

# Optimizing A Retirement Portfolio Using Annuities

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Lauren Minches, FSA  
VP, Product & Actuarial  
Blueprint Income  
[lauren.minches@blueprintincome.com](mailto:lauren.minches@blueprintincome.com)

## Abstract

A pre-retiree heads into retirement with many goals, some at odds with others. Often these goals include: maintaining a high standard of living, not running out of money, leaving a legacy after death, etc. But, a retiree's number one goal must be to not run out of money. In reality, having the right financial situation such that one can continue living without work and not run out of money is the definition of retirement.

This is becoming increasingly difficult in today's retirement landscape where the decline in pensions has transferred market and longevity risks onto the individual, leaving them far more susceptible to running out of money (i.e. having no personal savings or income streams other than Social Security, which is generally not enough to live off of, forcing a reduction in one's standard of living). And, because the mutual fund industry via 401(k)s and IRAs currently dominates retirement planning, most conversations around money in retirement are about accumulating wealth to then support some level of retirement spending, instead of talking directly about locking in one's ability to spend. Mutual funds and other market investments offer individuals the opportunity to take risk, not to eliminate it like pensions and annuities do.

The dominance of the mutual fund model, along with human tendency to under-insure, has left the majority of Americans unprepared for retirement and concerned about running out of money. As a Fellow of Society of Actuaries and an employee of Blueprint Income (digital annuity platform), this problem has been a focus of my professional career.

Annuities, whether purchased individually or in group format as with some pensions, along with Social Security, exist to help individuals avoid running out of money in retirement. Because of the pooling of longevity risk across participants, annuities are able to offer "mortality credits" which result in them outperforming bonds with respect to the goal of not running out of money. In this paper, and relying heavily on the good work done before me by retirement income experts, I demonstrate how adding annuities to one's retirement portfolio reduces the risk of running out of money. Moreover, I provide a new model for optimal asset allocation that goes beyond stocks and bonds to include annuities.

## Summary of Results

To minimize the risk of running out of money in retirement while maximizing the legacy one leaves behind at death, annuities play a crucial role in a retirement portfolio. The least efficient portfolios are those *with stocks and bonds but without annuities*. The most efficient portfolios are those *with stocks and annuities but without bonds*. (Efficiency captures the portfolio's ability to best accomplish the goals stated with the minimum level of risk necessary.)

This conclusion holds true before retirement as well, suggesting that retirees should be replacing their bond allocations with annuities and pre-retirees should be doing the same with at least a portion of their bond allocation (with annuities providing income starting at retirement).

Although not yet proven via modeling, initial analysis suggests that the most reasonable execution plan is to trade half of one's bonds in for annuities 10+ years from retirement and then increase the allocation year-by-year such that at retirement all bonds have been replaced.

## The Goal of Retirement Income Planning

When planning for retirement, pre-retirees should be thinking in terms of income instead of assets. The fundamental question is how much income one needs each year in retirement to maintain his/her standard of living. Thinking in terms of assets doesn't work because:

1. Assets are only valuable in that they can be converted into or generate income in retirement,
2. Assets don't reveal how much can be spent each year, and
3. Assets can run out while guaranteed lifetime income cannot.

Thinking in terms of assets also requires stipulating a time horizon, which is unknown. The amount of assets needed to support a 10 year retirement is markedly different than what's needed to support a 30 year retirement.

Thinking in terms of assets also grossly under-values income streams like pensions, annuities, and Social Security which might not have a market value in one's personal balance sheet but are providing significant value in retirement.

Annuities and strong retirement "decumulation" (the way in which one spends down retirement savings) plans are all about turning assets into sustainable sources of income. This paper aims to help pre-retirees optimize their use of

assets such that they are most efficiently converted into sustainable income with the maximum amount of assets left over at death.

While there are many ways to generate income, such as through real estate or business ventures, this paper limits itself to stocks, bonds, and annuities as investment options. As will be demonstrated, the addition of the annuity to a traditionally invested portfolio is what will make a significant, positive difference toward reducing the chance of running out of money.

