to allow “Fixed” parameters to be modeled in scenarios. This would entail a small update to the VBA code to incorporate a 3rd named parameter table into the scenario definition mechanism. Since we have this table defined already for the Profile save/restore mechanism, this would be a very simple change. The doubt is whether it is actually worth doing as it seems an unnecessary complication of the user experience.
6. Add visibility control for the Model worksheet that ensures the specific columns relating to parameters and/or summary information remain visible.
7. Generalize “Other Income.” One possible approach is to reference an “Other Income” worksheet that would have one row per year one or two columns of concern (taxed vs untaxed?) and allow the user to do whatever they wanted otherwise to get to that column(s) (e.g. summing up annuities, passive income, trust income, or inherited IRA’s)
8. Explicit support for commercial annuities and the decision process surrounding them. (Somewhat ironically, the earliest version of this workbook was put together to support discussions with an Annuity salesman – It didn’t go well for the salesman due to the author’s personal situation...)
9. Improved State tax modeling. The following are a few possibilities:
 - a. Allow for untaxed “special” pensions
 - b. Support exception/deduction phase-out and recovery rules like we see in CA, NY, and Conn.
 - c. Better parameterization of state taxes. Currently a few tax situations require tuning of the StateTaxInfo worksheet. Ideally no personalization changes would be required to this worksheet.
10. Monte-Carlo simulation. It would be possible to implement a Monte-Carlo simulation by repeatedly varying the investment returns (which might go negative) and possibly other parameters in a statistically sensible fashion over the years. From a practical perspective it is probably not possible to apply this to a wide range of scenarios, but it might be sensible to add it as an option while digging into a “favorite” scenario. It would take a few hours to get a respectable statistical view of the data for a single scenario using VB automation. But this might be OK.

11. Replacing “Integers” with “Longs” in the automation to eliminate various 32K limits. For example, today we cannot define more than 32K Scenarios.
12. Support for untaxed interest. This would probably be a new account type. It would contribute to total assets and be available for drawing on and would also have to be incorporated into MAGI calculations.
13. Automated testing. This would drive the tool with a wider range of input cases. These cases would vary the underlying financial situation (which is fixed for a normal model) as well as the more typically adjustable parameters.

One possible approach here would be a variation on the FactorTable mechanism:

- Wider range of parameters
 - Single scenarios rather than a range of scenarios
 - Some explicit notion of a baseline, or possibly just specify all of the parameters for each case
 - Define “expected results”
14. Support non-constant spending levels. For example, to expressly spend more earlier in retirement. This might possibly be expressed as parameters for an elliptic curve.
 15. Support for reactive spending levels. This would have spending vary with market conditions and other income sources, this might be particularly interesting in the context of Monte Carlo simulation.
 16. Support black swan events (explicit “bad years.”) This could be simple; for example, specifying a small set of {year, rate-of-return} tuples where the bad year “overrides” the typical expected rate of return. It could be a little more complex by incorporating it into a Monte Carlo evaluation.
 17. Introduce a “post plan” period. This would run the plan out for the 10 years that the qualified plans can be in play. An “accurate” view of this would demand that we capture financial details for each beneficiary – essentially what their expected income and tax rules would be. But this is probably too much work and at any rate, the further out we look in the future the more unknown all that is. A reasonable compromise might be to simply stipulate a “post plan” tax rate.
 18. Add a “getting started” Wizard has fields to personalize the *Model* and *FactorTable* workbooks. This could be structured as an interview via a set of forms if desired.
 19. Allow for a spending model that refuses to drop account values less than the prescribed goal. When there is insufficient funding, the result of this would be years when the spending amount is less than the request.
 20. Add “minimum spending” optimization that aims for a maximum legacy value.
 21. Support for charitable giving plans. Charitable giving can impact RMDs and impact income taxes.

22. More flexible federal income tax handling. For example, supporting both the standard deduction and itemized deductions.
23. Restructure code into a modest number of functionally aligned modules.
24. Generalize “future tax” models. The “post TCJA” mechanism was implemented during 2023 and 2024 when there was a lot more doubt about the future of tax law. That said, changes at ****some point**** in the future remain likely.
25. Implement mechanisms to create a new workbook containing the essentials of JRTN. This may become desirable because of the bloat and performance degradation discussed in section 12.13. The essence of this would be:
 - a. Copying distributed worksheets to new workbook
 - b. Transfer of all User Forms
 - c. Transfer of module code
26. Automatic calculation of “optimal” Roth conversion for the Roth Optimization modes ($\frac{1}{2}$ -Optimal and $\frac{3}{4}$ -Optimal) that reference a stored optimal value.
27. Miscellaneous UI improvements
 - a. Use a pull-down in the places where a Worksheet name is input.
 - b. Multiple item selection for “all but” scenario selection
 - c. Set scenario selection mode on data input
28. Calculate an estimate of taxes paid over the course of retirement for an IRA. This would look at the difference in situation between no IRA withdrawals for a specific scenario. These taxes would then need to be “growth” adjusted down on an annual basis. The sum of the taxes compared to the original IRA balances would be a good measure of the total tax load that the IRA carries. The number would vary with the effectiveness of Roth conversion scheme so it would provide another measure of Roth optimization.
29. Provide optional second Y axis for scenario data over-time plots
30. Decomposition export to support version management at a lower level of granularity.
31. Provide a “contingent” mechanism for the feature table. For example we might make the IRA tax factor or the required spending contingent on the state of residence. It is unclear how useful it would be to allow multiple factors with these contingent rules.
32. Provide control over whether IRA or Roth is preferred for draws once the RMD is reached.
33. Presentation of “funded ratio”

