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Retirement Income Covenant Position Paper: Stage One of the Retirement Income Framework – May 2018

As a global leader in implementing 'next generation' retirement solutions built around a retirement income goal, Dimensional Fund Advisors is well placed to provide guidance to the Australian Treasury in its design of a new retirement income framework.

Over recent years, Dimensional has helped lead the discussion in Australia around retirement income solutions. These efforts include sharing information on the retirement income-focused solutions we have developed for other defined contribution markets, engaging with global index providers to design indices that focus on managing retirement income risk, and sharing the contributions of Professor Robert Merton, a Nobel Laureate, MIT economist and resident scientist with Dimensional.

In this submission, we provide our thoughts on regulation, the market instruments that can facilitate the implementation of efficient retirement solutions, the design of retirement income-focused strategies and how to build meaningful engagement with fund members around such strategies.

Covenant Principles – 1. Retirement Income Strategy

We agree with Treasury that the superannuation system should provide members with investment choices focused around retirement income. Our view is that a key component of these solutions should be to manage retirement income volatility through both the accumulation and retirement phases.

We also believe that as appropriate disclosure will be a key component of any CIPR, funds should be required to provide meaningful income estimates to protect members against drawing incorrect conclusions on the stability of their retirement income streams.

To those ends, we believe any guidance or rule-making from Treasury should be outcome-based rather than prescriptive. Outcome-based guidance encourages innovation and competition. This in turn drives the creation of lower cost, liquid and more efficient retirement income-focused solutions.

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For example, it might encourage the creation of accumulation-phase vehicles that provide members with greater certainty about how much retirement income they can afford long *before* they retire. Having members take appropriate actions in the accumulation phase is the primary way to ensure they are ready for retirement and do not have to rely mainly on the age pension. Also, we believe that accumulation-phase solutions managed with the goal of integrating seamlessly to decumulation-phase solutions that provide steady retirement income are key to the successful adoption of the latter.

Our view is that prescriptive guidance and rules would increase the risk of members having access only to higher cost or incomplete solutions. For example, if superannuation funds conclude that offering guaranteed products is the only way to meet CIPR requirements members may be left with choices they either do not want, do not understand or cannot afford.

Covenant Principles – 2. Engagement

Along with performance-based guidance or rules, it is important that trustees provide meaningful calculators and income estimates to members during the accumulation and decumulation phases. The regulatory environment should be changed to allow for this.

Generally, we define successful retirement savings and investment approaches as those that allow members to move from working life to retired life without large shocks to their consumption. Such approaches should lead to steady retirement income and provide the flexibility people require to meet the costs of unexpected life events.

Our experience is that providing meaningful information about projected retirement income *prior* to retirement and ongoing estimates *in* retirement builds engagement with members.

To be meaningful, retirement income estimates must be communicated in an intuitive way and the estimates should be tied to the investment solution. Retirement income estimates are reliable only if the member's solution robustly manages retirement income volatility in both the accumulation and decumulation phases. To be meaningful, income estimates need to communicate intuitively the expected retirement income volatility in addition to any retirement income estimate.

By providing people with retirement income-based reporting *before* they retire, members can more easily assess their retirement readiness at a time in their lives when their actions, such as by saving more, have the potential to make a meaningful change to their retirement outcomes.

As many studies show member engagement tends to be infrequent, it means that when they do engage the information needs to be sufficiently meaningful to encourage further engagement. On this score, our experience shows that retirement income calculators and reporting on expected retirement income are effective in building that engagement. We also believe that effective communication during both the accumulation and decumulation phases is vital to successful outcomes.

Long-Term Bond Issuance

Finally, we believe Treasury should consider more frequent issuance of long-term bonds that are indexed to inflation or standard of living.

It might also be beneficial to explore bonds with different types of coupon payments - for example, bonds that pay coupons only (no principal repayment), but don't begin making those payments until well into the future. We believe a deep market in these types of securities would allow for the implementation of liquid and cost-effective retirement income-focused solutions.

Unexpected life events are part of living. Members would receive great utility from solutions that provide steady retirement income but allow them to retain control of their capital to deal with such events.

Accompanying this letter, we have included thought leadership pieces on retirement that Dimensional researchers have authored over the past decade around the subjects of how to provide both retirement income certainty and meaningful communication. These pieces were prepared by our U.S. affiliate for a U.S. institutional audience and were written in a U.S. regulatory context. Terminology and references contain therein should be understood in that context.

Dimensional

RESEARCH

Retirement Planning: An Introduction to Liability-Driven Investing

March 2016

Massi De Santis, PhD
Vice President
Research

Retirement planning often involves balancing potentially conflicting objectives, such as preservation of account balance and funding future retirement consumption from the portfolio (liability management). We look at how different fixed income strategies can have very different volatility profiles when measured in terms of account balance or in terms of consumption. The analysis highlights the importance of defining and managing risks in units consistent with the investment objective.

