MSCI

Research Insight

Goal-Based Asset Allocation in WealthBench

A Framework to Help Financial Advisors Create Asset Allocation Plans Based on their Clients' Life-Time Goals

Raghu Suryanarayanan, Ludger Hentschel, Giulio Panzano, Dan Schneider

Raghu.Suryanarayanan@msci.com

Ludger.Hentschel@msci.com

Giulio.Panzano@msci.com

Dan.Schneider@msci.com

January 2014

Contents

Introduction

MSCI recently introduced a goal-based asset allocation framework in WealthBench, MSCI's analytics and investment planning tool for financial advisors. This framework allows financial advisors to design asset allocation plans based on a client's specific financial goals. Goal-based asset allocation provides the following key potential benefits to financial advisors and their clients:

1. The ability to identify an individual investor's specific financial goal -- such as retirement or education -- in detail, including the client's specified acceptable levels of shortfall risk for each goal and the desired trade-off between goals.
2. Since different investors have different goals, their asset allocation plans will differ.
3. The intuitive Asset-Liability methodology of the framework allows financial advisors to compare an investor's assets values against the funding requirements of future goals, at individual goal and overall investment plan levels.
4. The methodology can be used to design intuitive portfolios that differ from portfolios created using traditional optimization methods. For example, goal-based allocations naturally provide for less risky portfolios as the investor progresses towards high-priority goals like retirement.

This paper describes MSCI's goal-based asset allocation framework used in WealthBench and illustrates its benefits based on a detailed example. The goal-based methodology follows an asset and liability management approach to asset allocation, incorporating insights from Sharpe's (2007) lockbox separation approach. The identification and modeling of the individual investor's financial goals are central to the methodology. Goals represent the liabilities for the individual investor. The amount required to fund each goal and the contributing assets, including future income and savings, are valued in present terms. Thus, the financial advisor visualizes the client's overall plan as a set of balance sheets, one for each goal and its associated assets. Of course, these balance sheets can also be aggregated into an overall financial assessment of the client's net worth. The wealth planner finds the allocation of wealth over the life-cycle that funds each goal at the lowest initial cost, given an individual's desired trade-off between financial goals. The resulting dynamic asset allocation unveils a glide-path specific to the identified goals and priorities.

Finding optimal asset allocations for a goals-based financial plan is more demanding than standard methods. This is in part because each investor has different goals and hence a different optimal allocation. In addition, each investor's optimal allocation is a collection of goal-specific optimal allocations. To overcome this hurdle, MSCI's goal-based methodology builds on the simulation framework that has been the heart of WealthBench since its inception. The simulation framework naturally accommodates an individual's specific financial goals that are unevenly distributed over the individual's life-cycle. Another key benefit includes the ability to handle relevant real-life complexities in wealth planning, such as different sources of income, separate treatment for tax regimes affecting different assets, and special funding vehicles like trusts. In addition, the simulation framework facilitates scenario and sensitivity analysis for the overall investment plan and for individual financial goals.

Goal-based asset allocation: an appealing framework for financial advisors

The mean-variance paradigm has served as the traditional work-horse for most practitioners to elaborate an investment plan and set the asset allocation for individual investors. Although useful and now widely understood, it ignores important aspects of real-life wealth management problems. In particular, it fails to adequately account for individuals' investment horizon, spanning their entire life. It also does not differentiate among investors with different characteristics, such as their desired trade-offs between current and future spending, their specific financial goals, or their savings and income profile. In particular, the 2008 financial crisis has cast doubts on the ability of this traditional paradigm to secure funding for individual investors' retirement and other financial goals.

Recently, the wealth management community has shown a keen interest in moving towards a *dynamic asset allocation* paradigm. Advocated early on by Merton (1971), the purposes of dynamic asset allocation are, in part, to take into account the individual investor's investment horizon, the specific investor characteristics described above, and the evolution of market and economic conditions over the individual's lifetime. Merton framed the dynamic asset allocation problem as a search for the allocation of wealth that maximizes an individual's utility over the life-time stream of current and future spending, given financial goals, savings and income profiles, and constraints on the investment opportunity set. Preferences dictate the desired trade-offs between current and future spending, and the individual's attitude towards risk. Financial goals are constraints on the desired stream of spending. Changes in market and economic conditions may affect both the investment opportunity set, and the individual's savings and income profiles.

Real-life applications of Merton's formulation of the individual life-cycle problem, in its strict sense, remain challenging and computationally demanding. Moreover, the complexities faced by wealth management practitioners, such as the different sources of funding and their tax treatment still seem difficult to handle in a systematic fashion within existing wealth planning systems.

Goal-based asset allocations provide a tractable and useful short-cut to overcome some of these challenges. WealthBench handles the computational demands of the solutions. The solutions are relatively easy to explain and appear intuitive to many investors. In its simplest form, this approach considers each financial goal separately, each goal (or liability) being financed by dedicated assets. The required amount to fund each goal and each source of funding, both current and future, are valued in after-tax present terms. This results in a balance-sheet perspective of the investment plan. An individual's desired trade-off between goals are captured by simple prioritization rules that may be elicited through a questionnaire. The advisor's objective then becomes to find the best sources of funding for each goal, given these prioritization rules.

Retaining much of the appeal of the institutional Asset and Liability Management framework (ALM) while capturing specific individual investor characteristics, goal-based asset allocation has gained recent interest in the wealth management community. For example, Brunel (2003), Nevins (2004) and Chhabra (2005) advocate its use to build a collection of portfolios, each portfolio being designed to meet a client's specific goal. Sharpe's (2007) "lockbox" solution focuses on retirement goals.

As emphasized by Shefrin and Statman (2000), Thaler's (1980) mental accounting theory provides additional motivation for the goal-based asset allocation approach because it is intuitive to many investors and may lead to better acceptance of the financial plan. A large body of evidence from lab experiments suggests that individuals group their spending needs, financial wealth, and different sources of income or savings into separate non-fungible categories. Moreover, there is also evidence that spending is constrained by either implicit or explicit budgets. Thaler and Shefrin (1981) also suggest that mental accounting may help individuals feel more in control of their investment plans, by prioritizing financial goals and allocating, for example, less funding to goals that are less relevant. Importantly, this may help some individuals save more for retirement than they otherwise would.

The next section describes our goal-based asset allocation methodology, which takes into account practical wealth management considerations, following Wang, Suri, Laster and Almadi (2011). In particular, it introduces additional flexibility by letting individuals choose acceptable levels of shortfall risk in achieving goals.

Designing an efficient lifetime wealth plan

MSCI's asset allocation framework enables financial advisors to design a goal-based glide-path that efficiently allocates assets and future cash-flows to an individual investor's financial goals. Instead of focusing on an abstract characterization of an investor's attitude towards risk, the methodology incorporates the investor's trade-offs between goals and the risk of shortfall the investor is willing to accept with respect to each goal. In this section, we describe the methodology and illustrate its key benefits. In particular:

- Individual investor's goals and desired trade-offs between goals can be described and captured in an intuitive fashion.
- The allocation to risky assets varies according to an individual investor's specific characteristics:
    - Shortfall risk tolerance for not meeting a goal
    - Term to each goal's maturity
    - Current wealth and future income and savings
    - Desired trade-offs between financial goals

WealthBench permits advisors to input their menu of pre-selected candidate funds[1], or model allocations, to finance a particular individual's goals. Each fund is characterized by its expected return and volatility (capital market assumptions) and mapped to an investment category (for example, taxable, tax-deferred or tax-exempt).

The asset allocation methodology contains two elements:

1. First, the framework identifies the fund or lockbox for each financial goal, and each stage in the life-cycle. The model identifies the asset-level allocation that requires the least amount of capital to finance the goal. The outcome from this first step is an allocation path specific to each goal. The path shows how the allocation in risky assets changes over time, as the individual progresses toward each financial goal. These allocation paths only depend on the individual's goals, and do not take the individual's sources of funding into account.
2. As a second step, the model evaluates the individual's assets, future income, and savings to determine the feasibility of each goal-specific allocation path. A particular individual may not

[1] While this paper focuses on the problem of selecting the optimal portfolio of funds from a menu of candidate funds provided by the advisor,, subsequent versions of our goal-based investing methodology may allow the advisor to consider broader and richer investment opportunity sets. WealthBench does not contain investment choices (e.g., a menu of available mutual funds) or recommend any specific investments.

have enough assets to fund all goals, and the resulting funded status determines the overall asset allocation and goal-based glide-path.

Defining an individual's financial goals and trade-offs between goals

Financial goals define the desired spending or liability profile over the individual investor's lifetime. Examples of relevant financial goals include retirement, buying a house, funding children's education, buying a luxury car or a sailboat, or establishing a foundation.

Goal attributes

The WealthBench methodology characterizes an individual's goals and the trade-offs between goals with four intuitive attributes: the term, amount, tolerance for shortfall risk, and priority.