### **The Structure of an Annuity**

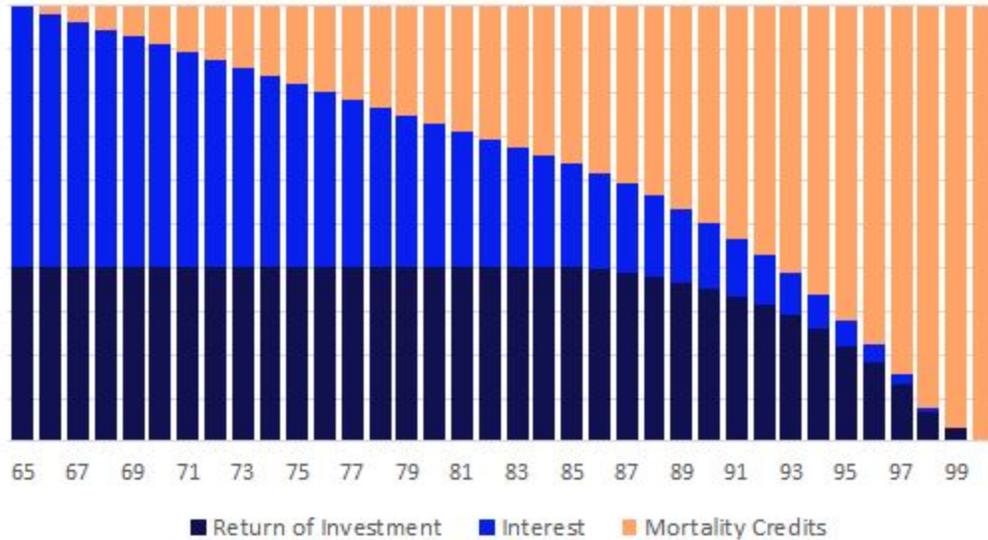
To understand why annuities are different and more valuable than traditional market investments, let's dissect them. An annuity is a contract with an insurance company. In exchange for money upfront, the insurer guarantees (subject to their claims-paying ability) steady income in retirement that continues for life. Annuities can be purchased at any age between 20 and 90 with income starting between 0 and 40 years from purchase. Those at or in retirement will often purchase annuities with income starting immediately, whereas those years from retirement will purchase annuities with a deferral of income until retirement. Note that for this paper, "annuity" refers specifically to an income annuity, the purest income guarantee an insurer offers. Other more complex annuity contracts which provide for accumulation of assets as well but have typically higher fees, are not in scope for this analysis.

The insurance company is able to offer a guarantee of income for life by pooling longevity risk across the population it insures. They price the annuities (determine how much income they can provide for each combination of age, gender, deferral period, and premium deposit) based on average life expectancies. For any given contract, they will most certainly price it wrong, in that they can't predict how long any specific person will live. But, the law of large numbers simply requires that they get it right on average across a large population. As long as a balanced number of annuitants die before vs. after they expect, they will have done their job well. The income that the early-dying group didn't need goes to the late-dying group, and the insurance company makes money for offering this pooling service and backing the guarantee. (They are also investing their annuitants' money and managing market risk behind the scenes to make this happen.)

We can break down the annuity income payments into three pieces: a return of money invested, interest earned on the money invested, and "mortality credits"

for those who outlive their life expectancy from those who don't. This is illustrated in Figure 1.