INTRODUCTION

An appropriate fixed income strategy should be consistent with an investor's objectives and the risks that the investor is trying to manage. Capital preservation is a common objective when one of the risks is uncertainty about the future dollar value of the investor's assets. Liability management is another common objective when facing interest rate risk resulting from any duration mismatch between the investor's assets and liabilities.[1] Strategies designed for capital preservation generally have little variability in dollar values. Strategies designed for real liability management often have low variability when measured in units tied to the cost of the liability.

Preserving capital and funding retirement consumption—an example of liability management—are common goals for many households. In this paper, we quantify how a fixed income strategy that meets one of these goals may not be effective in meeting the other. We also explore what drives the cost of funding future retirement consumption. We hope this paper provides a useful starting point for quantifying the tradeoffs between these goals so households can better manage the risks associated with them.

Chris Denning and Samuel Wang provided helpful comments and research assistance.

1. Duration measures the sensitivity of the value of an investment to interest rate changes. Duration is related to the average maturity of the cash flows expected from the investment. Investments with longer dated cash flows are typically more sensitive to interest rate changes. A mismatch can arise if liabilities and assets have different sensitivities to interest rates, as changes in interest rates can cause changes in net worth (capital risk).

SELECTING A FRAMEWORK FOR COMPARISON

It is important to choose appropriate units when analyzing the performance of an investment strategy. The most common way to measure performance is to track the balance of the account. This approach is most appropriate for strategies that have "dollar value" goals—such as wealth accumulation or capital preservation.

For strategies designed to manage a real or nominal liability, the most appropriate performance measurement unit should be linked to the liability that the strategy is designed to manage.

The following example illustrates the difference between the two goals. Consider investors Jill and Mary, who both need at least $100 in 10 years. Jill buys a zero coupon treasury maturing at $100 in 10 years. The cost of that bond depends on interest rates today. In other words, the cost of $100 in 10 years is known today. In our hypothetical example, if interest rates are 3%, the cost would be $75. So, $75 today would grow to $100 in 10 years if invested in a 10-year zero coupon bond.

The value of Jill's investment will change as interest rates change. As a result, her investment will exhibit some level of volatility. Regardless of what happens to interest rates and the investment value, Jill can reasonably expect to have $100 in 10 years. The liability is fully funded.

Mary also needs $100 in 10 years, but she prefers short-term bonds and chooses to invest in one-year notes and roll them annually over the next 10 years. Because of this investment preference, Mary is faced with two issues. First, she needs to estimate how much to save today, but there will be uncertainty in that estimate. The second issue is uncertainty in the final value of her investment. Therefore, she must also decide how much additional money to save today to mitigate a possible shortfall in 10 years.

To estimate how much she needs to save today, Mary might use today's yield on one-year notes. Short-term debt has generally had lower yields than longer-term debt, so it is reasonable to assume one-year notes are yielding 2%. Using a constant 2% yield, if the yield on one-year notes were to remain constant for the next 10 years, Mary estimates she must save $82 today to afford $100 in 10 years.

Mary's estimate of the cost to fund $100 is noisy. Jill's estimate is not. While not certain, Mary estimates it will cost her $82 to fund her liabilities. Jill is confident she can do it for less, at $75, and that she can "lock in" that price today.

In reality, interest rates change over time; there is uncertainty about what interest rates will be in the future. Mary is rolling one-year notes, which implies that when each one-year note matures, she needs to buy a new one-year note. Mary must deal with reinvestment risk. Starting with $82, there is no way to know today if Mary will have $100 in 10 years, something less, or something more. There is a lot of uncertainty in the final value of Mary's investment. What might Mary do to manage this uncertainty if she is not willing to purchase the 10-year bond? She could invest more than $82 today to improve the probability of attaining at least $100 in 10 years. How much more depends on how much certainty she desires. So the cost to fund at least $100 in 10 years might be even more expensive than $82 if Mary wants to reduce the probability of shortfall due to interest rate risk.

What is the lesson? While interest rate changes may lead to volatility in the value of Jill's 10-year bond, she has little uncertainty about the value of her investment at the end of 10 years. Mary preferred stability of principal. She chose to invest in short-term bonds when her goal was to fund a long-term liability. This is an unnecessary preference given her goal, and it comes with a cost. Mary must determine how to estimate the amount she needs to save today, is faced with considerable risk of not meeting her liability, and on expectation pays more to fund that liability. In short, Mary is using the wrong investment for the goal.

A common objective in retirement planning is to sustain an inflation-adjusted consumption stream for the expected retirement. Conceptually, an inflation-adjusted consumption stream could be constructed using a set of zero coupon bonds maturing at each planned withdrawal date in retirement. The cost of this consumption stream gives us an indication (based on market information and updated continually) of how much consumption a given level of wealth could provide. As interest rates change, the consumption level that can be expected from a given balance will change. If real interest rates rise (fall) the cost of the consumption stream is expected to fall (rise), and the consumption a given amount can afford will increase (decrease).

Thus, the cost of a $1 consumption stream can be used by an investor to convert their account balance now into consumption later. By measuring performance (particularly, the volatility of the returns) in both the performance of the account's balance and consumption units, we can compare strategies designed to achieve different goals and highlight the tradeoffs an investor should consider.

