

# Making Lifetime Investment Planning a Reality

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# Introduction

- While almost all wealth management organizations talk about the concept of an customized investment plan for each client household, essentially none deliver on that promise.
- *A plan is a set of contemplated actions for the future.* Instead, wealth managers provide recommendations only for the *current* asset allocation of the investment portfolio with the only “plan” being to revisit the allocation in a year or two.
- In this presentation, we illustrate a process to create the “maximum likelihood” forward time series of expected asset allocations through the investor’s lifetime (now, next year, 2 years out, 5 years out, etc.) using the life balance sheet concept described in Wilcox (2003), the non-parametric preference functions from Bolster and Warrick (2008), and a process to combine these two disparate concepts from diBartolomeo (2014).

# Key Benefits to Investment Planning

- The delivery of an actual investment plan reassures investors psychologically as they can see expected life events (e.g. college expenditure) reflected in the *planned changes in asset allocation*.
- In addition, the conditional foreknowledge of “what we are likely to be doing next” allows much of portfolio rebalancing to be done through cash flows (savings inward, reinvestment of income, and spending outward) thereby reducing transaction costs and often large taxes associated with periodic rebalancing.
  - See Balvers and Mitchell (2000)
- Having an actual plan also contributes to reduced uncertainty as to which assets to liquidate within the portfolio to augment investment income for consumption spending in today’s low yield environment.

# Simple Approaches In Practice

- Available to retail investors are target date funds
  - Include the concept of an **allocation glide path**, but such funds are based solely on expected year of retirement.
  - not sensitive to wealth levels, non-retirement financial goals or the complex preferences of high net worth investors. See diBartolomeo (2006)
- Asset allocations selected on the basis of Monte Carlo simulations
  - Can include the concept of one or more goals for consumption spending
  - Can include investment costs like fees and taxes
  - Allocation must be **selected** based on some criteria (e.g. probability of fulfilling consumption goals)
  - Implicitly assumes that allocations are rebalanced frequently back to original weights. Severely problematic in rare but important cases (e.g. the 1929 crash). See Barro (2005), Dimson, Marsh, Staunton (2014)

# A More Sophisticated Approach

- Some firms try to solve the lifetime investment problem as a multi-period optimization problem via stochastic dynamic programming
  - Future returns and risks are time varying but with formulaic expectations. For example, if bond yields go up, bond prices fall but return expectations increase.
  - Can accommodate multiple goals and costs (fees, taxes)
  - May be computationally expensive
  - Limiting factor is estimation error of time varying return forecasts. Most investors have a hard enough time with forecasting average asset class returns, without worrying about **predicting period to period changes in expected returns.**