**Figure 1: Breakdown of Annuity Income Payments**

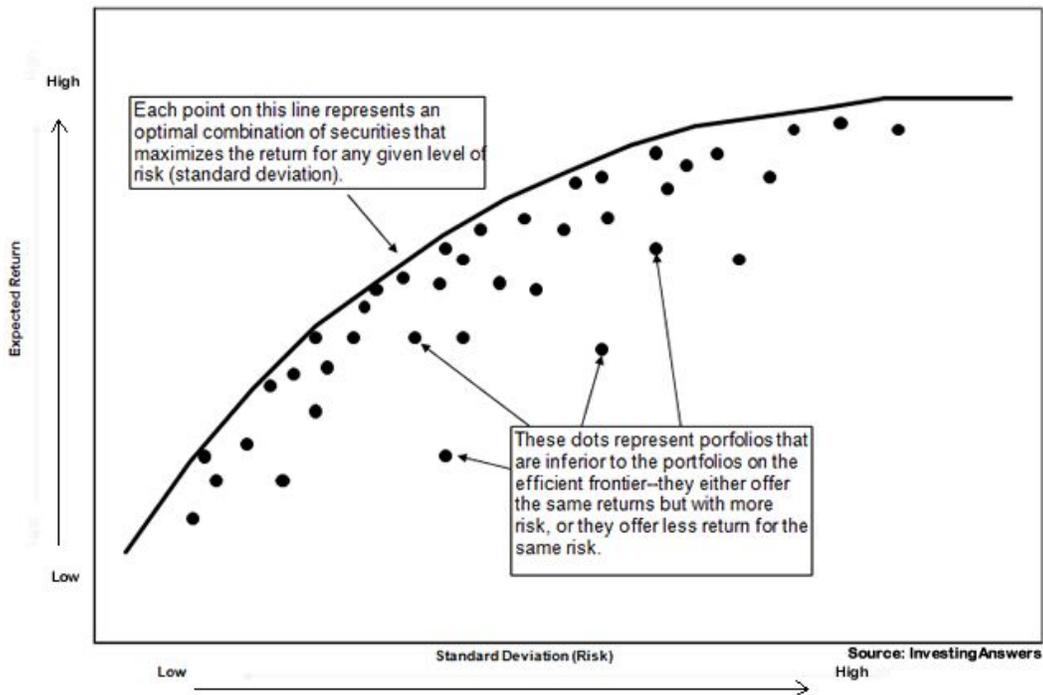


The two blue bars — return of money invested and interest earned - mimic what it looks like to draw down a standard market portfolio over time. Eventually it runs out. The peach bar - mortality credits - are the extra funds made available by pooling of longevity risk with annuities. These credits start paying off financially after life expectancy.

### The Efficient Frontier

Modern portfolio theory tells us that for every level of risk, there is an optimal portfolio that maximizes expected return. In Figure 2 below, this efficient frontier is shown. Since expected return increases as you move up the chart, and risk (volatility of that return) decreases as you move left on the chart, the most optimal portfolios are those closest to the top-left. For every level of risk you're comfortable with going right to left, you should logically choose the top-most portfolio which maximizes expected return. If you connect all of the top-most points at every risk level, you create an efficient frontier.

**Figure 2: Efficient Frontier of Risk vs. Returns for a Market Portfolio**



This theory is the foundation of best practice portfolio allocation methods today. A common rule of thumb is that one's allocation to stocks should be 120 minus your age, and the rest should be in bonds. I.e. a 40 year old would have 80% allocated to stocks and 20% allocated to bonds. As retirement nears, one's appetite for taking risk shortens along with the time horizon until the money is needed.

### **The Retirement Income Efficient Frontier**

The standard efficient frontier theory works well when the focus is simply accumulating wealth, as it is pre-retirement. But once in retirement and starting to spend money, the goal shifts from optimizing accumulation to optimizing "decumulation." That is, finding the best way to invest money such that it can be spent without running out and ideally with some leftover for a legacy.