The first two attributes, the term and the amount of the goal, specify the time when the goal needs to be fulfilled and how much money will be needed.

The third attribute is the individual investor's tolerance for not achieving the goal, or shortfall risk. Because most individuals have limited resources, and as the future is uncertain, individuals may have difficulty in specifying fixed spending targets for each financial goal over their entire life-time. Some goods are "must have", while some others are only "nice to have". The methodology permits some goals to be funded with low levels of acceptable shortfalls relative to the target amount, while being more lenient towards achieving other goals. Individuals may also specify desired incremental amounts relative to a target goal amount. For example, an individual may aspire to spend about $225,000 per year during retirement. However, only the first $125,000 may be required with high confidence. The additional $100,000 may be nice-to-have, but is not considered absolutely necessary. The methodology defines three levels of tolerance for shortfall risk, to account for greater flexibility in defining an individual's spending aspirations:

- Low: no more than 5 percent shortfall risk
- Medium: no more than 25 percent shortfall risk
- High: no more than 45 percent shortfall risk

Finally, priority ranks the goal by order of importance for the individual investor. For all individuals, funding sources are limited. Directly elicited through a questionnaire, priority is an intuitive attribute that captures the individual's desired trade-off between different goals. High priority goals will be funded first from the available resources.

Example

The four goal attributes allow a financial advisor to readily identify and model a client's financial goals, and desired trade-offs. For example, let us consider the hypothetical case of John Williams, who wants to set up a financial plan to fund, by order of importance: his retirement, his daughter's education and a vacation house. We now describe each of John's goals and their attributes from the advisor perspective in more detail. Table 1 summarizes how John's goals are captured within the goal-based asset allocation methodology.

John's first priority in life is to fund his retirement, starting 20 years from now and lasting 20 years. John will need at least $125,000 annually, growing at the yearly rate of 2 percent to support his family's basic needs. However with an additional $75,000 annually, growing at the same rate, he will also be able to afford a more comfortable lifestyle. With yet another incremental $25,000 annually, he could travel around the world with his spouse. The goal-based framework models John's retirement needs as 60 separate goals or lockboxes, corresponding to each of the basic and two additional needs and each year.

The basic needs ($125,000 per year growing at the annual rate of 2 percent) are assigned a "Low" tolerance for shortfall risk level, and are required to be met with no more than 5 percent chance of shortfall. The two additional needs ($75,000 and $25,000 per year growing at the annual rate of 2 percent) are assigned to the "Medium" and "High" levels. John is willing to tolerate a greater likelihood of shortfall, mapping to 25 percent and 45 percent, respectively, for not meeting these incremental amounts.

Table 1: John Williams' goals.

Goal	Term	Amount	Tolerance for Shortfall Risk	Priority
Retirement	20 – 40 Years	▪ Basic needs: $125,000 per year growing at 2% per year	▪ Low	1
		▪ Nice-to-have: additional $75,000 per year growing at 2% per year	▪ Medium	
		▪ Ideal: additional $25,000 per year, growing at 2% per year	▪ High	
Education	15-19 Years	▪ Basic need: $60,000 per year	▪ Low	2
Vacation House	8 Years	▪ Basic spending needs: $500,000	▪ Low	3
		▪ Nice-to-have house: additional $100,000	▪ Medium	
		▪ Dream house: additional $200,000	▪ High	

The table shows how our goal-based asset allocation methodology describes the main financial goals of a hypothetical investor in terms of the four goal attributes: Term, Amount, Tolerance for Shortfall Risk and Priority.

John's second priority in life is to fund his daughter's education. His daughter Emma is expected to start college 15 years from now. College tuition fees are typically not due all at once and John may wish to spread out the total cost over the four years. John's expected cost for each of the four years of a college degree is about $60,000. Similar to the retirement goal, education will be treated as 4 separate goals, corresponding to each college year. Besides the term, all other attributes are the same for all the goals. The goal amount is $60,000. The acceptable shortfall risk level is set to "Low", as John does not wish to tolerate a shortfall any greater than 5 percent.

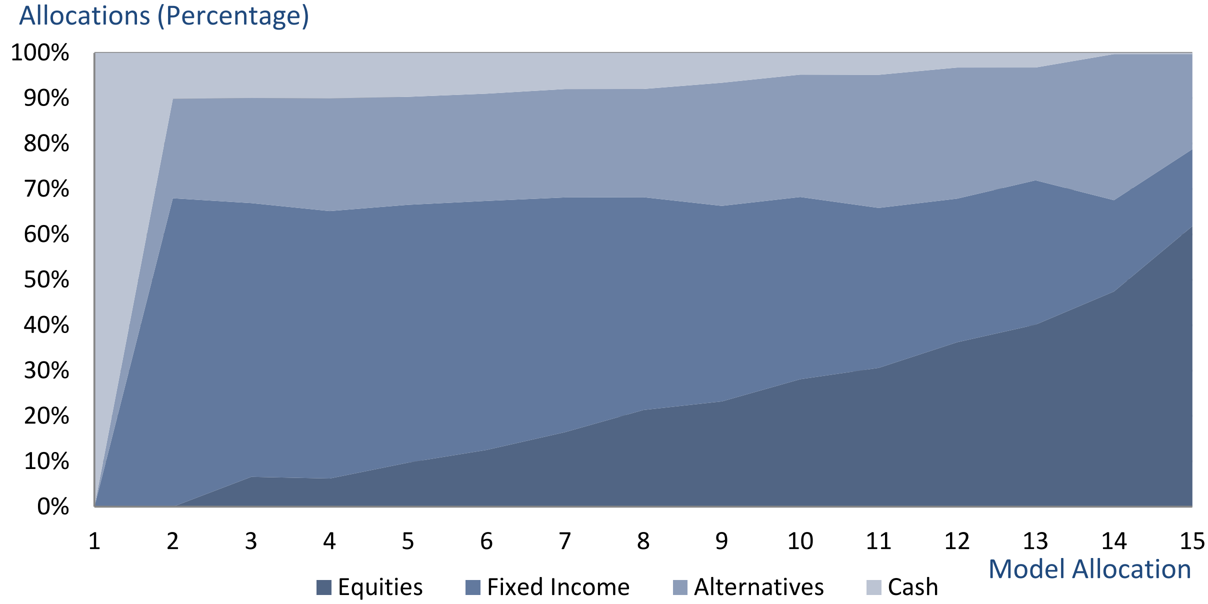
Securing funds for the purchase of a vacation house 8 years from now is John's third goal. His dream house, which would include a swimming pool, will cost him about $800,000. However, John and his family will already be happy if they could spend $500,000 on a house that will fulfill their basic needs, and well satisfied with a $600,000 nicely refurbished house. Like the retirement goals, the methodology models John's spending needs as three separate goals, for each of the basic and two incremental needs.

Investment opportunity set: a menu of available funds

The wealth management firm or advisor using WealthBench may create a menu of candidate funds (model allocations) to finance a particular individual investor's goals[2]. More precisely, the advisor provides, for each fund, the expected return and volatility, a set of constraints on asset holdings, and specifies how the fund's assets are mapped to broad asset classes (e.g. equities, fixed income, alternatives or cash).

For example, Figure 2 shows the composition of fifteen candidate funds selected by an advisor that may help finance John Williams' life-time goals[3]. Figure 3 provides the mean return, volatility and Sharpe ratios for these same funds. The funds are ordered from low risk (fund 1) to high risk (fund 15). Their volatility ranges from 0.9 percent for the cash-only fund (first fund) to 14.9 percent. All model allocations include equities, fixed income, alternatives and cash in varying proportions. As funds move higher in the risk spectrum, the allocation to fixed income decreases (from 67 percent to 17 percent), while the allocation to equities increases from about 6 percent to 62 percent. The allocation to alternatives remains fairly stable across all funds, ranging from 21 percent to 31 percent.

Figure 2: Menu of Model Allocations.