11.5 Unanticipated Enhancements

There are no plans for the following:

1. Detailed Budget/Spending Modeling
2. Investment/Portfolio Modeling
3. Support for the nuances of Roth withdrawal taxation. The assumption is that by the time we need to withdraw from a Roth, the funds in question have passed the 5-year test.
4. “Lifelong” financial planning. There are no plans to extend this to meet all of the needs of people regardless of their life-stage. (e.g. addressing other concerns such as saving for college that younger folks have.)
5. Open-ended account definitions, for example multiple IRA’s per person or multiple unqualified accounts.
6. Generalized “net assets” tracking (e.g. non-investment assets such as a home)

12 JRTN Implementation

JRTN uses spreadsheet formulas wherever possible. When the formula mechanism is not sufficient, it is augmented with automation. The automation is implemented via VBA (Visual Basic for Applications). This is not the only choice, but it is a natural choice given the level of integration provided. This is a singly threaded “fully interpretive” environment. The JRTN automation is relatively “safe” from a security perspective since it does not reach outside of the Workbook to the file system or network except to import and export workbooks. (This is not true of VBA in general, just of this particular applications use of it) But it is all relative; there is a certain inherent risk with running Excel with “macros enabled.”

12.1 Extending the Model Worksheet

Many potential changes (see Section 11.4 for some examples) involve extensions to the *Model* worksheet. Typically, this involves adding one or more columns and then integrating the columns into the “horizontal” math used to calculate the taxes and spending. There are a number of “handoff” columns used to capture intermediate results. For example, there is a “Total External Income” column that hands off to the “MAGI” column and the spendable income column. Unfortunately, tax calculations complicate this nice, neat story because different types of income are treated differently (especially at the state level).

The following are some suggestions for working with the *Model* Worksheet:

- Create a backup copy of the Model worksheet (or even the entire workbook at the file system level)
- Use *Trace Dependents* and *Trace Precedents* (on the *Formulas* Tab) to understand the worksheet mechanics before making any changes.
- Be cautious of introducing new columns near the left (before column “H”) side of the worksheet as these may interfere with tables below the main part of the worksheet
- New parameters can be introduced as follows:
 - Add a row for the parameter
 - Add a **worksheet** scoped name for the parameter via “*Formulas, Define Name*.” It is a good idea to follow the “ModelXXX” naming convention for consistency’s sake.
 - Update the appropriate table definition name via “*Formulas, Name Manager*”
- Be sure to drag any updated formulas from the top of the active area (row 5) to the bottom.

- The goal seeking assumes that the 4 draw accounts are adjacent and addressed via the “ModelAccountDraws” name are adjacent. Do not introduce new columns here without being prepared to dig into the VBA automation.
- The goal seeking also assumes that the two Roth Conversion columns are adjacent.
- If you add new columns, you can consider updating the VBA that manages column visibility, this code is straight-forward.
- Debug your changes via the “Solve Model” button
- Use model-compare and scenario-compare on the Tools form to help detect unexpected changes. When possible, it is helpful for new functionality to have a mode that is equivalent to the original behavior.

Example: A potential Social Security Reduction

Current trends have the Social Security fund failing to meet commitments in the 2030’s. That means that the annual expenditure is projected to be greater than the fund’s income unless something changes. One of the things that might happen at that point is a reduction in benefits. Politically, this seems a little unlikely; but it is *possible*. If you are concerned about the impact of this on your personal finances, you might add it to your model as follows:

1. Add a new column *SS Fraction* to the *Model* spreadsheet. It is tempting to insert this new column between “I” and “J”, but that is not a good idea because it will impact the state income tax table. Instead insert between “J” and “K.”
2. Add a couple of new parameters:
 - a. First year of reduction
 - b. Expected reduction

These cells are best added at the bottom of the *Fixed Controls* section of the *Model* worksheet. The reason for adding them here rather than the *Variable Controls* section is that all of the *Variable Controls* should have corresponding entries in the *FactorTable* and *Scenarios* worksheets.