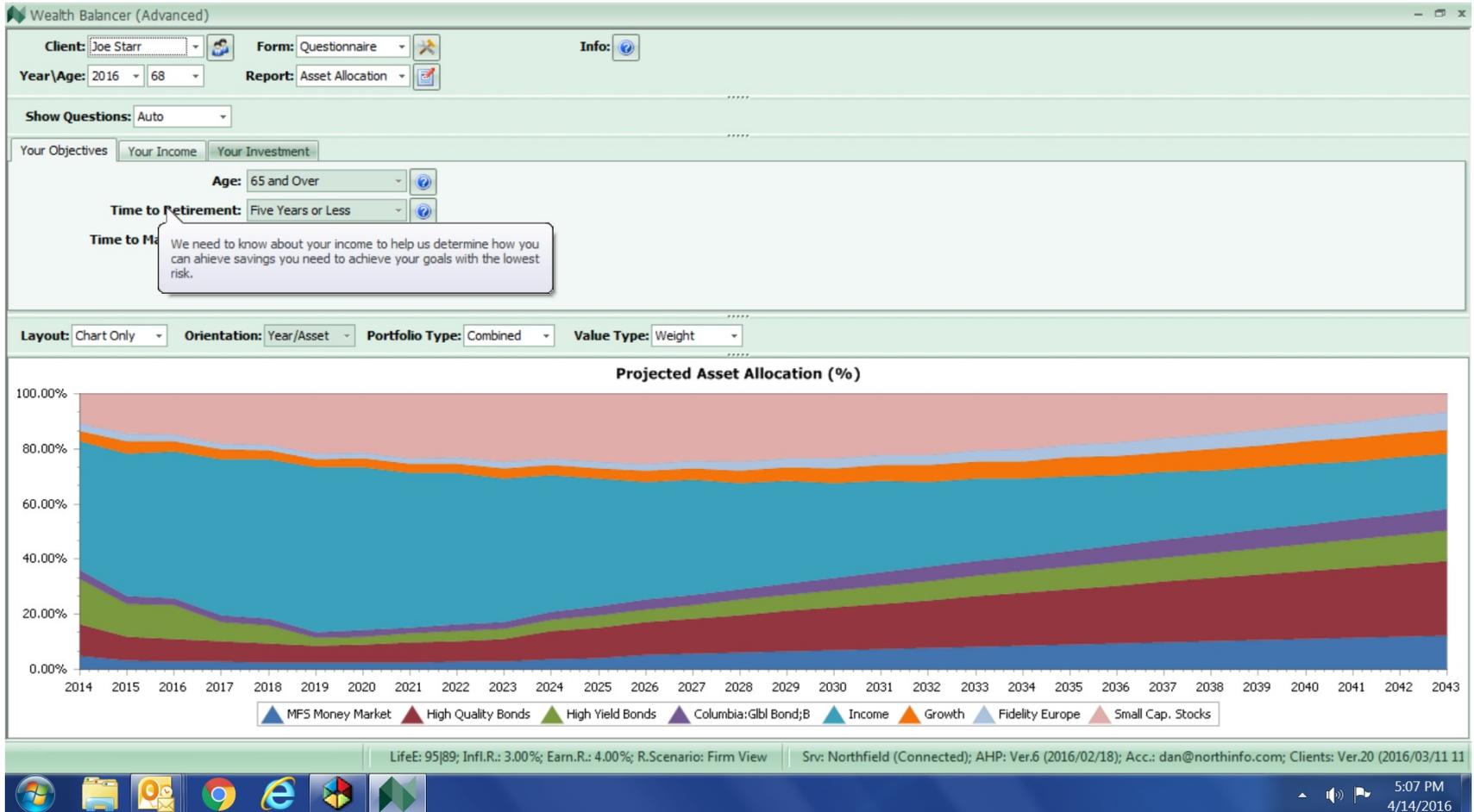
# A Quick Literature Review

- There is a large economics literature on intertemporal investment problems
  - Mossin (1968), Merton, (1971), Ingersoll (1987), Balvers and Mitchell (1997, 2000)
  - Markowitz and Blay (2016) show that allocations are time varying in taxable portfolios
- For our approach, the key papers are:
  - Kelly (1956)
  - Wilcox (2003), Ziemba and Zenios (2006)
  - diBartolomeo, Horvitz & Wilcox (2006, CFA Research Foundation)
  - Saaty (1980), Bolster and Warrick (2008)
  - diBartolomeo (2014)

# Disclosure: My Marketing Slide

- All remaining concepts in the presentation are incorporated into our new *WealthBalancer* suite.
  - Provides for unlimited number of consumption goals of differing priority levels
  - Taxable, tax deferred and tax exempt accounts can be combined into a single analysis, providing both **asset allocation and asset location, based on three dimensional “efficient surface”**.
  - Provides for non-parametric assessment of **any investor preferences outside return and risk** (e.g. ESG concerns) to tilt portfolio allocations to asset classes or financial products
  - At each moment in time, provides the predicted changes in asset allocation through the investor life cycle, **based on expected changes in the investor’s financial situation**, not on expected changes in expected returns.

# A Picture is Worth a 1000 Words



# Identifying Risk Aversion

- One of the most vexing problems for wealth investors and their advisors is to answer the question “How aggressive should my portfolio be and how should that change over time?” The traditional mean-variance utility function from Markowitz and Levy (1979) is stated as:

$$U = \alpha - \lambda \sigma^2$$

U is the investor's utility (satisfaction) from the portfolio

$\alpha$  is the mean return

$\lambda$  is the investor's risk aversion

$\sigma$  is the standard deviation of return

The  $\lambda$  value represents the slope of a line drawn tangent to the efficient frontier so as to intersect at the chosen portfolio.