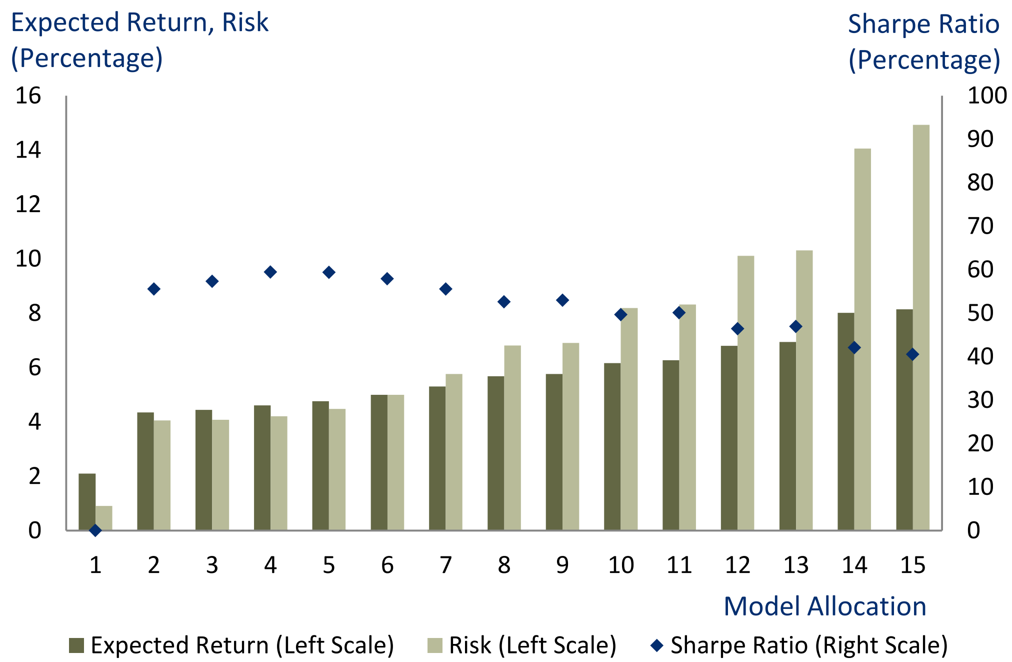
The figure shows the allocations of each candidate fund (model allocation) to Equities, Fixed Income, Alternatives, and Cash. The funds are ranked from low risk (fund 1) to high risk (fund 15). These funds

[2] Appropriate model allocations may also be built using the traditional mean-variance optimization tool available in WealthBench.

[3] The fifteen funds were picked on a constrained mean-variance efficient frontier. The capital market assumptions we used to build the frontier are provided in Appendix B. Note that these fifteen funds and capital market assumptions solely serve the purpose of illustrating our goal-based asset allocation framework. WealthBench does not contain investment choices (e.g., a menu of available mutual funds) or recommend any specific investments.

only serve the purpose of illustrating our goal-based asset allocation framework. WealthBench does not contain any investment choice or recommend any specific investments.

Figure 3: Model Allocation Expected Return, Risk, and Sharpe Ratio.



The figure shows each candidate model allocation's expected return, risk (volatility), and Sharpe Ratio. The funds are ranked from low risk (fund 1) to high risk (fund 15). The fifteen funds were picked on a constrained mean-variance efficient frontier. The capital market assumptions we used to build the frontier are provided in Appendix B. These funds and capital market assumptions only serve the purpose of illustrating our goal-based asset allocation framework. WealthBench does not contain any investment choice or recommend any specific investment.

Funding a financial goal: the share of risky assets increases with the investor's tolerance for shortfall

Given a menu of available funds provided by the advisor, there may be many model allocations that would satisfy the spending requirement for the goal with the acceptable level of shortfall risk. However, there is only one *optimal* model allocation or lockbox for each goal. The optimal allocation requires the least amount of initial capital to achieve the goal, given the acceptable level of shortfall risk.

Conceptually, WealthBench calculates the optimal allocation for a goal by simulating a large number of return outcomes for each model allocation and computing the minimum required investment to meet the acceptable shortfall risk for that goal[4].

[4] See Appendix A3 for the technical formulation of and solution to the fund selection problem.

For example, let us consider John's vacation house goal described in the previous section. Table 4 shows, for each of the three tranches with different acceptable shortfall risk level, the optimal model and its underlying asset allocation, the minimum amount of capital to be invested today and the model's risk. The cheapest way for John to fund the basic housing needs is to invest $463,265 today in fund 4. Given the return and risk characteristics for the funds provided by the advisor (see Figure 3), this investment would yield at least $500,000 in eight years time, with no more than 5 percent chance of shortfall. All other funds require a greater amount of initial investment.

The optimal goal-specific allocations in Table 4 are different from the one implied by the standard Capital Asset Pricing Model (CAPM). In the latter, all investors inherit the risky asset mix of the market portfolio, regardless of their financial goals, age, or other individual specific characteristics. In contrast, in the goal-based framework, the share of risky assets in the optimal model allocation varies with the acceptable level of shortfall for meeting the goal. As a result, the optimal allocation becomes more aggressive with increasing levels of tolerance for shortfall. Given John's low level of tolerance for his basic housing needs, the optimal fund is rather conservative and low risk, with only 7 percent allocated to equities, and nearly 70 percent allocated to fixed income and cash. However, for the more tolerant tranches, the optimal models pursue higher returns and accept the associated higher risk, allocating a much greater fraction to equities (40 percent and 60 percent respectively), with virtually no allocation to cash.

Table 4: The Risky Asset Mix Varies with an Investor's Tolerance for Shortfall Risk.

Tolerance for Shortfall Risk (Goal Amount)	Optimal Model Allocation	Required Minimum Initial Capital	Asset Allocation				Risk
			Equities	Fixed Income	Alternatives	Cash	
Low ($500,000)	4	$463,265	7%	58%	25%	10%	4.3%
Medium ($100,000)	13	$83,785	40%	32%	25%	3%	10.1%
High ($200,000)	15	$140,154	62%	17%	21%	0%	14.9%

The table shows for each acceptable shortfall risk level, the optimal model allocation that funds John Williams' vacation home with least amount of initial capital, its corresponding asset allocation, the required initial funding amount, and its risk.

Goal-specific allocation path: the share of risky assets decreases as the investor progresses towards the goal

For a given goal and shortfall risk level, the optimal model allocation also varies with the goal's term to maturity. An attractive feature of the goal-based allocation methodology in WealthBench is that the optimal allocation becomes less aggressive and less risky as the individual progresses towards the goal. This is intuitive as risky allocations are likely to increase the chance of not meeting a goal as the goal's term approaches.[5] Taking John's "Medium" level housing goal as an example, Table 5 illustrates that 5

[5] As the investment horizon shrinks, the contributions of expected returns shrink faster than the contributions of risk.

years away from the term of the goal, the optimal model would allocate only 28 percent to equities, instead of 40 percent and 40 percent to fixed-income, instead of 32 percent. One year away from the goal, the optimal model allocates fully to cash.

Generalizing the results from Table 5, each year there is an optimal allocation that requires the least amount of capital to finance a given goal. Thus, the model derives a *path* of such allocations to progress towards a goal at the lowest cost. Figures 6a-6c illustrate, for each level of acceptable shortfall risk, how the asset allocation changes, as John moves closer to the targeted date of his house purchase. Each allocation path may be markedly different. For example, the allocation path for John's basic housing needs is highly conservative, allocating fully to cash after five years. In contrast, the path for the tranche with high tolerance for shortfall risk remains fairly risky throughout, never allocating to cash.

Assuming that John can afford to invest the minimum required amount of capital in each path, Figure 6d depicts the blended path for John's overall housing goal. Not surprisingly, the blended path mostly retains the features of the path corresponding to the largest tranche, the one with low tolerance for shortfall risk.

Table 5: The Risky Asset Mix Varies with a goal's term to maturity.

Term to Maturity	Optimal Model Allocation	Asset Allocation				Risk
		Equities	Fixed Income	Alternatives	Cash	
8 Years	13	40%	32%	25%	3%	10.1%
5 Years	8	28%	40%	27%	5%	8.2%
1 Year	1	0%	0%	0%	100%	0.9%

The table shows how the optimal model allocation for John's "Medium" shortfall risk level vacation home goal changes as John progresses towards the goal. For each term to goal maturity, the table also shows the corresponding optimal asset class allocation and risk.

In a similar fashion, as shown in Figures 7a and 7b, the model calculates the optimal paths for the retirement and education goals. The asset allocation profile changes significantly across the different goals. The observed differences in the share of risky assets are attributed to differences in each goal's tolerance for shortfall risk, term to maturity, and goal amount[6]. The goal-based asset allocation framework allows for greater differentiation across individual investors. An individual's specific set of life-time goals dictate the allocation to risky assets. Such allocations are not a natural implication of traditional asset allocation models.

[6] While Figure 7a suggests that post-retirement allocations are more conservative, regardless of the individual's current assets and future income, this may not always be the case. For example, if the individual is over-funded thanks to high levels of income, any remaining surplus may be allocated to a risky portfolio. In such case, taking the surplus portfolio into account, the goal-based post-retirement allocations may become more risky. The following section further explains how an individual's assets and income may impact the share of risky assets in a goal-based asset allocation.

Figure 6a

Allocation Path For the "Low" Tolerance Level Vacation Home Goal.

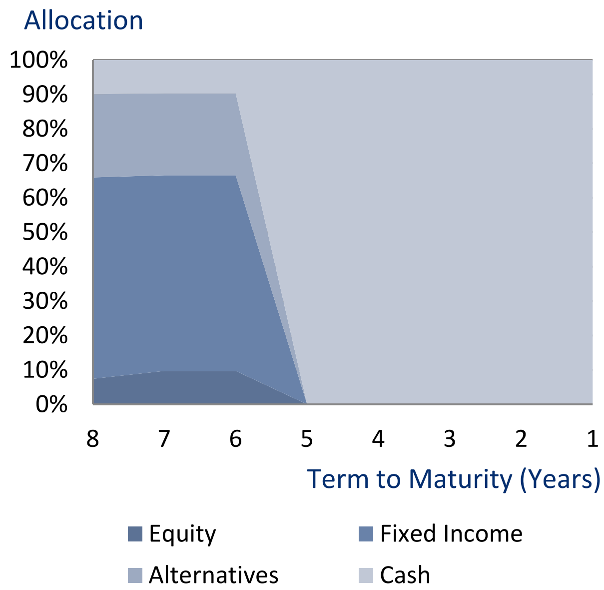


Figure 6b

Allocation Path For the "Medium" Tolerance Level Vacation Home Goal.