3. Define a formula for all Cells in the *SS Fraction* column that calculates the value based on the current year and the 2 new parameters
4. Update the Partner 1 SS and Partner 2 SS formulas to incorporate the *SS Fraction* value
5. Test the behavior by defining the parameters, recalculating spending, and observing the behavior (you will expect to see a reduction in investment assets at the end of the plan)

That's all there is to it. For "extra credit" you might add visibility control for this new column as follows:

1. Add a new worksheet-scoped name to reference the new column
2. Update the Model visibility VBA code

Section 12.2 extends this example to allow these two new parameters to be incorporated into your scenarios.

12.2 Extending the FactorTable and Scenarios Worksheets

You can freely change "factor" fields in the factor table or add value factors to the right of the existing factors.

To add a new parameter that is not currently modeled in scenarios:

1. Ensure that the parameter has an associated "Single Cell" Name in the Model worksheet and that this Cell is part of one of the 2 named blocks of variables (CoreVarParameters or CoreSpendControl)
2. Add the parameter to the Scenarios worksheet by creating a new column to the right of the last existing parameter column and before the "Adj Value Ref Column" Column.
3. Add one or more new factor rows. These factor rows will reference the Model parameter cell name, the block name, and provide the column number in the Scenario worksheet. Identify the data type for the factor. Each row should also identify a group for the parameters to vary in.
4. Test your changes by rebuilding the Scenarios worksheet and manually executing one or more of the scenarios.

To add a new group:

1. Add a new factor line with a set of factors that vary and a new group name
2. (Optional) Add additional varying factor lines with this same group name. The total number of scenarios in the group will be the product of the number of varying factor lines.
3. Test your changes by rebuilding the Scenarios worksheet and running the scenarios in this new group.

To add new results columns:

1. Add new columns as appropriate in the results sections of the Scenarios worksheet. These columns should be after the baseline reference columns and before the iteration count column.

2. Create **worksheet** scoped names for each new column
3. Update the scenario column visibility VBA code in the *ScenarioVisibility* subroutine. Possibly also extending the visibility form.
4. Ensure that your data is present on the Model worksheet after the spending calculation.
5. Update the results copy code in the *CopyResults* subroutine to copy the additional data

Example: Scenario support for potential Social Security Reduction

You likely don't need scenarios that vary both the reduction amount and the start year independently. Mechanically this would work just fine, but it would lead to a bit of overkill in terms of the number of scenarios and to some scenarios that are effectively identical. For example, a 0% reduction in 2030 and again in 2035. Instead, we will follow the same model as with the Social Security commencement age: One parameter in the *FactorTable* worksheet will map to two operative parameters in the Model worksheet. The first step is to update the Model worksheet to this new model:

1. Move the two new parameters from the *Fixed Parameters* section to the *Calculated Parameters* section. If you do this with cut-n-paste, Excel should update the social security calculation column for you.
2. Check that the social security factor column is intact
3. Insert a new variable parameter for the combine parameter
4. Add a new worksheet-scoped name for this new parameter
5. Add formulas for the two parameters you moved to generate them from the combined parameter (examine the Social Security Commencement parameters for an example)

The next step is to control this new combined parameter from the scenarios:

1. Add a new column to the Scenario worksheet for this parameter
2. Add a new row to the FactorTable worksheet with two or more values for this new parameter. Pick a group that you want to use. For example, *ExploreFunding*. Use Data Type "Other." Note that if you add three possibilities here you will triple the number of scenarios for this group. You might start with something like: {2032,0}, {2032, 25} and {2032, 50}. This will certainly provide a sense of how your finances would fair with a reduction. Note that the first of these will be the value used for groups where you are not trying to understand the impact of a social security reduction.
3. Test scenario creation and execution