THE DATA

The potential mismatch between assets and liabilities in terms of their sensitivity to interest rates is an important driver of how effectively the asset can manage interest rate risk for a given goal. To explore this relationship, we consider three common fixed income indices with different maturities and interest rate sensitivities: one-month US Treasury bills, the Barclays US Aggregate Intermediate Bond Index (Barclays index), and the S&P 15+ Year US Treasury TIPS Index (S&P 15+ year TIPS index).

Because future retirement consumption is a real liability, we must measure consumption risk in inflation-adjusted units. We adjust all returns by the consumer price index (CPI) and show results in real wealth and consumption units. Performing this analysis requires real interest data. We use real interest data on S&P TIPS indices from January 2003 to December 2015.[2]

For our example, consumption payouts typically do not start until retirement, so we assume that the consumption stream starts in January 2016. This way we can think of our experiment as measuring the performance for a hypothetical investor who plans to retire in 2016. To convert from a lump sum of money to future consumption, each month we compute the theoretical price of a consumption stream that begins payments in January 2016 and makes monthly payments for 25 years. We call this theoretical price the estimated "cost of retirement consumption." We divide total wealth by this price to derive an estimate of the consumption stream a level of wealth can afford. By doing this we are asking the following questions: If in January 2003, our goal was to manage the risk that we could not fund retirement consumption with payments beginning in January 2016, what bonds would have worked best? By choosing such bonds, what would we have sacrificed?

Our sample period includes two equity market declines and significant interest rate volatility around a generally declining interest rate. When measuring "success," we focus on the variability of a strategy in wealth and consumption units. While our sample period is relatively short, it provides useful information about the ability of different fixed income instruments to manage the risks associated with real capital preservation or real liability management goals over different market environments.

We use the returns of one-month T-bills as a simple capital preservation strategy and the returns on the Barclays index as a benchmark for an intermediate-term fixed income investment. We use the returns on the S&P 15+ year TIPS index to represent the returns on a long-term bond strategy that is more closely aligned with the cost of the consumption stream in terms of its sensitivity to interest rates. Later in the paper we will use TIPS indices of different durations as component pieces of a liability management strategy in which the critical input is the duration of the asset and the liability.

RESULTS

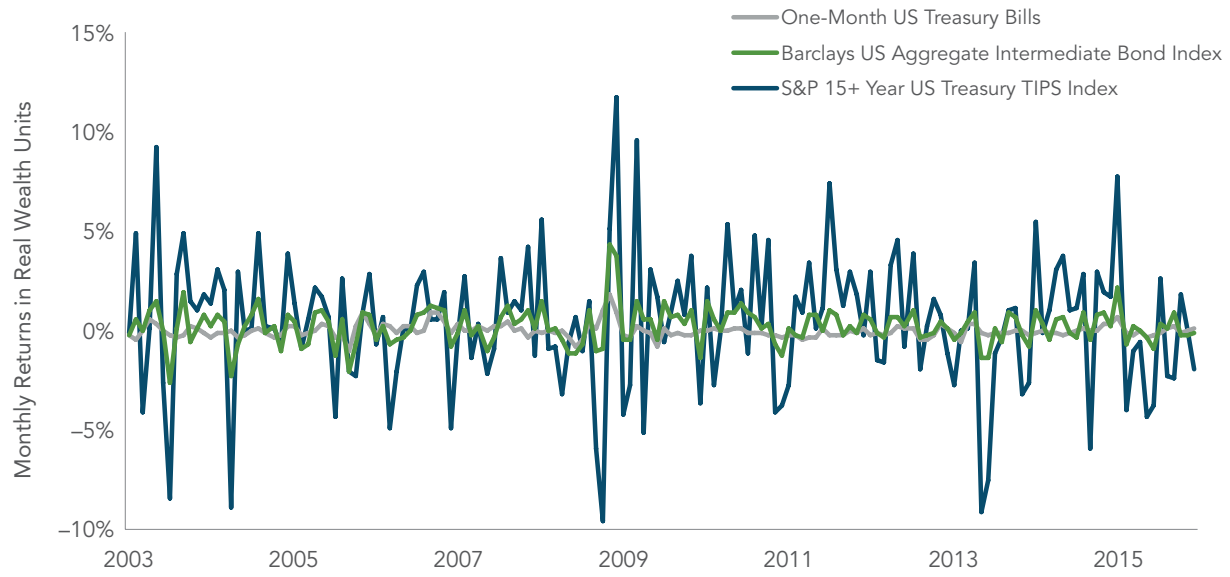
Exhibits 1 and **2** show the returns of the three fixed income strategies in wealth and income units, respectively. When measuring returns in wealth units, one-month T-bills have the lowest volatility while the S&P 15+ year TIPS index has the highest. It is striking how this pattern is reversed when measured in consumption units—T-bills have the most volatile returns.

This pattern is further illustrated in **Exhibit 3**, which shows summary statistics measured as monthly changes in account balance and in consumption units. Again, we see that while one-month T-bills protect capital against large swings, they have the highest volatility in consumption units: 1.2% vs. 13.3%. The S&P 15+ year TIPS index has the highest standard deviation in wealth units and the lowest in consumption units: 11.8% vs. 3.8%.