# Discretionary Wealth Hypothesis

- One approach to optimal  $\lambda$  is the “DWH” developed in Wilcox (2003).
  - Stated simply, the DWH says “investors should set their risk aversion so as to maximize the expectation of their geometric mean return on the portion of their wealth that they can afford to lose (but no more)”. It is an investment application of “fractional Kelly” betting.
  - The implication of this assertion is that investors should operate as to put a “floor” value on their wealth, and that the value of the floor is approximately equal to their financial liabilities.
  - The financial condition of a household is expressed in a “life balance sheet” wherein the asset side of the balance sheet contains all available financial resources of the household including the present value of expected future savings, and the liability side of the balance sheet contains all liabilities inclusive of the present value of expected future consumption expenditure Like any balance sheet, the surplus of assets over liabilities in the net worth of the household.

# Why Do We Need Explicit Risk Aversion?

- A key decision that an investor must make about asset allocation is how to change the allocation when market conditions change
  - If we have an explicit value for  $\lambda$ , we have a clear path of action. If we believe that expected returns had changed for certain asset classes (e.g. Asian equities, or European sovereign bonds) this would have the effect of changing the shape of the Markowitz efficient frontier.
  - However, there would be no reason that such a change in our return expectations would change the investor's risk aversion. We would then apply the same tangency slope to the revised efficient frontier to find our new mean-variance portfolio (hopefully using the AHP portfolio as a prior).
  - A change in risk aversion would be appropriate if the financial circumstances of a household might change due to particular events such as changes in age, marriage, divorce or inheritance.
  - By helping to explicitly identify appropriate levels of investor risk aversion, the process of revising the asset allocation is neatly divided *into situations that involve changes in the state of the world (i.e. capital market expectations) and changes in the circumstances of the investor.*

# Getting to Risk Aversion

- Wilcox shows that under very reasonable assumptions, the optimal value of the risk aversion parameter  $\lambda$  is linearly is given by:

$$\lambda^* = T / (2 * (T-L))$$

$\lambda^*$  = optimal value of risk aversion

T = the total assets on the life balance sheet

L = the total liabilities on the life balance sheet

If we have a sufficient knowledge of the household circumstances, we not only know the best value for  $\lambda$ , *but also how this value should change over time as the financial condition of the household changes*, both of changes in the market value of assets and family events such as college expenses, inheritance or divorce.

# The Rich are “Different”

- While the DWH is a powerful conceptual tool for the management of asset allocation, there is often an impediment to use of this technique for very wealthy households.
  - For such families, the value of explicit liabilities will approach zero, and the value of the ratio of assets to net worth will approach one. Under such a circumstance, the DWH would suggest that the very wealthy should invest quite aggressively, since they can afford to absorb large losses without meaningful reduction in their ability to support their lifestyle.
  - In practice, most very wealthy investors prefer to hold relatively conservative portfolios, and the “preservation of capital” is the key phrase in the vocabulary of their advisors.
  - This behavior can be reconciled to the DWH in a simple fashion. Very wealthy investors know that their wealth will last beyond their lifetime, and they make asset allocation choices in a fashion consistent with *an implicit liability to provide financially for future generations* of the family or favored charitable causes.

# Customizing for Arbitrary Preferences

- The Analytic Hierarchy Process is a non-parametric technique that is well suited for making complex decisions of household asset allocation robustly. There are many considerations that are difficult to reduce to the familiar two-parameter Markowitz problem.
  - For example, a family planning to live abroad after retirement would have a different preference for holding investments outside their home currency.
- There may be many other issues of a non-economic nature arising from the attitudes and experiences of the investor, as well as questions of legal aspects of suitability, liquidity, taxation and inter-generational transfers.
- The AHP is also useful as an adjunct to traditional mean-variance methods. It can effectively address the popular criticism of mean-variance methods with respect to a severe lack of robustness of optimal solutions due to estimation error.

# The Analytic Hierarchy Process

- The Analytic Hierarchy Process is one of the most widely used mathematical applications in decision theory.
  - Originally developed by Thomas Saaty in the 1970s, the AHP has been used for an almost innumerable set of applications from ranking the importance of historic buildings for the purpose of budgeting funds for restoration to determining where industrial firms should locate off-shore manufacturing plants for optimal long-term profitability.
  - Under certain assumptions it is mathematically demonstrable that the AHP produces optimal decision outcomes for a wide variety of problems, particularly those involving multiple, potential conflicting criteria or contributing opinions.
  - An extensive discussion of the numerical aspects of the AHP can be found in Saaty (1980).