12.3 Model Solution Code Structure

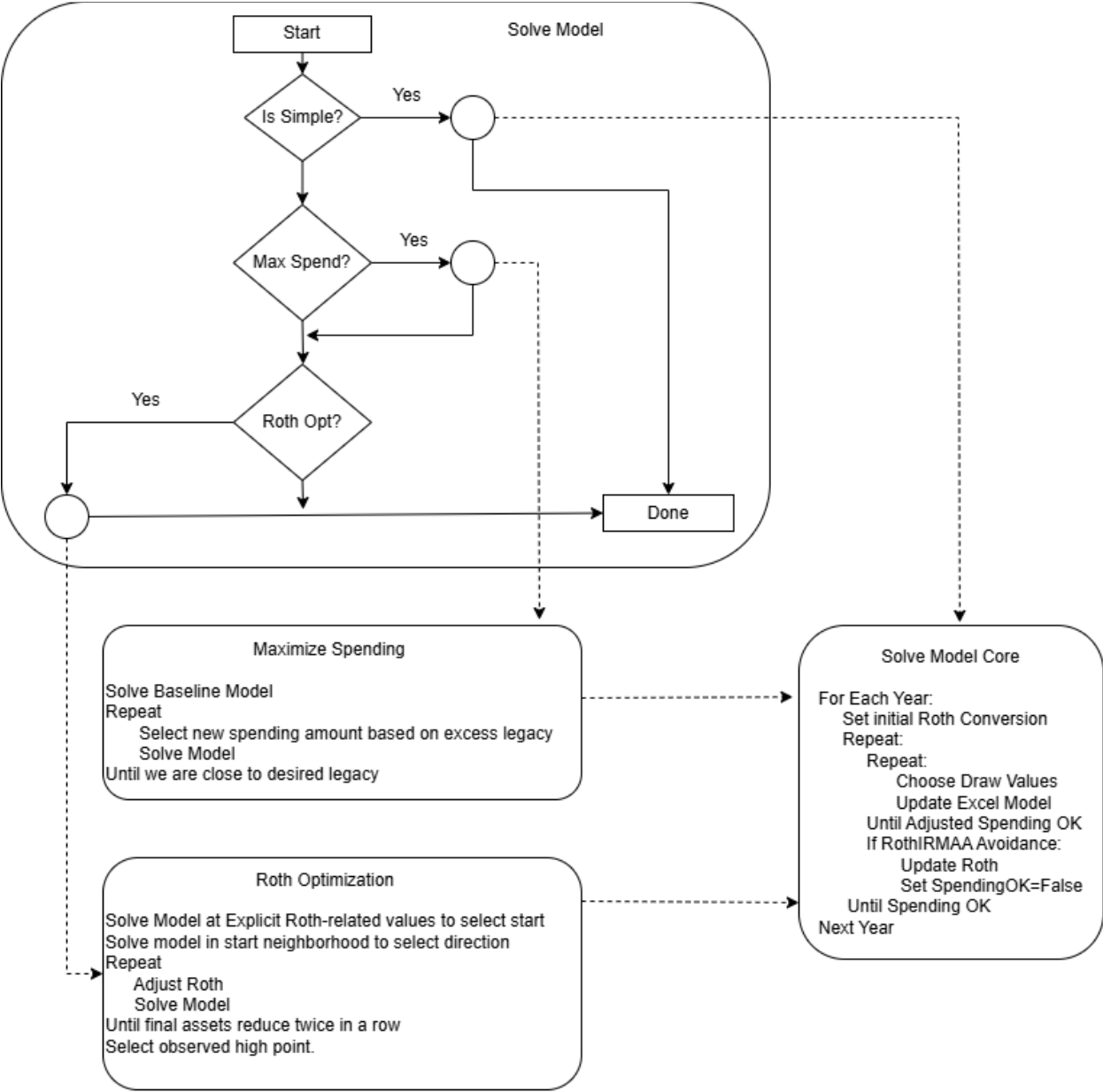


Figure 35 - Model Solution Design

Figure 35 is a hybrid flow-chart/pseudo-code diagram (as a *retired* software engineer, I can take a few liberties...) that outlines the design of the model solution code. At its core is a routine that sets the draw for spending and Roth conversions. For a simple scenario this will be invoked once, for a scenario involving optimization, it may be invoked many times. Each of the 3 boxes at the bottom of the diagram is implemented as an iterative goal-seeking heuristic. They are described in more detail in the following sections.

12.4 Spending Heuristics Overview

This heuristic iterates by taking estimated draws from 1 or more accounts. The account(s) used depends on the current situation, which varies from year to year. For example, if we are required to take RMD's the spending needs are satisfied from the qualified accounts up to at least the amount of the RMD. The heuristic respects the minimum account balance settings and the requested qualified/unqualified fractions. When we are unable to meet the need from unqualified and qualified (e.g. IRA) accounts we resort to drawing on the Roth. The amount of the proposed draw for an iteration is scaled to account for taxes based on the accounts we are drawing from. Once we step over the spending goal (ideally on the first loop of the search), the draw is reduced based on a memory of where it came from, ensuring that we come back down the same way we went up. The following is a flavor of the different considerations:

1. Can money be taken from one or both IRA's without penalty?
2. Is an RMD required?
3. What fraction of the draw should be qualified vs unqualified when there is a choice?
4. Where is the money likely coming from? (this impacts the heuristic optimization math which tries to take into account how much of the draw will be taxed – scaling it accordingly)
5. Are any of the draw sources going to be depleted? Reduce the draw's accordingly and move on to other sources (e.g. Roth)
6. Are we doing a Roth conversion in a situation where the IRA is moving to depletion?