The low annualized standard deviation of one-month T-bills highlights the strength of this strategy for preserving capital. The minimum monthly return (in units of real wealth) is –1.1%. The S&P 15+ year TIPS index is the least suitable when capital preservation is the objective.

2. The start date corresponds to the date when there is a rich enough set of S&P TIPS indices to estimate yield curves.

Exhibit 1 CPI-Adjusted Monthly Returns: January 2003–December 2015



Returns in real wealth units are monthly returns of one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices minus the contemporaneous change in CPI. Past performance is no guarantee of future results.

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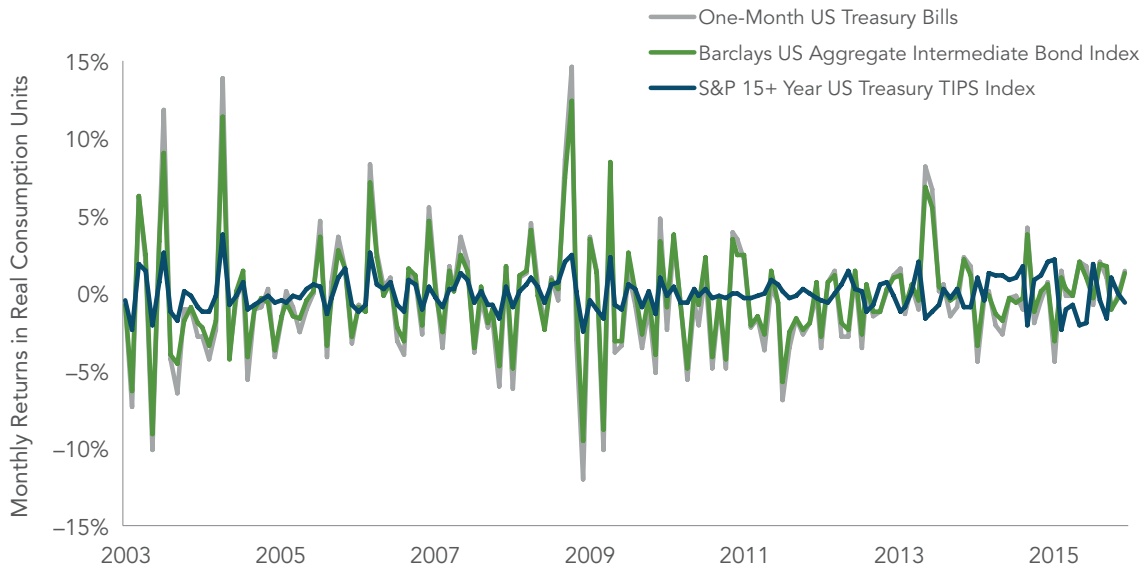
Exhibit 2 Monthly Returns in Units of a Real Consumption Stream: January 2003–December 2015



Monthly simulated returns in real consumption stream are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016. Please see disclosure section for important information regarding simulated data and its limitations.

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Exhibit 3 Returns in Real Wealth and Consumption Units: January 2003–December 2015

	Real Wealth Units			Real Consumption Units (Simulated)		
	One-Month US Treasury Bills	Barclays US Aggregate Intermediate Bond Index	S&P 15+ Year US Treasury TIPS Index	One-Month US Treasury Bills	Barclays US Aggregate Intermediate Bond Index	S&P 15+ Year US Treasury TIPS Index
Average (annualized)	–0.8%	1.9%	4.5%	–4.1%	–1.7%	–0.5%
Std. Dev. (annualized)	1.2%	3.2%	11.8%	13.3%	11.3%	3.8%
Best Month	1.8%	4.3%	11.8%	14.6%	12.5%	3.8%
Worst Month	–1.1%	–2.7%	–9.7%	–12.0%	–9.5%	–2.5%
Best Quarter	3.1%	12.5%	29.1%	23.9%	21.1%	5.4%
Worst Quarter	–3.6%	–4.0%	–20.4%	–11.7%	–9.9%	–4.7%
Best Year	3.6%	7.6%	12.4%	21.9%	22.4%	11.3%
Worst Year	–1.8%	–3.1%	–17.1%	–24.7%	–19.9%	–6.2%

Returns in real wealth units are monthly returns of one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices minus the contemporaneous change in CPI.

Monthly simulated returns in real consumption units are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016. Please see disclosure section for important information regarding simulated data and its limitations.