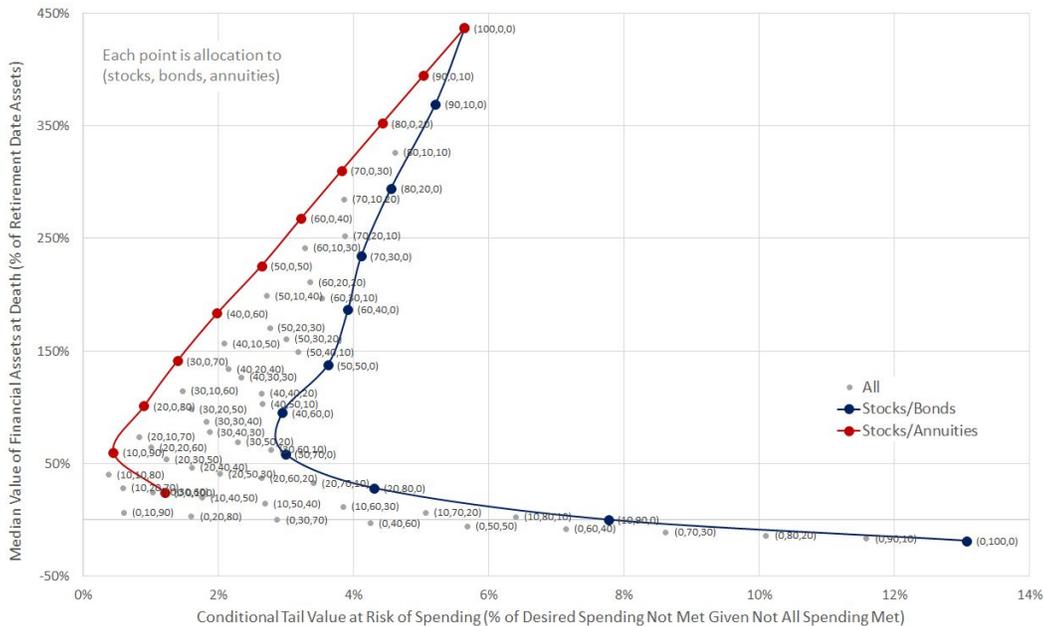
To model the most efficient portfolio to accomplish this goal, we need to change the definition of risk. Now, instead of risk simply being portfolio volatility, it should measure the potential for running out of money in retirement and the

severity of the extent of runout (i.e. if you run out, by how much are you short). And now, return will be measured by the median value of the legacy you'll leave behind.

Figure 3 below shows the efficient retirement income frontier for a 65-year-old couple (assumptions outlined below). Each point represents the results of 100 simulations for 1 of 66 portfolios made up of stocks, bonds, and annuities. For simplification, only static portfolio allocations were considered for this analysis, i.e. the mix of stocks, bonds, and annuities stays constant over time.

As you move left on the chart, you decrease the extent to which you might run out of money. As you move up the chart, you increase the median value of assets left to your heirs. Like before, the most efficient portfolios are those closest to the top-left which maximize median legacy for every expected spending shortfall.

**Figure 3: Efficient Frontier of Retirement Spending vs. Legacy**



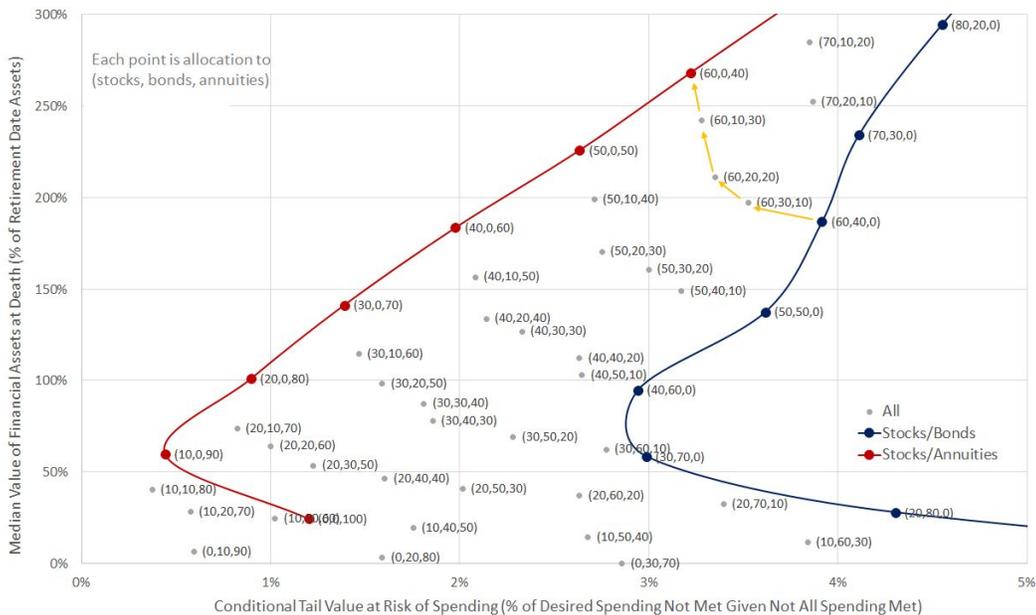
The blue line connects standard market portfolios consisting only of stocks and bonds. The red line connects portfolios that consist of only stocks and income annuities. All other dots are portfolios with a mix of stocks, bonds, and annuities.