A second level of heuristics involves tuning any Roth conversions to account for taxes in the current year. But of course, changing Roth conversions changes the taxes. When the spending is calculated directly from the Model spreadsheet, the SpendCalcLog worksheet is populated with a detailed history of the iterations (including draws, etc) at each row if it is enabled. When spending is calculated via *Scenarios* worksheet, we capture just the total iteration count.

Would it be possible to leverage Excel's Goal Seeking functionality to this same end? It probably would. Notwithstanding the inherent inefficiencies of coding on Visual Basic, I am skeptical about whether this would be faster or more reliable. The reading about Goal Seeking on complex worksheets is not all that encouraging and the <1 second we see when executing the spending calculation from the *Scenarios* worksheet and the average per-row iteration count of less than 3 just don't seem that bad.

12.5 Max Spend Optimization

The Max Spending Optimization aims to identify the largest nominal spending amount consistent with the desired end of plan (legacy) value. In other words, it is trying to reduce the “excess legacy” to about zero. The process starts by evaluating the excess at the nominal spending amount.

The iteration involves calculating a new spending value by dividing the excess legacy at the current spending level (which might go negative) by the number of years in the plan and multiplying it by a “convergence factor”

12.6 Roth Optimization

The Roth Optimization mechanism is looking for the largest “final assets” value for a set of different nominal Roth Conversion values early in the plan. There are a few challenges:

- In situations where the qualified account is being “spent down at any rate,” the optimal conversion might be zero. If it is not zero, the behavior of the value curve is likely be quite noisy.
- The optimization mechanism is looking for a “peak” in the data rather than the largest value that meets a criteria. The focus here needs to be on the derivative of the value rather than the value itself.
- The “peak” can be rather rounded. More like a plateau
- Even well-behaved data with a clear trend line can have occasional “blips” due to non-linearities in the tax rules.

Given the noise, the only 100% reliable approach to finding the optimal Roth conversion would be to run the model at different conversions starting at zero and proceeding to empty the qualified account. This would be expensive and it likely would not lead to a meaningfully better ultimate result; instead, the following less computationally intensive heuristic is used:

1. Evaluate final assets with
 - a. Nominal Roth Conversion value (the manually specified value)
 - b. Zero Roth Conversion
 - c. 50% of the Nominal Roth Conversion
 - d. 125% of the Nominal Roth Conversion
2. Select the largest as the starting point
3. Decide whether to go forward by looking at whether 2 of the next 3 increments result in a growth in assets

4. Move in the indicated direction until two increments in a row move the final assets the wrong way
5. Choose the best value seen during the overall process

12.7 Debugging Spending Heuristics

As with most heuristics, the heuristics are imperfect. If it does fail, it is most likely to fail at boundary conditions such as "emptying a particular account" or "Not enough money to reach spending goal." These situations, in turn, are most frequent when running the "find maximum spend" calculation since that is more likely to push the calculations to the boundaries.

This is running on a PC, so of course it can also fail for "PC reasons." For example, I have seen it fail with "out of memory" when an out-of-control tab in a browser chewed up all the memory on the PC.

The Error Handling section discusses how errors are reported. The following is a discussion of how you can proceed if you encounter one of them:

1. If there was a VBA fault, identify the location of the fault and then request a "reset" on run menu that should now be present in a VBA window.
2. If the error occurred while executing scenarios, load the failed scenario by executing just the single scenario.
3. Run the set spending request from the Model worksheet – examine the SpendCalcLog worksheet
4. Examine the area around the failed row for "badness" (often signaled by nonsensical negative numbers). You can ignore any rows after the failed row.

You might be able to adjust the parameters directly in the Model worksheet to avoid the boundary condition that is likely getting us in trouble. You will then want to reflect this back into the FactorTable and hence into the Scenarios. Alternatively, If you have some programming skills, you might consider trying to debug the code as described in the example below.

The following is real-life example that happened during development. After running 8600 different scenarios there were a handful of errors in the error log including this one:

```
Scenario-4080    Failed to converge at Row: 11 FlipCount: 38 Need: -AA.BBB Target: XX.XYZ
```

Both AA.BBB and XX.XYZ were whole numbers with a string of digits after the decimal point. XX.XYZ was also much larger than the nominal spending request. This tells us that we are

failing on one of the max spending calculations attempts and at the time we were trying to set the spending for a dollar value of XX.XYZ.