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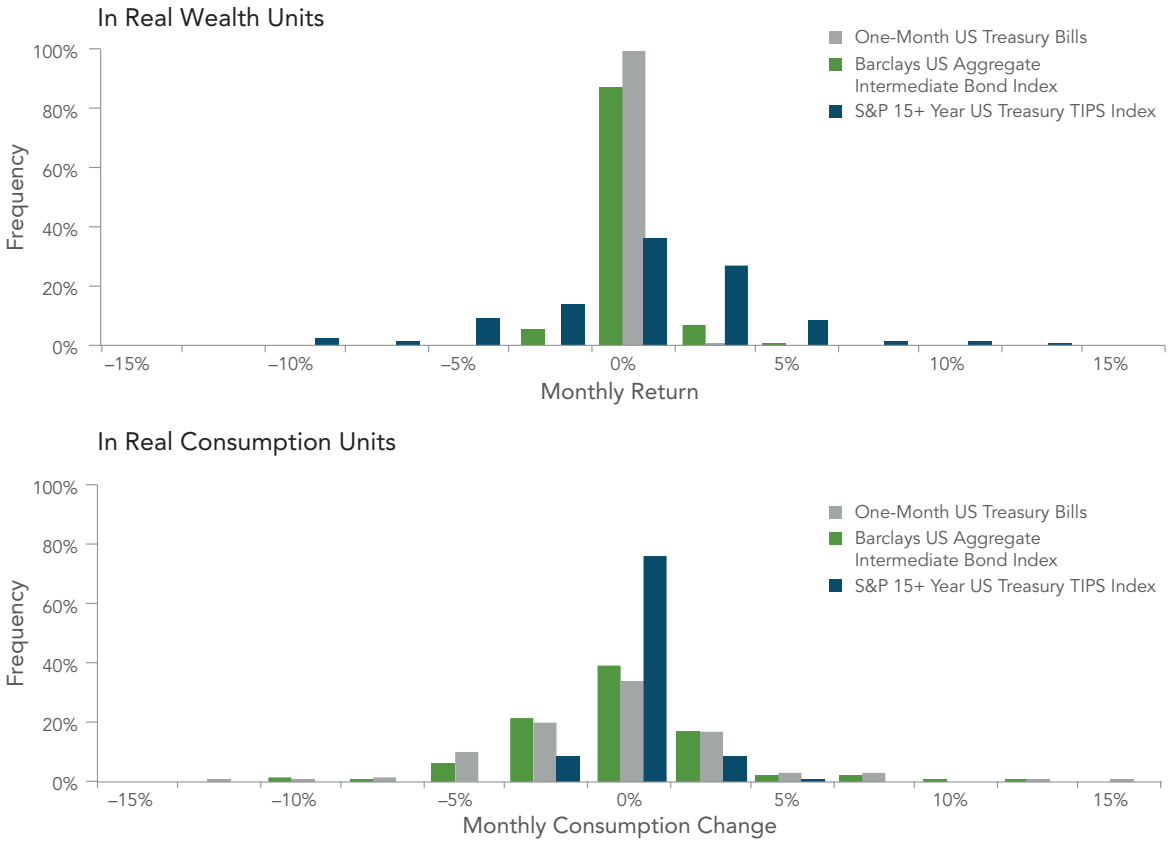
The minimum monthly return of this strategy (measured as change in account value) is –9.7%. In contrast, when measured in consumption units, one-month T-bills are the least suitable of the three strategies to hedge future consumption, while the S&P 15+ year TIPS index is the most suitable. **Exhibit 4** further illustrates this. One-month T-bills have the tightest distribution in wealth units, while the S&P 15+ year TIPS index has the tightest distribution in consumption units.

We summarize the wealth-consumption volatility tradeoff in **Exhibit 5**. One-month T-bills are on the left of the graph. They have the smallest changes in value but the largest consumption volatility. In contrast, the S&P 15+ year TIPS index has small consumption volatility but can experience large fluctuations in value. The Barclays index lies approximately on a line between one-month T-bills and the S&P 15+ year TIPS index. This chart is not designed to illustrate the superiority of one investment over another. Rather, it illustrates that an investment well suited for capital preservation may not be suitable for liability management and vice versa. The most appropriate strategy should be related to the investor's priorities—the objectives and risks to be managed.

So, if in January 2003 our goal was to manage the risk that we would not be able to fund retirement consumption with payments beginning in January 2016, this analysis shows that longer-term TIPS would have been most appropriate. What would we have sacrificed? Low volatility when measured in real dollar terms. This highlights the tradeoff between short-term capital preservation and longer-term liability management. A strategy that effectively manages the risk of not achieving one objective may do a poor job of managing the risks associated with the other.

Exhibit 4 Histogram of Monthly Returns: January 2003–December 2015



Returns in real wealth units are monthly returns of one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices minus the contemporaneous change in CPI.

Monthly simulated returns in real consumption units are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016. Please see disclosure section for important information regarding simulated data and its limitations.