We can draw the conclusion that portfolios without annuities are inefficient when it comes to retirement as they don't maximize the potential legacy for every level of risk of running out of money.

Even stronger, and consistent with the conclusion drawn by Wade Pfau in "Why Bond Funds Don't Belong in Retirement Portfolios" (2015), we can say that the most efficient portfolios don't include bonds at all, using annuities as a more efficient way of generating income in retirement. The value of replacing bonds with annuities comes from the mortality credits offered by annuities, as well as the increased safe withdrawal rate in early years afforded by the income guarantee in later years.

In Figure 4, we can see more clearly how replacing bonds with annuities improves both median assets at death and ability to meet spending for life. We start with the inefficient portfolio that's 60% stocks, 40% bonds marked as (60,40,0) on the blue line. If we swap 10% of the portfolio allocation in bonds to annuities, we move to point (60,30,10) with lower severity of running out of money and higher median assets at death. This movement continues for points (60,20,20) and (60,10,30) until eventually we hit the efficient red line with point (60,0,40).

**Figure 4: Replacing Bonds With Annuities**



The portfolio of 60% stocks and 40% bonds produces an expected loss, if a loss occurs, of 4% of desired spending and a median legacy of assets at death 1.87x what they were at the beginning of retirement. Swapping bonds for annuities reduces the expected loss to 3% and increases the median legacy to 2.68x. Both the severity of loss and the median assets remaining at death have improved by replacing bonds with annuities.

This retirement income frontier was crafted with the following assumptions:

- 65-year-old male/female couple retiring now
- \$1,000,000 in assets saved
- Spending \$60,000 per year in today's dollars
- Receiving a Social Security benefit of \$20,000 per year in today's dollars, starting at age 70
- Inflation of 2% per year
- Borrowing cost of 4.50% per year if the couple runs out of money
- 100 Monte Carlo simulations of normally-distributed stock and bond returns with parameters:
  - Stock market modeled using a 60/40 blend of Vanguard Total Stock Market (VTSMX) & International Stock Market (VGTSX) funds with average returns calculated over the past 1, 10, and 30 years (or since inception), volatility and expense ratio of:
    - Average return in year 1 = 19.6%, then grading to
    - Average return in year 10 = 7.8%, then grading to
    - Average return in years 30+ = 9.0%
    - Volatility = 18.0%
    - Expense ratio = 0.15%
  - Bond market modeled using a 60/40 blend of Vanguard Total Bond Market (VBTIX) & International Bond Market (VTIBX) funds with average returns calculated over the past 1, 10, and 30 years (or since inception), volatility and expense ratio of:
    - Average return in year 1 = 1.0%, then grading to
    - Average return in year 10 = 3.2%, then grading to
    - Average return in years 30+ = 5.2% (VBTIX only)
    - Volatility = 4.1% (VBTIX only)
    - Expense ratio = 0.08%
- Assets under management fee of 0.25%
- Immediate income annuity rate of 5.81% for a life-only joint annuity for a 65-year-old male/female couple with 100% continuation (best rate for an A-rated or higher insurer on the Blueprint Income platform in May 2018)

- This rate reflects the annual income available to the customer as a percentage of the amount deposited, net of all expenses, fees, and commissions
- Life expectancies modeled using the Social Security 2014 Period Life Table

For simplicity, taxes were excluded from this study.