The worksheet ModelCalcLog contains a log of each iteration attempted by the SolveModel calculation. This is helpful in debugging convergence failures and in trying to optimize iterations counts. In the interests of performance and to avoid creating an enormously large worksheet, this log is only created when you manually run the set spending request from the model worksheet (and when it is enabled). In light of that, the following steps were followed in debugging this problem:

1. Run the single scenario 4080 from the Scenarios worksheet
2. Copy the value XX.XYZ into the spending goal field on the Model worksheet
3. Run “Solve Model” from the Model
4. We see that it now fails with a pop-up
5. Examine the SpendCalcLog Worksheet
6. Examine the Model worksheet. Any lines after the failure line can be completely ignored. The one immediately above the failed line is usually the most important.
7. Fix the code, possibly after some interactive debugging:
 - 7.1. Find the line that reads: “If Row = XXX” Then” followed by a DoEvents request
 - 7.2. Adjust the test to match the failed row (or occasional the row before)
 - 7.3. Set a breakpoint on the DoEvents line
 - 7.4. Run Solve Model
 - 7.5. Step through the code and/or set additional breakpoints

This problem turned out to be a logic flaw which has since been fixed. The failure had to do with a corner case where the IRA accounts are fully depleted.

12.8 Other VBA Debugging

The goal seeking heuristics are the most complicated part of the code and the part most likely to fail, but problems can occur elsewhere, especially if you are making changes to the code itself. There are several possible failure modes:

- VBA fault pop-up. This might happen, for example, because of a Name change or a math fault such as dividing by zero.
- Infinite loop. This generally only going to happen because of a coding error, but since some operations such as scenario generation are data-driven there are probably some non-coding opportunities for failure. Generally your only recourse is to kill Excel from the task manager and then set break points appropriate.
- Incorrect results. Generally, this is something we see in the *Scenario* worksheet since the execution of the *Model* worksheet is entirely formula-driven

- Broken visibility controls. If you add or remove columns from either the Model or the Scenario worksheet you may break visibility management.

There is not a lot of wisdom to impart here. VBA is an interactive and straightforward environment. If you have done any programming at all, you will likely find it straight-forward.

12.9 Use of Names

The VBA code generally avoids direct reference to worksheets with hardcoded cell addresses. (One exception to this is that starting rows indexes are hard-coded to reflect whatever header rows are present in a worksheet.) Instead, it relies on named cell groups on the different worksheets. There are several different “name geometries” in play:

- Names that refer to an entire column
- Names that refer to specific cells
- Names that refer to blocks of cells

This goes a long way towards making the worksheets independent of the code. For example, the “Inflation Adjusted Spending” column on the model worksheet is given a name and then anytime the code needs to refer to this column, it uses the name. This ensures that this code will not be impacted by the insertion or removal of columns to the left.

This naming scheme does not provide complete isolation. For example, there is a single name that refers to the 4 draw account columns and another name that refers to the 2 birthdays.

Workbook scoped names are avoided in favor of worksheet scoped names to ensure that the mechanisms that allow us to have multiple functional worksheets are robust. This is a check against a programming error were a name is referenced without qualifying the name with the worksheet.

Note that names are *not* used to reference cells from Excel formulas. If you are wondering how a name is used (or whether it used), there are only two places to look:

1. The VBA code itself (do a find across the entire workbook)
2. The *Name Reference* column in the *FactorTable* worksheet

12.10 Modeless Dialogs

The long execution time for scenarios leads to a need for two things:

- Status feedback
- The ability to cancel execution

These would be trivial in most modern programming environments. It is not quite so simple with VBA. With VBA, the application itself needs to do the heavy lifting:

1. Periodically call “DoEvents” yield back to the VBA operating environment. This yielding is necessary both to present updates to the form and to process Cancel button presses. Yes, this is the way we programmed under Microsoft DOS!
2. Set an application flag when the Cancel button press is detected.
3. Check the application flag to see if a cancel has been requested.
4. Return back up the stack robustly.

This is a little fragile from a programming perspective because every loop must be either inherently safe (e.g. looking for an empty cell in a column), have built-in protections (e.g. we are only going to execute the heuristic loop N times) or embed this cancel logic directly. Any careless loop can cause Excel to lock up with the only recourse being to kill the program from the Task Manager. If you have not saved your code or spreadsheet changes you can easily lose them. (If you are changing code and thus increasing the chances of this happening it is therefore a good idea to save the worksheet before requesting the calculation). This is just the price to pay for developing in VBA.

12.11 Data Driven Scenario Management

The population of the *Scenario* worksheet from the *FactorTable* worksheet and the subsequent population of the model worksheet from the *Scenario* worksheet is driven by the data present in the *FactorTable* worksheet:

- Name of the Parameter on the *Model* Worksheet
- Name of the Parameter block on the *Model* Worksheet
- Column number of the Parameter in the *Scenarios* Worksheet
- The Data Type

This is presented in some detail because the use of names as worksheet values is a little unusual in Excel. The population of the *Scenarios* worksheet progresses one group at a time. The code builds a variable array with one row for each scenario and one column for each parameter. It starts by creating the first scenario based on the first parameters in each of the factor rows tagged for this group as well as any unvarying parameters. This first row is then permuted by the varying parameters to fill the array which is copied as a group to the *Scenarios* worksheet. The parameter block name is not used at this stage.