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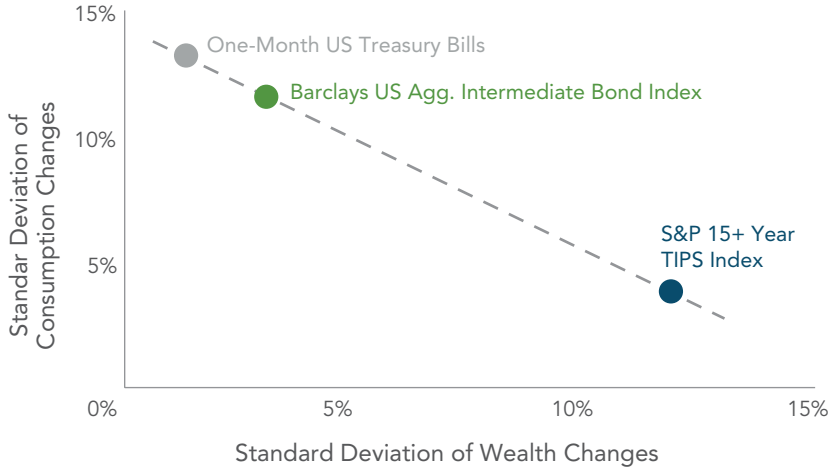
In general, the least risky investment for each goal depends on the cash flow pattern of the goal. If the goal is to meet a nominal liability in *N* years, the investment that reduces the risk of not meeting the liability is the *N*-year nominal discount bond. For a real liability, a real discount bond. With this framework in mind, the risk reducing asset for any cash flow pattern can be constructed, at least theoretically.

A LIABILITY-DRIVEN INVESTMENT STRATEGY

So far, we have considered three strategies with different interest rate sensitivities. We observed that the longer-term strategy had the lowest volatility in simulated consumption units. The question naturally arises: Can we do better? That is, can we construct a strategy with lower volatility in consumption units? In this section, we focus on the cost of future retirement consumption, what drives that cost, and how we might better hedge that cost.

Exhibit 6 shows the theoretical price of a $1 annual consumption stream that begins payments in January 2016 and makes monthly payments for 25 years (300 monthly payments of $1 / 12 beginning in January 2016) using

Exhibit 5 Standard Deviation of Wealth vs. Consumption: January 2001–December 2015



Returns in real wealth units are monthly returns of one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices minus the contemporaneous change in CPI.

Monthly simulated returns in real consumption units are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016. Please see disclosure section for important information regarding simulated data and its limitations.

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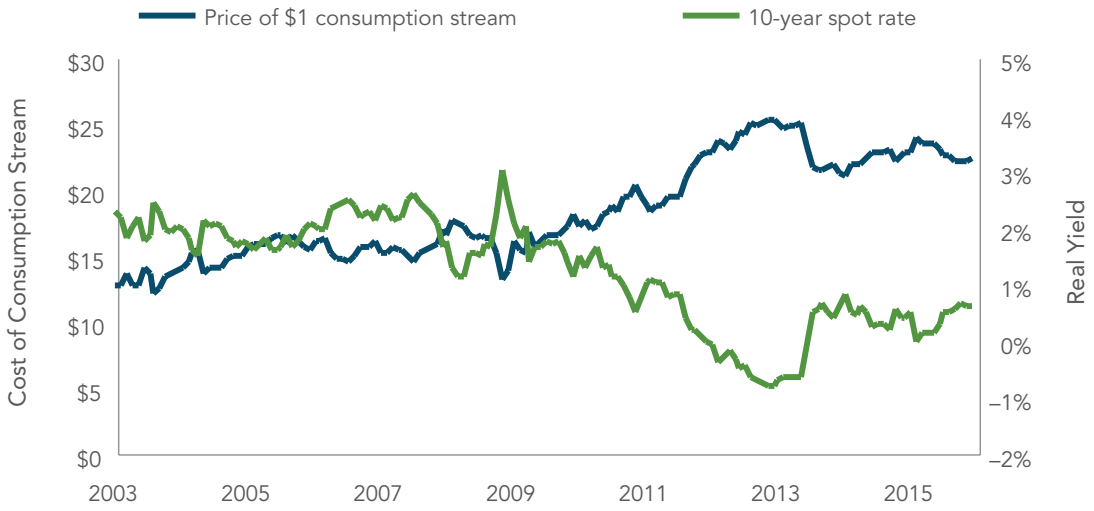
Exhibit 6 Estimated Cost of Future Consumption: January 2003–December 2015.



Monthly simulated returns in consumption stream are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016. Please see disclosure section for important information regarding simulated data and its limitations.

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prevailing interest rates at the end of each month.[3] Also shown are 10-year real yields. We can see that as interest rates declined, the cost of the estimated future consumption stream increased. The consumption stream is "real" because payments are assumed to adjust with inflation. The insight we gain from **Exhibit 7** is that future consumption payments are like a bond. As with the price of a long-term bond, the price of these future payments will be strongly related to their duration.

This explains why the strategies from the previous section behave so differently when their performance is measured in units of wealth vs. units of consumption. Long-term bond prices are more sensitive than short-term bond prices to interest rate movements. So, the dollar volatility of the S&P 15+ year TIPS index was higher than the one-month T-bills strategy. Retirement investors, however, can view their fixed liabilities as a real retirement consumption stream—a series of future cash flows that behave like a long-term bond. When interest rates go down, bond prices tend to go up; so does the value of their liability (the cost to fund the retirement consumption stream). Because the duration of the S&P 15+ year TIPS index was closer to the duration of the liability (the cost of the future consumption stream) than one-month T-bills, it tended to move in tandem with it. So, the S&P 15+ year TIPS index partially neutralized changes in the liability and had lower volatility than the one-month T-bills strategy when measured in units tied to that liability.