# AHP Basics

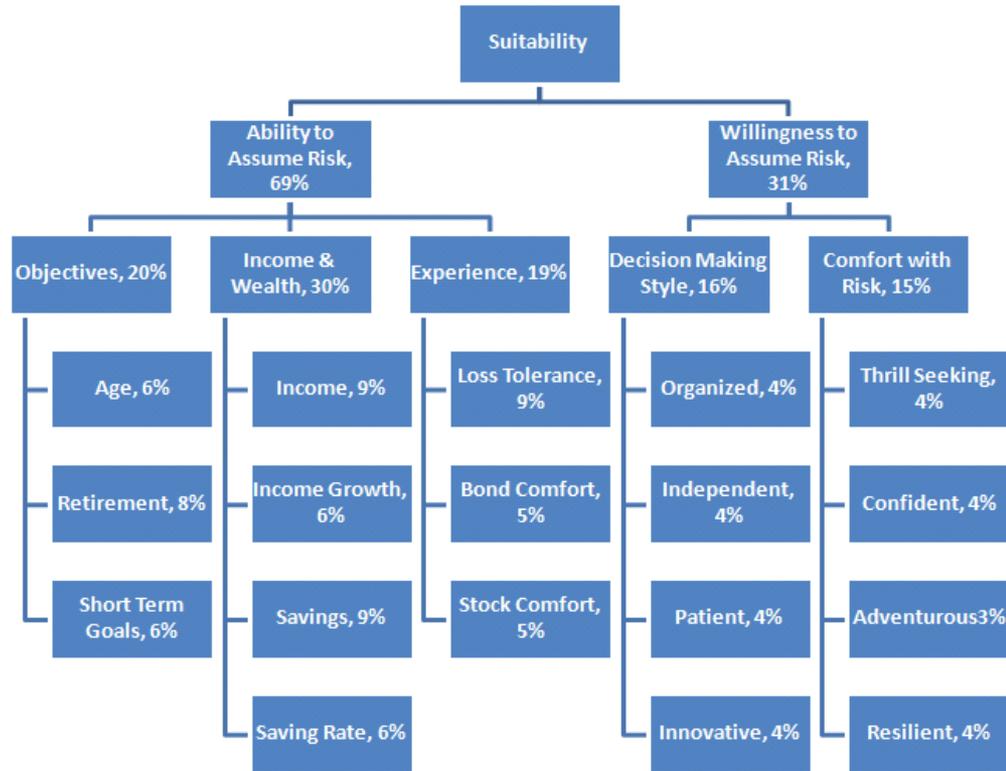
- The basic idea of AHP is to formulate multiple decision criteria in the form of questions, with each question having multiple discrete answers. **Questions may be time related** (e.g. age, time to retirement, etc.) For each possible response, every solution choice (an asset class) is subjectively evaluated in a pair-wise comparison.
  - For example, we might say that in the absence of other information, an individual between 25 and 35 years old is 3 times better off investing in equities than holding cash.
  - Similarly, we might believe that in the absence of other information that bonds are four times as good an investment as small cap stocks for an individual living on a modest retirement income.
  - By rating all possible pair-wise comparisons possible given the set of questions, answers and solution choices we form a set of numerical matrices that describes all of the relevant information and preferences
  - A final pairwise matrix gives the relative importance of the questions. The optimal allocation is a function of the eigenvectors of these matrices

# Asset Allocation and Suitability

- Given the complex objectives of real world investors, AHP would seem to be a natural complement to Markowitz (1952).
  - AHP first proposed as an alternative asset allocation method for investors in Khasari, Kamath and Grieves (1989).
  - The ability of AHP to address investor objectives other than simple return and risk was explored in Bolster, Janjigian and Trahan (1995). This paper first addressed the issue of how to incorporate the legal concept of “suitability” into the portfolio allocation process.
  - Investment services are subject to substantial “suitability” regulation in most countries. The conceptual basis of most of these regulations arises from the “prudent man rule” (Justice Samuel Putnam in 1830)
  - Some countries including the USA (e.g. Dodd-Frank Act 2010) have tightened the regulatory framework for financial institutions dealing with individual investors to create a higher degree of fiduciary responsibility.
  - Saraoglu and Detzler (2002) uses AHP to match retail investor preferences for portfolio management experience and fee levels to mutual funds.

# An AHP Illustration

Figure 1



Reproduced from Bolster, P. and S. Warrick, "Matching Investors with Suitable, Optimal and Investable Portfolios", *Journal of Wealth Management*, 2008.