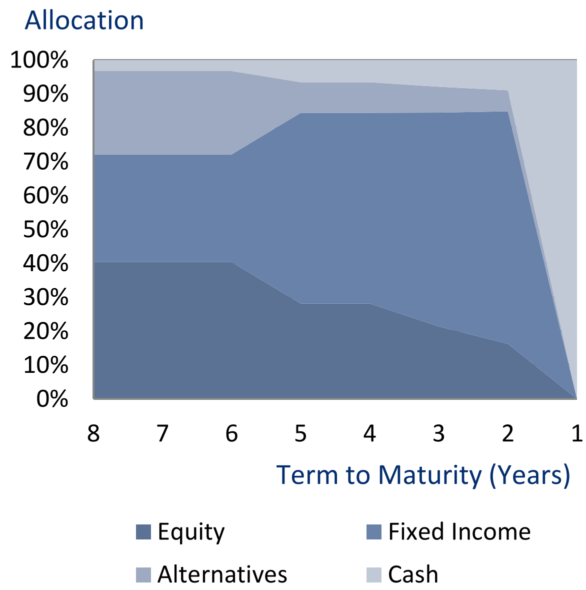


Figure 6c

Allocation Path For the "High" Tolerance Level Vacation Home Goal.

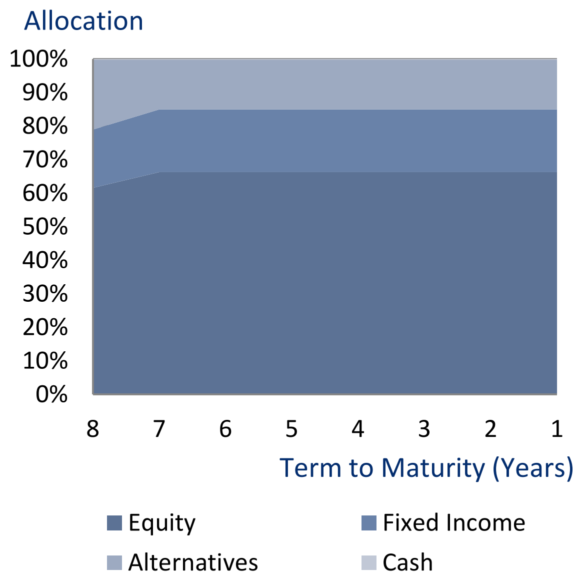
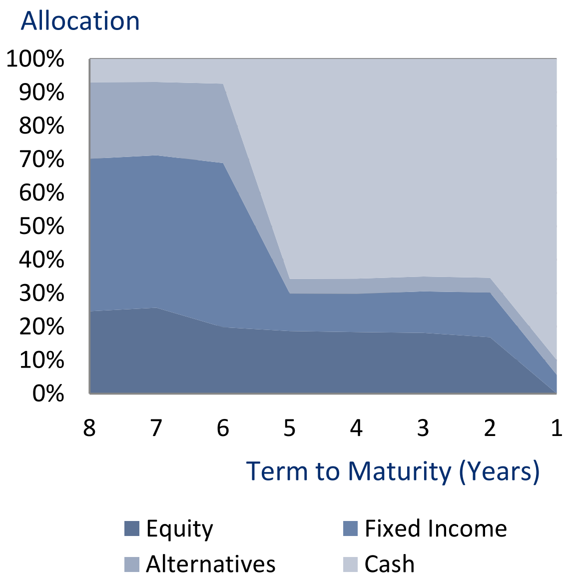


Figure 6d

Blended Allocation Path For the Vacation Home Goal.



The figures (6a-6c) show how the vacation home specific allocations change with the term to maturity for each shortfall risk tolerance levels. Figure 6d shows the blended allocations for the overall vacation home goal.

Figure 7a

Blended Allocation Path for the Retirement Goal.

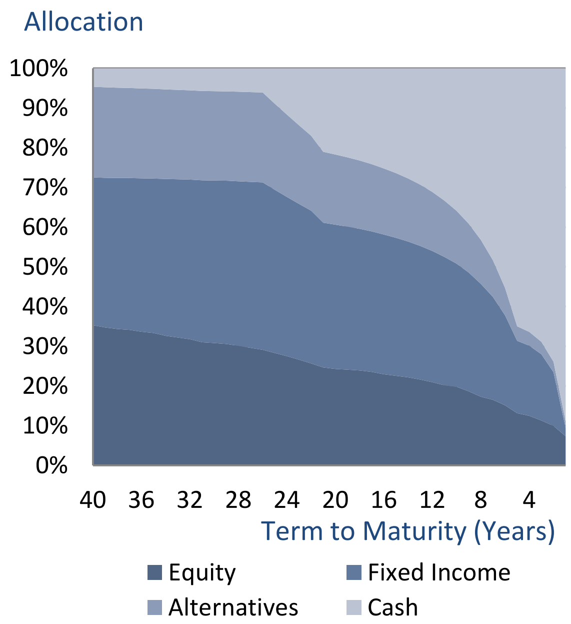
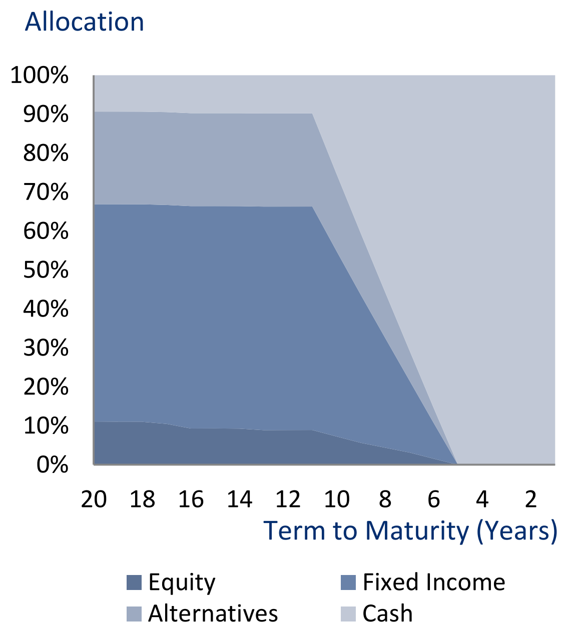


Figure 7b

Blended Allocation Path for the Education Goal.



Figures 7a and 7b show how the retirement goal specific and education goal specific allocations change as John Williams progresses towards each goal.

Moreover, the resulting asset allocation profile in a goal-based investing framework also differs from the ones exhibited in typical target date fund allocations. As an individual investor's financial goals are unevenly distributed over time, we would expect the allocation profile to be irregular. Figure 8a shows this is indeed the case for the combined glide-path for all John's goals, assuming that John can fully afford all lockboxes. This is especially the case between the first three and eight years, where there are significant changes to the allocation to cash. These changes are not surprising and rather intuitive, as John needs to buy a house eight years from now. The allocation to cash increases significantly from 5 percent to about 14 percent by the fourth year and further increases to 16 percent by the eighth year, the term of the housing goal. After the eighth year, the lockboxes that were dedicated to the housing goals are all liquidated, resulting in a shift in the overall allocation away from cash, reverting nearly back to the present year allocation.

In comparison, the typical target date fund glide-path portrayed in Figure 8b[7] (for the same retirement date) exhibits a much smoother profile, with the share in risky assets only decreasing gradually through time. In particular, there is no consideration for the shortfall risk a particular individual is willing to tolerate. Such a smooth profile is mainly the result of common target date funds accounting only for broad level characteristics of an individual investor, such as the age group, and an abstract characterization of attitudes towards risk. Even so, standard mean-variance optimization does not produce glide-paths of this type. Our goal-based asset allocation framework directly produces intuitive glide-paths and allows financial advisers to design customized asset allocations for individual investors,

[7] MarketGlide Index as of 2013 Q1. Note that this glide-path targets the beginning of retirement (year 20). We thank Business Logic Corp for providing us with the data.

taking into account the specificity of each financial goal they are saving for, and the individual's acceptable level of shortfall risk for each goal.

Figure 8a

Goal-based glide-path.