For investments that closely track the cost of future consumption, we should also observe a higher correlation between the returns on those investments and the changes in that cost. Exhibit 7 shows that this is the case. The duration of the future consumption stream decreases from approximately 24 years to approximately 12 years during our sample period, with an average duration of 18. The duration of the S&P 15+ year TIPS index ranges from 14 to 23 in the sample, so it is the investment that moves closest to the cost of retirement consumption among the ones considered so far. In contrast, T-bills, with a duration of approximately one month, have very little co-movement with the estimated cost of retirement consumption.

Investments that co-move with the cost of retirement consumption help narrow the distribution of outcomes in consumption terms. Thus, choosing investments that, on expectations, co-move closely with retirement consumption (the investor's liability) is a form of liability-driven investing or LDI. The duration of the consumption stream decreases to 11.7 by the end of the sample period, when payments are assumed to start. This result suggests that we can design a more efficient LDI strategy by combining the S&P 15+ year TIPS index with a shorter duration TIPS index to form a portfolio that can more closely match the duration of the future consumption stream. For this purpose we use the S&P 7–10 Year US Treasury TIPS Index, with an approximate duration of seven to eight years.

Exhibit 7 Correlation between Monthly Return and Cost of Future Consumption (Simulated)

Correlation Jan 2003–Dec 2015	One-Month US Treasury Bills	Barclays US Aggregate Intermediate Bond Index	S&P 15+ Year US Treasury TIPS Index
Cost of $1 Cash flow for 25 years	5.9%	70.9%	96.2%

Returns in real wealth units are monthly returns of one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices minus the contemporaneous change in CPI.

Monthly simulated returns in real consumption units are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016. Please see disclosure section for important information regarding simulated data and its limitations.

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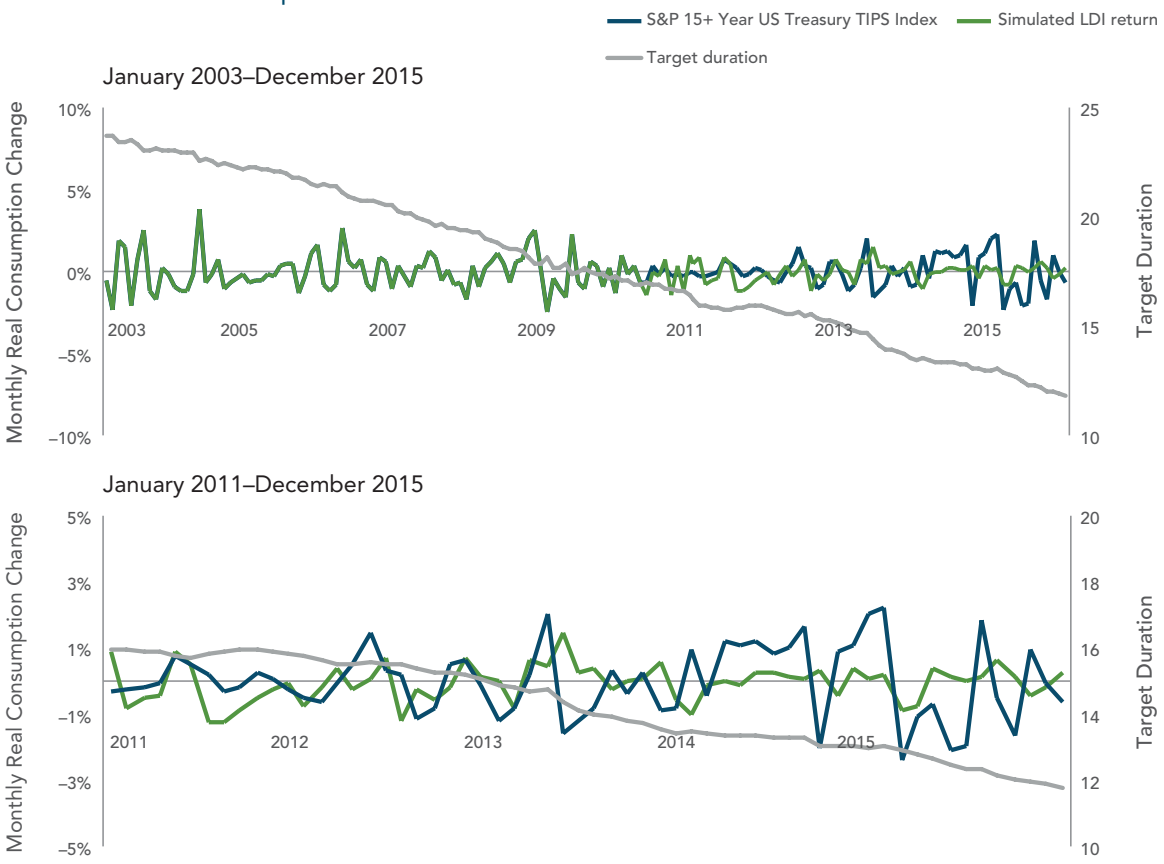
3. Source: US Industry annuity provider, September 2013. Life-only assumptions are based on qualified assets for a male age 65, living in Texas, Single Life payout option. The annuity rate for a female may cost more than the rate for a male; this may generate less income over the life of a female retiree. Income payment depends on claims-paying ability of issuing insurance company. Monthly income amount depends on variables that will change, such as age, mortality, and interest rates.