# Bolster and Warrick (2008)

- The most important paper in the AHP finance literature is that of Bolster and Warrick (2008).
  - In this paper which is focused on private wealth investors, AHP and traditional mean-variance are first compared to illustrate the fact that “suitable” portfolios formed using AHP methods are often “close enough” to mean-variance efficient under the criteria established in Jobson (1991).
  - This work then uses process of Black and Litterman (1992) to conform the set of AHP portfolios and the set of portfolios on the adjusted mean-variance efficient frontier until the differences are no longer statistically significant under Jobson test.
  - The paper also combines AHP and mean-variance optimization to conform the portfolios created to real world constraints encountered by retail investors. Such constraints would include minimum dollar amounts that can be invested in particular funds, or the unwillingness of an investor to hold more than a selected number asset classes to be chosen out of a larger set.

# Solving the Lack of Robustness

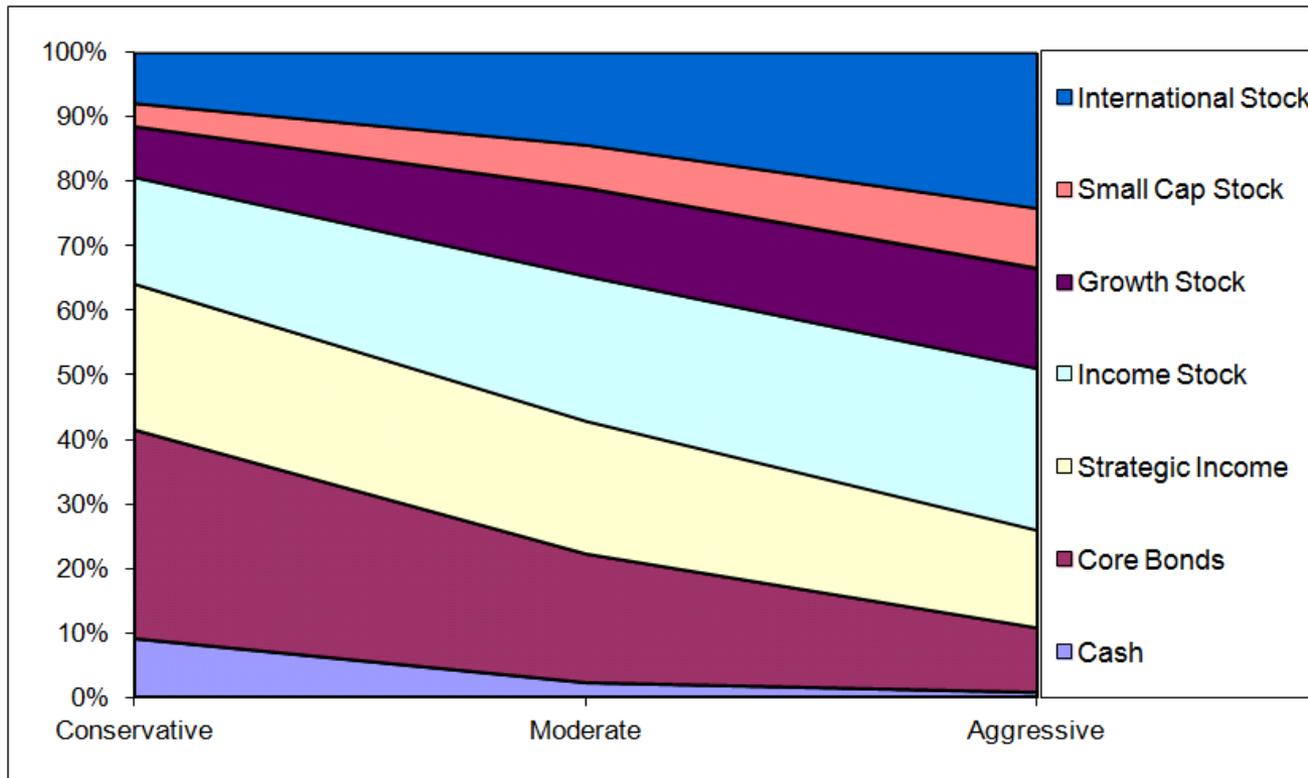
- Combining AHP methods into traditional mean-variance optimization can resolve solution instability more efficiently than other procedures
  - The goals are the same: first to ensure that asset allocation portfolios are well diversified without undue concentration in any one asset class, second to promote smooth transitions in asset weights as we increase the risk tolerance of the investor, and third to reduce sharp changes in asset weights as the result of small changes in return and risk assumptions (i.e. adding to robustness).
- Two Alternative Approaches
  - Add additional terms to objective function, as in Goldfarb and Inyegar(2003) and Haldorsson and Tutuncu (2003).
  - The second approach is to include Monte-Carlo simulation processes into the optimization process itself. Bey, Burgess and Cook (1990). A particular variant (parametric resampling) was described and patented by Michaud (1998). Gold (1995) extends the method of Bey, et. al. to the special case of illiquid assets such as real estate.