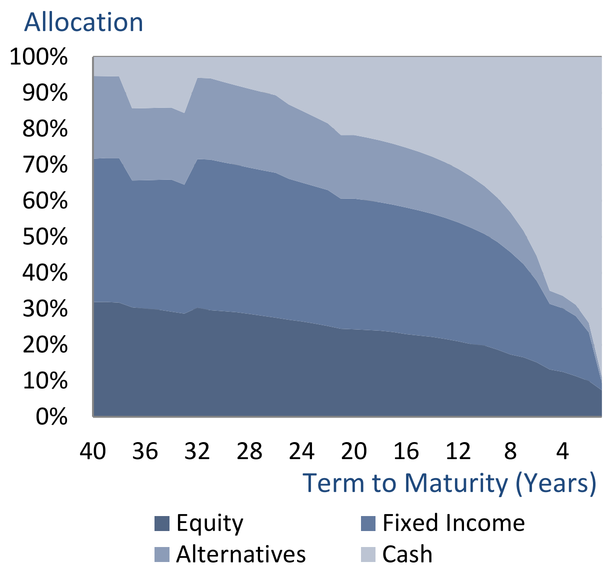


Figure 8b

Typical target date fund glide-path.

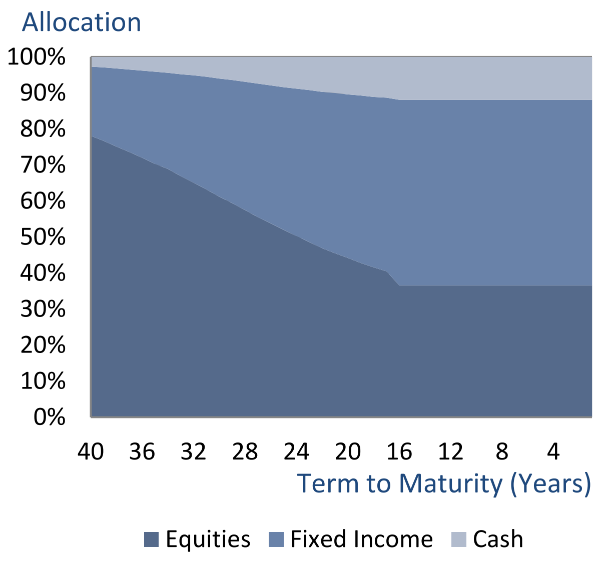


Figure 8a and 8b contrast the lumpy glide-path obtained from the MSCI goal-based asset allocation methodology with the smooth glide-path implied by a typical retirement target date fund.

Financing goals over the life-cycle: current assets, future cash-flows, and the desired trade-offs between goals dictate the share of risky assets over the life-cycle

The goal-specific allocation paths we discussed in the previous section do not depend on an individual investor's assets. Thus, these allocation paths may not all be affordable and suitable for all individuals. In this section, we discuss how the methodology treats an individual investor's assets and future cash flows. The model requires the financial adviser to specify the investor's goal priorities or desired trade-offs across goals. Based on this information, the model can assess the feasibility of each goal-specific allocation path, and calculate the individual investor's goal-based glide-path[8].

Discounting

The framework uses a current asset/liability balance sheet view of the plan, where the financial advisor can readily assess and visualize the required amount of funding to finance a particular goal (liability), and any matched financial wealth, income and savings (assets). To this effect, the advisor must map each goal to existing funding sources.

The current value of the associated financial wealth for each goal is simply the value of the portfolio invested in the corresponding funding vehicle. To discount future income and savings to present, the model employs an approach akin to common asset and liability management practice. The advisor provides an estimate of the size and timing of each future cash-flow and its riskiness. Given these

[8] See Appendix A1-A3 for the technical details.

parameters, the model then uses the yield curve of bonds with credit ratings corresponding to a similar level of riskiness, to discount each cash-flow.

Finally, each goal-specific asset allocation path and its return and risk profile allow the model to compute the current funding requirement for each goal.

The model can then analyze the funded status for each goal and at the overall plan level and solve for the goal-based glide-path.

Budgeting rules and asset allocation

The methodology employs the following budgeting rules to address trade-offs among goals where not every goal can be fully funded:

- Goals with the lowest level of acceptable shortfall risk get financed first, as the investor has little tolerance for not meeting these goals.
- Goals with highest priority, set by the individual investor, get financed first, within each shortfall risk grouping.

Proceeding by order of priority until all funding sources are exhausted and following the budgeting rules outlined above, the model computes the funded status at the overall plan level as well as at the goal and shortfall risk grouping levels. In the event of a surplus, the model allocates any of those surplus assets depending on whether the investor wants to preserve capital, further maximize wealth, or both[9]. The funded status and the surplus determine the optimal asset class allocation, and the goal-based glide-path.

Assets, future cash-flows, and the desired trade-offs between goals also drive the risky-asset mix in the goal-based glide-path

While the goal-based glide-path in Figure 8a assumed the ideal situation when all the goals are affordable, this may not always be the case. In this section, we show how current assets and future cash-flows, as wells as goal prioritization can affect the allocation to risky assets in the goal-based glide-path. Again, this attractive and intuitive feature of our goal-based methodology stands out relative to the asset allocations implied by traditional mean-variance optimization models and typical target date funds. Indeed, these methods fail to take into account an individual's specific income profile and desired trade-offs between goals in an explicit fashion.

Table 9 presents a high level balance sheet view of John's assets, including the current value of future income and savings and funding requirements for each main goal. In summary, John needs $4,365,068 today to be able to meet all his goals, including the ones with high tolerance for shortfall risk. However, the current value of John's assets is only $3,100,000. Clearly, John will not be able to meet all his financial goals and will have to either change them, or give up some of them.

Although John can only afford 71 percent of all goals, he may still be able to fully fund some of them, and leave the rest unfunded. Table 10 shows John's funded status for each goal and level of acceptable shortfall risk. Given the model's budgeting rules for the goals, we see that John can only fully fund the goals with lowest tolerance for shortfall risk. In addition, he may be able to partially fund the retirement goal at the intermediary level. All other medium and high tolerance level goals will remain unfunded d for now, as retirement is John's highest priority goal.

[9] See Appendix A4 for more details on the treatment of surplus.

Table 9. Assets and Funding Requirements Balance Sheet.

Goal	Assets	Funding Requirements
Retirement	$3,100,000	$3,497,766
Education		$180,097
Vacation House		$687,204
Total	$3,100,000	$4,365,068

The table presents a high level balance sheet view of John's assets, including the current value of future income and savings, and funding requirements for each main goal.

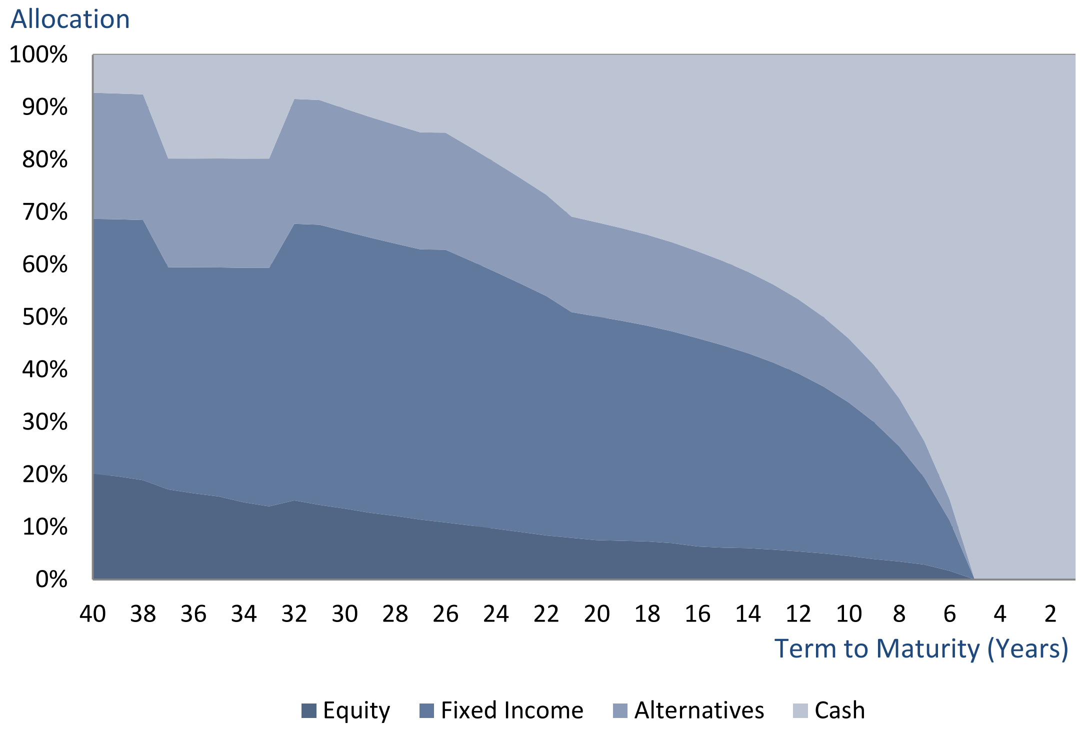
In turn, this means that John may only be able to fully afford the allocation paths corresponding to the goals with low tolerance for shortfall risks and part of retirement-specific medium tolerance ones. Figure 11 shows how the funded status affects John's goal-based glide-path. In contrast to the fully funded case portrayed in Figure 8a, the asset allocation is now more conservative. Current allocations to equities decreased from 30 percent to 20 percent. While allocations to fixed income increased from 40 percent to about 50 percent. In addition, the goal-based glide-path allocates fully to cash in the last 5 years of the plan. This shift towards lower risk assets is intuitive to most investors and advisors and is consistent with the previous section. Indeed, the goal-based glide-path now focuses mainly on funding the goals with low acceptable levels of shortfall. As we saw from Table 4, these goals require more conservative allocations.