### **The Retirement Income Efficient Frontier Pre-Retirement**

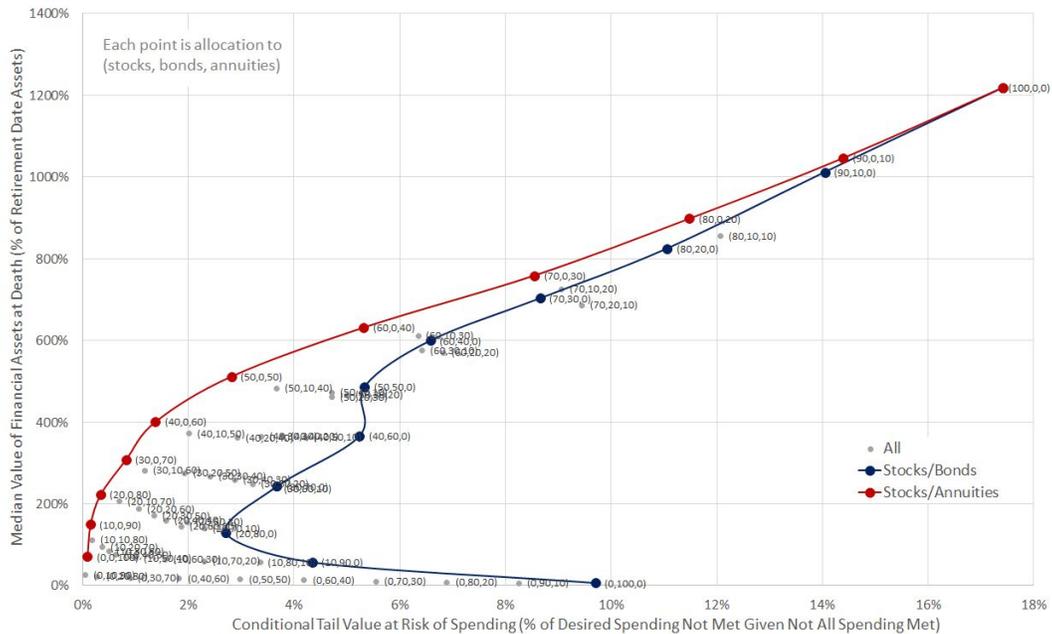
For the 65-year-old couple above starting their retirement, it makes sense to replace their bond allocation with annuities. But what should their portfolio look like pre-retirement? More specifically, if we know that by age 65 they should have replaced their bonds with annuities, should they wait until right before retirement to buy an annuity, or should they start the buying process over time?

Before even looking at any numbers, the latter option feels intuitively right. Just like stocks and bonds, annuity rates change over time. If you do all your purchasing on one day, you're subject to the risk that rates on that particular day aren't good. The same way we're advised to "dollar-cost-average" the stock market, annuity purchasing follows the same logic. By buying slowly over time, you are able to do the following:

1. Lock in the value of longer deferrals earlier on (the longer the timeline between purchase and income start, the more income you'll get),
2. Continue to benefit from any potential market upside if your portfolio is invested with an expected return higher than that of an annuity, and
3. Potentially benefit from future increases in annuity rates for later purchases.

To answer the question more academically, we ran the same Monte Carlo analysis that produced the 65-year-olds' retirement income efficient frontier for a 50-year-old couple retiring at 65. Shown in Figure 5 below, the exact same conclusions hold — portfolios without income annuities are the most inefficient; portfolios with income annuities are the most efficient. Because this couple has a longer future time-horizon, there is a wider range of outcomes than for the 65-year-olds.

**Figure 5: Efficient Frontier of Retirement Income for 50-year-olds**



The above analysis maintained the same portfolio allocation in all years from age 50 on, but in reality individuals tend to shift their allocations away from stocks and towards fixed income as time passes and they lose the ability to recover from losses. In that case, it would be recommended that the decrease from stocks towards fixed income should result in buying additional annuities instead of bonds. Proving this to be the case will be the subject of a future study.