# AHP as Bayesian Prior in Place of Black-Litterman

- Portfolios formed by the AHP method naturally have the properties of robustness, avoiding the major criticism of mean-variance portfolios.
  - AHP portfolios are also not subject to the criticisms leveled by Michaud et. al. at the Black-Litterman method. In AHP, the solution is closely related to the first principal component of the combined AHP matrix. This has the effect of filtering out competing aspects of the problem to arrive at a sensible compromise solution.
  - In addition, the AHP portfolios themselves are formed in the context of a much richer set of objectives than just risk and return. Those objectives could encompass liquidity, income needs, taxation and fee structures. As such, AHP portfolios are highly efficient as Bayesian priors for the formation of mean-variance portfolios.
  - The robust nature of the AHP frontier is illustrated in Exhibit 6 of Bolster and Warrick (2008). The portfolios have high diversification and very smooth weight transition as we move across the spectrum of investor risk tolerance. This exhibit is very similar to Exhibit 6.2 of Michaud and Michaud (2008).

# The AHP Frontier

**Exhibit 6: Suitable Model Portfolios for Aggressiveness Variations**



# Calibrating AHP to the DWH

- The problematic aspect of the MV process is we need to know  $\lambda$  before we can select our optimal portfolio.
  - The AHP method can again be used to add richness to the investor decision process. To the extent that AHP methods can identify a single specific portfolio as appropriate for a given household, we can use our normal capital market assumptions to estimate the value of the return and risk of that portfolio.
  - If we assume the AHP portfolio is “close enough” to the efficient frontier, we can then ask ourselves “If we are happy holding the portfolio derived from the AHP process, what is the value of  $\lambda$  that would have selected this point on the efficient frontier?”

# A Couple Details

- Some investment experts have argued that an important investor motivation is the “avoidance of regret”.
  - O’Brien (Northfield conferences 2009, 2015)
  - An investor may sustain losses subsequent to having had adequate funds to fulfill their goals. They would potentially regret not “de-risking” their portfolio to lock in their wealth at a sufficient level.
  - A capital preservation goal can be established in the DWH as previously described case of the very wealthy.
- DWH and AHP procedures can be adjusted to compensate for the uncertainty in household circumstances (e.g. time varying probability of divorce)
  - See Wilcox and Fabozzi (2009) and Scherer (2014)

# Gauging Goal Fulfillment

- Most allocation tools based on Monte Carlo simulation use the **probability of meeting/not meeting financial goals as the primary evaluation criteria.**
  - Makes sense only if asset returns are **always** normally distributed.
  - Both probability and magnitude of possible shortfalls must be considered
- Due to the time varying allocations in our investment plans, the calculation of probability and expected magnitudes of shortfalls is complex but does not require numerical simulations.
  - We summarize consumption outflows into a single payment, like a short position in zero coupon bond with equal duration
  - Calculate IRR over the projected investment path to the “duration date”, see Dietz (FAJ, 1966).
  - Convert to equivalent arithmetic mean and standard deviation

# Conclusion

- Private wealth investors would benefit greatly from a practical process that allows for **lifetime investment planning**, conditional on those aspects of the problem that can be forecast with high confidence (in a year I'll be a year older).
- The “life balance sheet” approach of Wilcox can be used to optimal set investor risk aversion. As the balance sheet is expected to evolve through time (based on both investment performance and cash flows), **so does the investor risk aversion and optimal allocation**.
- Investment planning improves the probability of achieving goals for consumption expenditure, reduces potential disasters due to mechanical rebalancing and can materially reduce long term investment costs for taxable investors as rebalancing can be largely accomplished from cash flows.