Table 10. Funded Status by Goal and Tolerance for Shortfall Risk Grouping.

Tolerance for Shortfall Risk	Retirement	Education	Vacation House	Overall
Low	100%	100%	100%	100%
Medium	7%	NA	0%	6%
High	0%	NA	0%	0%
Total	70%	100%	67%	71%

The table shows the funded status at the overall, goal, and tolerance for shortfall risk levels.

Figure 11. Goal-Based Glide-Path, Conditional on John's Assets, Future Income and Savings, and Desired Trade-Offs Between Goals.



The figure shows the asset allocation profile from John's goal-based glide-path, which accounts for John's assets and future cash-flows, and the goal priorities described in Table 1.

Conclusion

Goal-based asset allocation has recently gained attention and appeal within the wealth management community, as a useful and practical framework to grapple with the complex dynamic asset allocation problem individual investors confront. In this paper, we describe MSCI's goal-based asset allocation methodology and illustrate the benefits it brings to financial advisors and their clients.

Our goal-based investing framework allows financial advisors to incorporate detailed descriptions of their clients' specific financial goals, taking into account the acceptable levels of short-fall risk for each goal they are saving for and the desired trade-off between goals. Additionally, the asset-liability approach used in this framework allows financial advisors to compare an investor's assets values against the funding requirements of future goals, at individual goal and overall investment plan levels.

Finally, the resulting asset allocations have intuitive characteristics that are not associated with traditional portfolio optimization and typical target date fund glide-paths. Indeed, our goal-based methodology incorporates investors' specific financial goals, as well as their particular income and savings profiles, to calculate a goal-based glide-path. Goal-based asset allocations naturally provide less risky portfolios when the individual investor's tolerance for shortfall risk is low, or as the investor progresses towards important goals like retirement. The risky asset mix in the optimal portfolio also depends on the individual's current and future assets and desired trade-offs between goals.

References

Brunel, J.L.P. (2003) “Revisiting the Asset Allocation Challenge through a Behavioral Finance Lens.” The Journal of Wealth Management (Fall 2003), pp. 10-20.

Brunel, J.L.P. (2011) “Goal-Based Wealth Management in Practice.” The Journal of Wealth Management (Winter 2011), pp. 17-26.

Chhabra, A.B. “Beyond Markowitz: A Comprehensive Wealth Allocation Framework for Individuals.” The Journal of Wealth Management (Spring 2005), pp. 8-34.

GoalMetrics (October 2013), MSCI White Paper.

Merton, R.C. (1971) “Optimum Consumption and Portfolio Rules in a Continuous-Time Model,” Journal of Economic Theory, Vol.3(4), pp 373-413.

Sharpe, W.F. (2007) “Lockbox Separation”, http://www.stanford.edu/~wfsharpe/wp/lockbox.pdf.

Shefrin, H., and M. Statman (June 2000), “Behavioral Portfolio Theory.” Journal of Finance and Quantitative Analysis, Vol. 35, No. 2, pp. 127-151.

Shefrin, H. H. and Thaler, R. H. (1988) "The behavioral life-cycle hypothesis." Economic Inquiry, 26, pp. 609-643.

Thaler, R. H. (1980) "Toward a positive theory of consumer choice." Journal of Economic Behavior and Organization, 1, pp. 39-60.

Wang, H, A.Suri, D.Laster, and L. Almadi, 2011, “Portfolio Selection in Goal Based Wealth Management”, Journal of Wealth Management, (Summer 2011), pp.55-65.

Appendix

A. Goal-Based Asset Allocation Methodology

A1. Definitions and Notations

Investor's portfolio

The investor's aggregate portfolio consists of holdings in multiple analytic vehicles. Each analytic vehicle is characterized by:

- Its composition: type of assets held and holdings in each asset
- Its tax status: taxable, tax deferred, or tax exempt

A given funding vehicle *F* can be either the aggregate portfolio, a specific subset of analytic vehicles, or a single analytic vehicle. We define for *F*:

- $\Phi^{L}_{F,T}$, the distribution of the liquidation value of funding vehicle F at date *T*
- $Q^{L}_{F,T}$, the corresponding quantile function:

  $Q^{L}_{F,T}(1-\alpha)$ gives the $(1-\alpha)^{th}$-percentile liquidation value at date *T*, below which any value drawn under the distribution $\Phi^{L}_{F,T}$ will fall under with probability $1-\alpha$.

  Conversely, any value drawn under the distribution $\Phi^{L}_{F,T}$ will be at least greater than $Q^{L}_{F,T}(1-\alpha)$ with probability α

The quantile functions will be determined through simulations, and we will use them to determine the required initial capital to fund a goal.

Goals

Goals are the liabilities for the investor. They represent the desired spending profile over the investor's life-time.

We model each goal (*k*) by characterizing the following four attributes, specified by the user:

- **Term** (T_{G_k})

Time when the spending is due (measured in years)

- **Amount** (A_{G_k})

Amount due at the end of year T_{G_k}

- **Shortfall Risk Tolerance Level** (SR_{G_k})

SR_{G_k} implicitly defines the desired probability of success of meeting the goal (α_{G_k}).

SR_{G_k} can only take one of three values.

- **Priority** (p_{G_k})

  Relative rank of goal *k* (relative to all the other goals), an integer number between 1 and N_G, the number of goals.

Current balance sheet items

Assets

- $V_{P_i,0}$: current liquidation value of funding vehicle *i*
- $V_{P,0}$: current liquidation value of all assets held in the investor's aggregate portfolio

$$V_{P,0} = \sum_i V_{P_i,0}$$

Inflows

Inflows are uncertain (see the Discounting section below). We define:

- $C_{I,j,0}$: current, discounted value of cash-inflow (j) (future income and savings) received at the end of year T_j and to be used to finance a goal or several goals, as specified by the user. More specifically, a particular inflow will be either used to finance a dedicated goal, or will not be dedicated to any particular goal, and could be used in this case to finance several goals.
- $C_{I,NA}$: current value of all unassociated inflows C_{I,G_k} : current value of all inflows that are dedicated to goal G_k
- $C_{I,0}$ current value of all inflows

$$C_{I,0} = \sum_j C_{I,j,0}$$

Goals (liabilities)

- $V_{G_k,0}$: current required amount of capital to fund goal (k)
- $V_{G_\alpha,0}$: current required amount of capital to fund all goals with shortfall risk tolerance level α
- $V_{G,0}$: current required amount of capital to fund all goals

$$V_{G,0} = \sum_k V_{G_k,0}$$

Mapping funding sources to goals

The user needs to specify the funding vehicle $v(k)$ and funding sources (current and future savings) that will be used to fund each goal *k*.

A single funding source may be used to fund multiple goals.

A goal may also be funded through multiple sources: a funding vehicle and additional inflows. More precisely, a funding source can be either "unassociated" or "dedicated."

A funding source is “unassociated” if it is not dedicated to a specific goal (or goals). It can be used to fund any goal on the basis of its priority.

If a funding source is dedicated to a specific goal (or goals), then it will be used, regardless of the goal’s priority. We distinguish two types of dedicated funding sources:

a. Locked:
A deficit cannot be funded with other sources.

   Any remaining surplus cannot be used to fund other goals.

b. Unlocked:
A funding deficit can be financed with other sources.

   Surpluses, if any, cannot be used to fund other goals.

A2. Current Balance Between Assets and Liabilities, and Funded Status

Required initial capital to fund a goal

The required initial capital to fund a goal, G_k, is the goal amount divided by the $Q^L_{v(k),T_{G_k}}(1-\alpha_{G_k})$-liquidation value of the corresponding funding vehicle $v(k)$:

$$V_{G_k,0} = \frac{A_{G_k}}{Q^L_{v(k),T_{G_k}}(1-\alpha_{G_k})} \tag{1}$$

In other words, investing V_{G_k} in the funding vehicle $v(k)$ today will ensure that the investor will have at least the goal amount A_{G_k} with probability (shortfall risk tolerance level) α_{G_k} at the goal’s maturity T_{G_k} .