It's worthwhile noticing that, according to the 120 minus your age rule, the 50-year-old couple should be 70% in stocks and 30% in fixed income. In our analysis, that allocation puts them at a potential shortfall loss of 8-9% of their desired spending, which is likely unknown and also uncomfortable for some. Our goal is to help improve individuals' understanding of the risks they're exposed to.

The assumptions for the 50-year-olds were the same, with the following modifications:

- 50-year-old male/female couple retiring at age 65
- \$700,000 in assets saved
- Annuity rates of 9.91%, 9.41%, 9.03%, 8.71%, 8.41%, 8.23%, 7.83%, 7.46%, 7.14%, 6.88%, 6.63%, 6.31%, 6.08%, 5.86%, 5.95%, and 5.81% for life-only joint annuities with 100% continuation starting at age 65

purchased at ages 50, 51, 52, ... ,65 (best rates for an A-rated or higher insurer on the Blueprint Income platform in May 2018)

- These rates reflect the annual income available to the customer as a percentage of the amount deposited, net of all expenses, fees, and commissions
- Annuities were purchased upfront and over time to achieve and maintain target allocation

## **Drawing a Conclusion About Annuities in Retirement Portfolios**

This study set out to identify the ideal portfolio allocation for a retiree who wants to avoid running out of money, balanced with the desire to leave a legacy. Building off of the modern portfolio theory efficient frontier and following the path of retirement income thinkers that came before us, we constructed retirement income efficient frontiers for 50-year-old and 65-year-old couples retiring at 65. We did so using 100 Monte Carlo simulations of stock and bond returns rooted in historical performance and 66 portfolio combinations of stocks, bonds, and income annuities. For each portfolio combination, we compared the expected shortfall in retirement spending if the couple runs out of money to the median assets left behind at death, both calculations weighted by the probabilities of death in any given year.

The results showed that the most efficient portfolios were made up of stocks and income annuities with no bonds, and the least-efficient portfolios were made up of stocks and bonds with no annuities.

The conclusion to be drawn for any individual or couple shifting their financial planning focus towards retirement is that they should replace bonds in their portfolios with annuities. Practically, this can be implemented at any time prior to retirement. We believe both that:

1. It doesn't make sense to wait until retirement to do all annuity buying because the buyer is overly sensitive to the annuity rates on that day, and
2. It doesn't make sense to buy too much ahead of time as money transferred into an income annuity cannot be refunded or surrendered.

## **Study Limitations & Areas for Future Analysis**

While thorough, this study does not reflect all risks and factors facing retirees. The following present opportunities for future analysis:

### **Asset vs. Spending Levels**

The analyses we undertook assumed reasonable, recommended levels of asset levels relative to the amount someone wants to spend. It is likely that different asset and spending levels — i.e. those with so much assets that running out is nearly impossible or those with so little assets that running out is inevitable — would produce different results. A future study could aim to place limits on annuity buying by determining the scenarios in which annuity buying makes less of an impact on the potential to run out of money in retirement.

### **Taxes**

This analysis was completed on a pre-tax basis, when in reality taxes may be owed on portfolio withdrawals and income earned based on the qualified status of those funds. This adds an additional level of complexity for one's retirement income planning, as it can be advantageous to plan on using money from one portfolio or source before another.

### **Correlated Investment Returns**

The stock and bond returns were modeled independently for this study, when in fact they have been shown to be correlated in history. The correlation can, at times, increase risk by lowering diversification benefits. However, determining the appropriate correlation is challenging, as it depends on economic conditions and, at varying points in history, been both positively and negatively correlated. This could be improved in a future study.

### **Correlation of Annuity and Market Rates**

In the 50-year-olds' analysis, annuities were being purchased over time. However, the annuity rates used were based on today's levels. In reality, and particularly as bond rates move, annuity rates move as well. We are working to build a correlation matrix between annuities of different purchase and income start ages to refine the relationship in a future study.