Before executing scenarios, an internal data structure called the ParamMap is created that represents the incoming parameters. This is essentially a summary of the *FactorTable* worksheet. This data structure is indexed by parameter column number in the *Scenarios*

worksheet. The parameter copy operation involves filling two arrays of parameters and then copying these arrays to the *Model* worksheet. The “State” parameter block is treated as a special case – code is called to copy a variety of state-specific parameters from the *StateTaxInfo* worksheet to the *Model* worksheet.

12.12 Performance Tuning

There are several aspects of performance tuning for this application:

1. Tuning the VBA code itself using traditional mechanisms such as invariant extraction.
2. Tuning the mechanisms for moving data between VBA and the Excel engine. This involves using array transfers back to the spreadsheet when appropriate, and by using “value2” for data extraction
3. Environment modifications such as suspending auto save operations and automatic screen updates.
4. Tuning the heuristics to minimize the number of times that we need to execute the inner spending calculation loop
5. Streamlining the spreadsheet definition to minimize the amount of work that Excel needs to do when a value changes
6. Addressing what is a performance bug (or possibly limitation) of Excel: The use of INDIRECT in cell formulas can slow down the Excel engine substantially.

The low-hanging fruit has already been picked for all of these.

The array transfer mechanism was the biggest win. In some cases, the difference was tremendous. For example, the time to generate scenarios went from 15-20 minutes down to a couple of seconds. For the Model Solution heuristic there was a performance gain of over 50% just for this one simple measure. There might be a little more to do here but improvements are likely to be small increments now.

Substantial progress has also been made in tuning the heuristics. The measures here are the average iterations per row in the spending calculation and the max spending calculation. Both are now in the high 2’s for the full set of scenarios. There is likely room for a bit more improvement here – probably by moving the first guess closer to a closed form solution, but possibly also via the traditional heuristics that adjust the size of the step as we approach or pass the goal. One challenge is that the same parameters and mechanism we are tweaking to try to minimize the number of iterations also impacts the ultimate convergence of the algorithms. It is possible to hurt overall performance while addressing convergence issues or visa-versa. A related challenge is that a change to the algorithm or control variables might improve one scenario while making others worse.

An initial round of “spreadsheet cleanup” helped a bit, but it turns out to be surprisingly difficult to make a meaningful impact on performance via the structure of the spreadsheet. Consider the following failed experiments:

1. The simple expedient of temporarily clearing formulas on the N+1 account value rows as we iterate on row N slows down the overall process. Apparently, the expense of incorporating dependency changes is more than the expense of recalculating existing dependances.
2. A variation on this approach that used a formula to suppress account accumulation to subsequent years also slowed down processing.
3. A change that made the spreadsheet a little easier to read – replacing a long equation calculating taxes with a simpler one that referenced precalculated baseline amount for each bracket, had no measurable impact. It is certain that there is less math to do on recalculation; but this does not appear to matter much.

There are several sets of logging information to help with this:

1. The ModelCalcLog provides a detailed log of the iterations for a single “SolveModelCore” execution from the Model worksheet.
2. The Scenarios worksheet has a column for capturing the total number of iterations for the baseline calculation and another column to capture the number of max spending iterations for each scenario.
3. The MaxSpendLog logs the Maximum Spending iterations. This has one row for each Max Spending iteration (several rows per scenario). It also provides an explicit last iteration statement that captures the relationship between the first guess and what a perfect first guess would have been.
4. The PerRowLog contains one entry for each row that we iterate on. This captures iteration statistics as well as the relationship between the first guess and what the perfect first guess would have been.
5. The PerfLog provides summary execution time and iteration count metrics with one row for each time the Run Scenarios request is executed.

Note:

Any change to the heuristics is going to change the precise values that result. This means that testing of heuristics changes needs to use the “percentage difference” for the *Scenario Worksheet* or *Model* worksheet comparisons (See the Testing section below).

12.13 Excel Automation Learnings

This section summarizes some important guidance for interacting with the Excel application from VBA.