Current value of future inflows

We define the current value of future inflows as:

$$C_{I,j,0} = \frac{C_{I,j,T_j}}{R_{C_{I,j}}} \tag{2}$$

Where:

C_{I,j,T_j} is the value of inflow *j* when it is received at time T_j

$R_{C_{I,j}}$ will be a rate at maturity T_j taken from a specific interest rate curve. Each curve will correspond to a level of certainty assigned by the user to each inflow.

Ranking the Goals

The goals are ranked according to their level of shortfall risk tolerance (High, Mid and Low) and, within each shortfall risk tolerance group, according to their priority (p_k). Note that this requires that within each shortfall risk tolerance group, the priority (p_k) defines a strict ranking of goals.

The ranking defines a permutation, σ, which maps a given rank to the corresponding goal. For example $\sigma(1)$ is the goal with highest ranking, $\sigma(2)$ is the goal with second highest ranking.

Goal Budgeting Rules

The goal's rank defines the order in which it gets funded and its final funded status. Goal $\sigma(1)$ gets funded first, then comes $\sigma(2)$, and so on. We can define an indicator for the funded status I_F of each goal recursively as follows:

- Step 0: Identify the goal with highest ranking ($\sigma(1)$)
- Step 1: Check the current value of dedicated assets (invested in the dedicated vehicle $v(\sigma(1))$) and dedicated inflows to be used to finance the goal $\sigma(1)$:

$$B_{v(\sigma(1)),0} = V_{P_{v(\sigma(1))},0} + C_{I,G_{\sigma(1)}} \tag{3}$$

A. If the current value of all assets and inflows is greater than the required initial amount to fund the goal ($B_{v(\sigma(1)),0} \geq V_{G_{\sigma(1)},0}$), the goal is fully funded:

i. Update the funded status indicator, $I_F(\sigma(1))$, which is equal to zero if the goal is under-funded, and equal to one otherwise:

$$I_F(\sigma(1)) = 1$$

ii. Update the value of dedicated assets to the goal:

$$B_{v(\sigma(1)),0} = V_{P_{v(\sigma(1))},0} + C_{I,G_{\sigma(1)}} - V_{G_{\sigma(1),0}} \tag{4}$$

iii. Repeat Step 1 with the next highest ranking until we run out of funding sources

The current value of dedicated assets to be used to finance the goal $v(\sigma(2))$ is:

$$B_{v(\sigma(2)),0} = V_{P_{v(\sigma(2))},0} + C_{I,G_{\sigma(2)}} \tag{5}$$

B. If the current value of all assets and inflows is strictly less than the required amount to fund the goal, $B_{v(\sigma(1)),0} < V_{G_{\sigma(1)},0}$, then the goal is under-funded and ($V_{G_{\sigma(1)},0} - B_{v(\sigma(1)),0}$) is the required additional capital to fully fund the goal.

There are two possibilities:

i. The funding sources are locked to the goal. In this case, the funding process for goal $\sigma(1)$ stops here.
The funded status indicator for the goal is equal to zero:

$$I_F(\sigma(1)) = 0$$

ii. Other assets (assets from the unassociated funding vehicle and unassociated inflows) can be used to fund the deficit:

- If the sum of the current value of the unassociated vehicle and unassociated inflows V_{NA} is greater than the current value of the unfunded amount, $V_{G_{\sigma(1)},0} - B_{v(\sigma(1)),0}$, then the goal is fully funded and $I_F(\sigma(1)) = 1$

  Update the value of the unallocated sources of funding:

$$V_{NA} = V_{NA} - (V_{G_{\sigma(1)},0} - B_{v(\sigma(1)),0}) \tag{6}$$

  Update the value of the unallocated sources used to fund the goal:

$$V_{NA,\sigma(1)} = V_{G_{\sigma(1)},0} - B_{v(\sigma(1)),0} \tag{7}$$

  Consider the goal with the next highest ranking and repeat Step 1 until we exhaust all funding sources

- If the sum of the current value of the unassociated vehicle and unassociated cash-flows V_{NA} is strictly lower than the unfunded amount, $V_{G_{\sigma(1)},0} - B_{v(\sigma(1)),0}$, then the goal still cannot be fully funded and $I_F(\sigma(1)) = 0$.

  Update the value of unassociated pool of funds used to finance the goal:

$$V_{NA,\sigma(1)} = V_{NA} \tag{8}$$

  Update the current value of the overall unassociated funding sources:

$$V_{NA} = 0 \tag{9}$$

Consider the goal with the next highest ranking and repeat Step 1 until we exhaust all funding sources.

Current Funded Status

We define the current funded status as the ratio of the current value of liabilities to the current value of both assets and inflows at the portfolio and analytic vehicle levels, shortfall risk tolerance, and goal levels:

- Funded status at the portfolio level:

- Number of goals that are funded overall, as a fraction of the total number of goals

$$F_{P,N_G} = \frac{1}{N_G} \sum_{i=1}^{N_G} I_F(\sigma(i)) \tag{10}$$

- Goal amount funded as a fraction of total portfolio liability

$$F_{P,V_G} = \frac{1}{V_{G,0}} \sum_{i=1}^{N_G} I_F(\sigma(i)) V_{G_{\sigma(i)},0} \tag{11}$$

- Funded status by shortfall risk tolerance level:

- Number of goals that are funded within each shortfall risk tolerance group (α) as a fraction of the total number of goals for each shortfall risk tolerance group

$$F_{\alpha,N_\alpha} = \frac{1}{N_\alpha} \sum_{\sigma(i)\in G_\alpha} I_F(\sigma(i)) \tag{12}$$

Where N_α is the number of goals with shortfall risk tolerance level α , and G_α is the set of goals with shortfall risk tolerance level α

- Goal amount funded within each shortfall risk tolerance group (α), as a fraction of the total value of all goals with shortfall risk group (α) :

$$F_{\alpha,V_{G_\alpha}} = \frac{1}{V_{G_\alpha,0}} \sum_{\sigma(i)\in G_\alpha} I_F(\sigma(i)) V_{G_{\sigma(i)},0} \tag{13}$$

Note that one can define the funded status by any other goal grouping in a similar fashion.

- Funded status by goal: fraction of the amount effectively funded for a given goal. If the goal is funded only through its dedicated funding sources:

$$F_{G_{\sigma(i)}} = \frac{V_{P_{v(\sigma(1))},0} + C_{I,G_{\sigma(1)}}}{V_{G_{\sigma(i)},0}} \tag{14}$$

The funded status indicator for each goal is $I_F(\sigma(i))$ (0 if under-funded, 1 otherwise)

The required amount ($RA_{\sigma(i)}$) to fully fund a goal is:

$$RA_{\sigma(i)} = Max(0, V_{G_{\sigma(i)},0} - (V_{P_{v(\sigma(1))},0} + C_{I,G_{\sigma(1)}})) \tag{15}$$

If the goal is funded through both its dedicated and the unassociated sources:

$$F_{G_{\sigma(i)}} = \frac{V_{P_{v(\sigma(1))},0} + C_{I,G_{\sigma(1)}} + V_{NA,\sigma(i)}}{V_{G_{\sigma(i)},0}} \tag{16}$$

The funded status indicator for each goal is $I_F(\sigma(i))$ (0 if under-funded, 1 otherwise)

The required amount ($RA_{\sigma(i)}$) to fully fund a goal, if under-funded is:

$$RA_{\sigma(i)} = Max(0, V_{G_{\sigma(1)},0} - (V_{P_{v(\sigma(1))},0} + C_{I,G_{\sigma(1)}}) - V_{NA,\sigma(i)}) \tag{17}$$

A3. Optimal Model Allocation Selection and Goal-Based Glide-Path

The derivation of the goal-based glide-path over the individual investor's life-time follows three steps. We first select the optimal model allocation that finances a given goal with the least required amount of initial capital. We then derive the goal-specific paths. Finally, accounting for the individual investor's current assets, and both current and future income and savings, we derive the goal-based glide-path.

A model allocation is a portfolio of assets, with a given distribution of portfolio returns and a tax status. We assume that the user has already predetermined a menu of model allocations, given a set of capital market assumptions (asset class level expected returns and covariance matrix), including one that allocates 100% to cash, or a "low risk" asset class.

Optimal Model Allocation and Goal-Specific Allocation Path

For each model $(M_i)_{i=1 \ldots N_M}$ and each goal G_k with acceptable level of shortfall risk, α_{G_k}, and term to goal maturity T_{G_k}, we define the quantile functions for the distribution of the model's liquidation values, $Q^L_{M_i,T_{G_k}}(1-\alpha_{G_k})$, for an initial one dollar investment.