### **Optimal Annuity Buying Over Time**

This study made use of only fixed investment portfolio allocations. i.e. the 66 different portfolio allocations modeled used allocations that were fixed for the rest of time. In reality, especially for those years away from retirement, portfolio allocations are likely to change over time, typically becoming safer as retirement nears. To draw stronger a conclusion on how pre-retirees should buy annuities, a future study that allows for portfolio allocations to change over time and also correlates the annuity rates with bond rates will be necessary.

## Creating a Rule of Thumb for Annuities in Retirement Portfolios

In this study, we were able to prove that annuities should replace bonds in a retirement portfolio. Technically, we demonstrated this for both the 50-year-old and 65-year-old couples. While we're comfortable saying that a retiree (represented by the 65-year-old couple) should replace all of their bond allocation with annuities, we don't believe that conclusion makes sense for a younger, pre-retiree. The study was limited in its ability to identify an appropriate annuity buying pattern for those years away from retirement because only static portfolio allocations were considered and annuity rates' correlation with bonds was ignored.

However, based off of our modeling conclusions, paired with our understanding of our own pre-retiree customers' needs, we have developed an actionable annuity-buying rule of thumb, the proof of which will be the subject of a future study.

As a rule of thumb for those considering buying annuities for retirement, we recommend:

1. By retirement, all bonds should be replaced by income annuities.
2. Starting 10+ years before retirement, half of bonds should be replaced by income annuities.
3. The proportion of annuities as a percent of total fixed income in the portfolio should be increased each year until retirement as shown in Figure 6:

**Figure 6: Recommended Percentage of Fixed Income Allocation in Annuities**

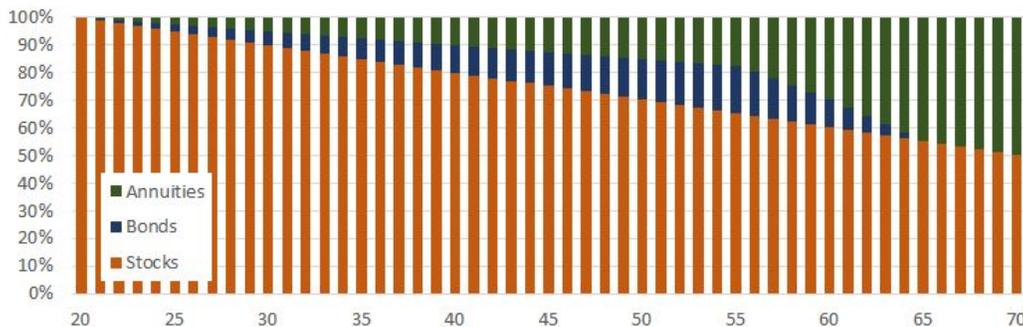
Years Left Until Retirement	% Fixed Income in Annuities	Years Left Until Retirement	% Fixed Income in Annuities
> 10	50%	5	75%
10	50%	4	80%
9	55%	3	85%
8	60%	2	90%
7	65%	1	95%
6	70%	0	100%

Assuming you follow the 120 - your age rule of thumb for your total portfolio and plan to retire at age 65, your allocations to stocks, bonds, and annuities would be as follows, shown in Figures 7 & 8:

**Figure 7: 120 - Your Age Portfolio Allocations Including Annuities**

Age	% in Stocks	% in Bonds	% in Annuities
20	100%	0%	0%
30	90%	5%	5%
40	80%	10%	10%
50	70%	15%	15%
60	60%	10%	30%
70	50%	0	50%

**Figure 8: 120 - Your Age Portfolio Allocations Including Annuities**



By having pre-retirees maintain some bond allocation while buying annuities slowly, this rule of thumb balances the following real considerations:

- Once spending has begun, annuities outperform bonds.
- Buying annuities all at once is not ideal as one is overly sensitive to annuity rates that day.
- Income annuities are irrevocable and illiquid, so pre-retirees want to avoid over-allocation.

The rule-of-thumb buying pattern shown above offers a reasonable approach to annuity buying with the goals of minimizing the risk of running out of money and maximizing legacy upon death.

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