1. Forms are best initialized at activation time (e.g. in the “Showxxx” subroutine). The problem with using “standard” initialization logic is that it is one-time. If the standard initialization is data driven, then it will be out of date when the underlying data changes.
2. Turn off screen updating to improve performance.
3. Turn off auto-save. This improves performance, but more significantly it is necessary for the robustness of long-running automation. With auto-save on the automation simply breaks in an apparently random fashion.
4. There are three things required to get forms to interact while VBA code is running (e.g. to accept changes to fields and to respond to clicks):
 - a. The form must be opened as vbModeless
 - b. The code must periodically call DoEvents()
 - c. For interaction (e.g. cancel a long-running computation), other code needs to check the form field
5. Set attributes for many cells (typically an entire column) at one time.
6. Use cell formulas in preference to code when possible. For example, the original implementation of the “future federal tax law” had VBA code setting two different parameters. The updated approach of setting a single “variable” parameter in the *Model* worksheet and having formulas calculate the two operative “calculated parameters” results in cleaner code and a more obvious worksheet.
7. Avoid the use of direct two-dimensional references to worksheet cells. In virtually every case this is better done with a named range (e.g. names a column) and one index or a name that refers to a specific cell.
8. There is a significant cost for each instance of moving data from VBA to Excel. This cost is minimized by moving blocks of data (vertical, horizontal, or two-dimensional) whenever possible.
9. Do not use workbook-scoped names on worksheets that can have more than one instance. They will work properly when scoped by the code, but if you forget the scoping, you will be referencing the wrong sheet.
10. There is a substantial cost of moving data from Excel to VBA. This is most efficiently accomplished via arrays and via the value2 method.
11. Turning on and off automatic calculations can help in some circumstances, but generally batched updates via arrays is a better approach when possible. This has an impact on spreadsheet organization since we now need this data to be adjacent.
12. Excel has an apparent bug related to the use of the INDIRECT formula operation. Populating a large number of INDIRECT uses into a spreadsheet will impact the performance of all spreadsheet changes – even those that do not touch the worksheet containing the INDIRECT. For example the 3 columns in the Scenario

worksheet that provide an analysis of “how much better is the Optimized Roth Conversion” use this. That slowed down Model worksheet set-spend calculations by a factor of almost 3. The workaround is to clear these cells before executing the set-spend operations and re-load the formulas when done.

13. It is a little tricky to create new worksheets in a transparent manner from the code because Excel wants to make the new worksheet the active worksheet. It turns out that this small dance is needed:
 - a. Dim Active As Worksheet
 - b. Set Active = Application.ActiveSheet
 - c. “Create the new worksheet”
 - d. Application.ScreenUpdating = True
 - e. Active.Activate
 - f. Application.ScreenUpdating = False
14. Performance can be substantially impacted by having multiple workbooks open. This performance impact is seen even if there are no obvious explicit links between them. But if there are links the performance is much worse

Test Case	Set-Spend Time
Baseline (one workbook open)	.24 Seconds
Second WB opened with links back	2.02 Seconds
Second WB opened with no links back	.43 Seconds

Explicit links between worksheets happen when a worksheet contains a reference to another worksheet via a “worksheet!” reference and that worksheet is then copied to a second workbook.

15. Workbooks can become “bloated” and slow. The author’s development practice is to periodically save versions of the workbook with a new name. This is an archaic but safe and reasonably effective backup mechanism. During the course of development, we got to about .24 seconds/Set-Spend request (as measured for a consistent simple scenario). Later, performance was seen to have reduced to about 1 second/Set-Spend. Yikes! A third workbook was created by copying the earlier one and then updating the various components (worksheets, forms, modules) to match the newest one. This resulted in:

Workbook	Size	Set Spend Time	Comment
RetirementFunding.xls	7,979 KB	.91 Seconds	Latest work-in-progress
RetirementFundingC.xls	3,246 KB	.24 Seconds	Recreated Workbook

There may be some mechanism for fixing the bloated and slow file, but the author hasn't found anything that works reliably. The most robust approach is to recreate the work in a new workbook.

16. The combination of the previous two observations argues for avoiding direct references between sheets since we want to be able to easily copy worksheets from one workbook to another. This is the reason why we have lots of "control" tables on the Model worksheet. It would look neater to have these all off on one or more auxiliary sheets, but that just doesn't work very well in practice.

12.14 Testing

Two tools are provided on the Tools worksheet for regression testing of the financial calculations on the Model worksheet:

1. Compare Scenario Worksheets. This tool does a comprehensive comparison of all of the results columns.
2. Compare Model Worksheets. This tool compares the values of key results columns. For example, the total tax each year. Additional columns can easily be added.

The workflow is as follows:

1. Before making any changes it is a good idea to have a backup copy of the entire workbook.
2. Execute all of your scenarios
3. Make copies of both the scenarios and the Model worksheet. For example to "Modelbaseline" and "scenariosbaseline"
4. Make your changes to Model worksheet and/or code. If you are adding functionality, aim to have parameterization that retains current behavior
5. Re-run your scenarios
6. Compare the updated scenarios. If there are Errors (differences) then repeat:
 - 6.1. Execute the failed scenario in both the new Model and the baseline Model
 - 6.2. Compare the Model worksheets
 - 6.3. Address issues. It is possible that you may discover a flaw in the baseline Model. If so address the issue there.
 - 6.4. Rerun scenarios for one or both Model worksheets depending on where you made changes. To rerun the baseline, temporarily rename the scenarios worksheets.

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