The optimal model allocation, $M^*_{\alpha_{G_k},T_{G_k}}$, that achieves goal G_k with the least required amount of initial funding is the model which yields the highest liquidation value quantile at T_{G_k}:

$$M^*_{\alpha_{G_k},T_{G_k}} = \underset{i\in\{1,\ldots,N_M\}}{Max} Q^L_{M_i,T_{G_k}}(1-\alpha_{G_k}) \tag{18}$$

Likewise, we can derive the allocation path associated to goal G_k. Indeed, for a given term to maturity, $T \quad (T < T_{G_k})$, there is an optimal model allocation, $M^*_{\alpha_{G_k},T}$ that requires the least amount of initial capital to achieve the goal:

$$M^*_{\alpha_{G_k},T} = \underset{i \in \{1,\ldots,N_M\}}{Max}\, Q^L_{M_i,T}(1-\alpha_{G_k}) \tag{19}$$

We define the goal-specific allocation path as the set of all optimal model allocations $\left(M^*_{\alpha_{G_k},T}\right)_{0<T\le T_{G_k}}$.

Goal-based Glide-Path

Given the optimal model allocations from equation (19) and the budgeting rules defined in section A1, we determine the funded status and the affordability of each goal. We then derive the optimal allocation across all models (the optimal portfolio of funds), and the investor's goal-based glide-path.

More precisely, the current optimal amount invested in each model portfolio is given by:

$$V_{M_i,0} = \sum_{\substack{k \text{ such that:} \\ M_i = M^*_{\alpha_{G_k},T_{G_k}}}} F_{G_k} \cdot V_{G_k} \tag{20}$$

And the corresponding current optimal weight in each model portfolio is:

$$w_{i,0} = \frac{V_{M_i,0}}{\sum_{j=1}^{N_M} V_{M_j,0}} \tag{21}$$

We derive the goal-based glide-path in a similar way. The projected amount invested in each model portfolio at time *t* is:

$$\begin{cases} V_{M_i,t} = \sum\limits_{\substack{k \text{ such that:} \\ M_i = M^*_{\alpha_{G_k},T_{G_k}-t+1}}} F_{G_k} \cdot V_{G_k} & \text{if } 0<t<T_{G_k} \\ V_{M_i,t} = 0 & \text{otherwise} \end{cases} \tag{22}$$

And the corresponding weights are given by:

$$w_{i,t} = \frac{V_{M_i,t}}{\sum_{j=1}^{N_M} V_{M_j,t}} \tag{23}$$

$(w_{i,t})_{i=1,\ldots,N_M,\, t\ge 0}$ determines the glide-path.

A4. Surplus

If the budgeting process (described in A2 and applied in A3) results in a surplus from unlocked or unassociated funding sources, we allow the user to choose one or both the following two options:

- *Capital preservation*

We treat the capital preservation option as another goal:

- The term (T_{end}) is the terminal year of the plan
- The goal amount is the total surplus
- The shortfall risk tolerance level is 5% (α_S = 95%).

The objective is to select the model allocation and the required initial amount of capital to be invested in the model allocation in order to match the surplus value at the end of the plan (T_{end})

$$M_{i_S} = \underset{i}{Max}\, Q^L_{M_i,T_{end}}(1-\alpha_S) \tag{24}$$

The amount of capital to be invested in the optimal model M_{i_S} is:

$$V_{M_{i_S}} = \frac{S}{Q^L_{M_{i_S},T_{end}}(1-\alpha_S)} \tag{25}$$

The resulting and final surplus is:

$$S_F = S(1-1/\,Q^L_{M_{i_S},T_{end}}(1-\alpha_S)) \tag{26}$$

Depending on the user's choice, the surplus S_F may still be re-invested in the model allocation $M_{i_{S_F}}$ with the highest mean end wealth and lowest end wealth volatility.

- *Speculation*

In this case, the surplus will be invested in the model allocation M_{i_S} with the highest mean end wealth and lowest end wealth volatility (subject to risk bounds).

B. Capital market assumptions

Long term expected returns and volatility assumptions are obtained by averaging those used by selected large wealth management institutions. Correlations are based on historical un-weighted weekly returns on indices representing each asset class from August 2008 through August 2013. Table B1, B2a and B2b summarize the capital market assumptions used in this paper. These capital market assumptions only serve the purpose of illustrating our goal-based asset allocation framework. WealthBench does not contain any investment choice or recommend any specific investment.

Table B1. Expected Return and Risk

Asset Class	Expected Return	Risk
Large Cap	8.3%	17.0%
Small Cap	9.3%	20.5%
International Equity	9.0%	19.7%
Emerging Market Equity	11.3%	24.3%
Investment Grade	3.9%	5.2%
High Yield	6.3%	12.8%
International Fixed Income	2.6%	8.2%
Hedge Fund	6.1%	9.2%
Private Equity	11.6%	23.7%
Private Real Estate	7.6%	17.1%
Commodities	7.4%	17.6%
Cash	2.1%	0.9%

The table shows, for each asset class, the average of the expected return and risk estimates used by seven large wealth management institutions as part of their capital market assumptions.

Table B2. Correlation Matrix, Part 1 and Part 2

The tables shows the historical correlations based on weekly returns on indices representing each asset class from August 2008 through August 2013.

Table B2, Part 1

	Large Cap	Small Cap	International Equity	Emerging Market Equity	Investment Grade	High Yield	International Fixed Income
Large Cap	1.00	0.94	0.83	0.77	-0.13	0.59	0.19
Small Cap	0.94	1.00	0.75	0.70	-0.12	0.54	0.13
International Equity	0.83	0.75	1.00	0.90	-0.12	0.60	0.39
Emerging Market Equity	0.77	0.70	0.90	1.00	-0.07	0.61	0.28
Investment Grade	-0.13	-0.12	-0.12	-0.07	1.00	0.12	0.35
High Yield	0.59	0.54	0.60	0.61	0.12	1.00	0.12
International Fixed Income	0.19	0.13	0.39	0.28	0.35	0.12	1.00
Hedge Fund	0.04	0.00	0.05	0.03	0.05	0.19	0.20
Private Equity	0.81	0.76	0.91	0.85	-0.08	0.65	0.27
Private Real Estate	0.84	0.86	0.64	0.63	-0.02	0.48	0.21
Commodities	0.55	0.48	0.58	0.55	-0.15	0.43	0.32
Cash	-0.24	-0.20	-0.20	-0.21	0.15	-0.19	0.20

Table B2, Part 2

	Hedge Fund	Private Equity	Private Real Estate	Commodities	Cash
Large Cap	0.04	0.81	0.84	0.55	-0.24
Small Cap	0.00	0.76	0.86	0.48	-0.20
International Equity	0.05	0.91	0.64	0.58	-0.20
Emerging Market Equity	0.03	0.85	0.63	0.55	-0.21
Investment Grade	0.05	-0.08	-0.02	-0.15	0.15
High Yield	0.19	0.65	0.48	0.43	-0.19
International Fixed Income	0.20	0.27	0.21	0.32	0.20
Hedge Fund	1.00	0.02	0.04	0.22	-0.01
Private Equity	0.02	1.00	0.66	0.52	-0.21
Private Real Estate	0.04	0.66	1.00	0.40	-0.12
Commodities	0.22	0.52	0.40	1.00	-0.09
Cash	-0.01	-0.21	-0.12	-0.09	1.00

Client Service Information is Available 24 Hours a Day

clientservice@msci.com

Americas

Americas	1.888.588.4567 (toll free)
Atlanta	+ 1.404.551.3212
Boston	+ 1.617.532.0920
Chicago	+ 1.312.675.0545
Montreal	+ 1.514.847.7506
Monterrey	+ 52.81.1253.4020
New York	+ 1.212.804.3901
San Francisco	+ 1.415.836.8800
Sao Paulo	+ 55.11.3706.1360
Stamford	+1.203.325.5630
Toronto	+ 1.416.628.1007

Europe, Middle East & Africa

Cape Town	+ 27.21.673.0100
Frankfurt	+ 49.69.133.859.00
Geneva	+ 41.22.817.9777
London	+ 44.20.7618.2222
Milan	+ 39.02.5849.0415
Paris	0800.91.59.17 (toll free)

Asia Pacific

China North	10800.852.1032 (toll free)
China South	10800.152.1032 (toll free)
Hong Kong	+ 852.2844.9333
Seoul	00798.8521.3392 (toll free)
Singapore	800.852.3749 (toll free)
Sydney	+ 61.2.9033.9333
Tokyo	+ 81.3.5226.8222

Notice and Disclaimer

About MSCI

MSCI Inc. is a leading provider of investment decision support tools to investors globally, including asset managers, banks, hedge funds and pension funds. MSCI products and services include indices, portfolio risk and performance analytics, and governance tools.

The company's flagship product offerings are: the MSCI indices with close to USD 7 trillion estimated to be benchmarked to them on a worldwide basis[1]; Barra multi-asset class factor models, portfolio risk and performance analytics; RiskMetrics multi-asset class market and credit risk analytics; IPD real estate information, indices and analytics; MSCI ESG (environmental, social and governance) Research screening, analysis and ratings; ISS governance research and outsourced proxy voting and reporting services; and FEA valuation models and risk management software for the energy and commodities markets. MSCI is headquartered in New York, with research and commercial offices around the world.

[1] *As of September 30, 2012, as published by eVestment, Lipper and Bloomberg on January 31, 2013* *Apr 2013*