In **Exhibit 8**, we compare the simulated monthly returns of the LDI (7–10 year/15+ year) bond combination and the S&P 15+ year TIPS index in consumption units for the last five years of the period.[4] In our analysis, we assume that the consumption payments start at the end of the sample period. Thus, Exhibit 8 illustrates the last 13 and five years prior to retirement for a hypothetical investor. If we had perfect hedging of consumption risk (e.g., by holding units of a "theoretical" retirement bond that matches all the cash flows), we would observe a flat line in the chart. The LDI strategy based on duration matching is not a perfect hedge because the price consumption stream does not change linearly with respect to the underlying interest rate.[5] But it is an effective hedge, with an annualized standard deviation in consumption units equal to 3.3% over the full sample and 2.9% over the last five-year period of Exhibit 8. The ability to hedge consumption risk using the LDI strategy can be a helpful tool for investors seeking to "lock in" at least partially, a consumption goal prior to retirement. The exhibit shows the improvement over the S&P 15+ year TIPS index closer to the retirement date, when a shorter duration is needed to match the duration of the liability.

Exhibit 8 Returns in Consumption Units



Returns in real wealth units are monthly returns of one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices minus the contemporaneous change in CPI.

Monthly simulated returns in real consumption units are the CPI-adjusted returns of the one-month US Treasury bills, Barclays US Aggregate Intermediate Bond Index, and S&P 15+ Year US Treasury TIPS indices adjusted by the monthly change in the cost of $1 inflation-adjusted annual stream for 25 years. The cost of a 25 year $1 cash flow is computed using real yields on TIPS. TIPS data from S&P indices. The $1 cash flow starts on 1/1/2016.

Simulated LDI bond portfolio is constructed by weighting S&P 15+ Year US Treasury TIPS Index, S&P 7-10 Year US Treasury TIPS Index, and S&P 30 Year US TIPS Index through duration matching. Simulated LDI portfolio and S&P 15+ year TIPS index are presented minus the contemporaneous change in CPI. Durations of the 25-year cash flow are calculated under same assumptions as Exhibit 2. Please see disclosure section for important information regarding simulated data and its limitations.

One-month US Treasury bills © 2015 and earlier, Morningstar. All Rights Reserved. S&P data provided by Standard & Poor's Index Services Group. Barclays indices copyright Barclays 2015.

4. At each month end, we choose the weights of the S&P 15+ Year US Treasury TIPS Index and the S&P 7–10 Year US Treasury TIPS Index so that the duration of the resulting LDI bond combination is equal to the duration of the consumption. In earlier periods, the duration is high enough that most of the investment is in the S&P 15+ Year US Treasury TIPS Index, so the two strategies overlap.
5. Duration matching is based on a linear approximation of the price change.

CONCLUSION

We quantify the tradeoff between consumption and wealth variability for selected investment strategies. We find substantial differences when switching performance metrics from wealth units to consumption units. These differences suggest that investors concerned with capital preservation can benefit from focusing on wealth risk, while investors concerned with retirement consumption can benefit from focusing on consumption volatility. For consumption-focused investors, we show that a simple LDI strategy can be effective in managing consumption risk.

The analysis reveals that managing wealth variability and consumption variability are two different investment goals. Investments with low wealth volatility can have high consumption volatility and vice versa. The key to identifying the right investment strategy is deciding what matters most—wealth or retirement consumption.

Our findings highlight that in general, the risk reduction investment for a given goal depends on the cash flow pattern of the goal. So risk management should be based on instruments that attempt to match the sensitivity of the goal to key risks for the goal (a liability management framework).

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Investing involves risk and possible loss of principal. There is no guarantee strategies will be successful.

Fixed income securities are subject to increased loss of principal during periods of rising interest rates. Fixed income investments are subject to various other risks, including changes in credit quality, liquidity, prepayments, call risk, and other factors. Inflation-protected securities may react differently from other debt securities to changes in interest rates.

A liability-driven investment (LDI) strategy is designed to focus on assets that match future liabilities. LDI strategies contain certain risks that prospective investors should evaluate and understand prior to making a decision to invest. These risks may include, but are not limited to, interest rate risk, counterparty risk, liquidity risk, and leverage risk.

Simulated data disclosure: Simulations used in this paper are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results may vary with each use and over time. These hypothetical incomes are used for discussion purposes only and are not intended to represent, and should not be construed to represent, predictions of future incomes or returns. Actual incomes may vary significantly.

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Dimensional

Dimensional's Solutions for Effective Retirement Planning

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Two key elements of striving toward a successful retirement are for plan sponsors, advisors, consultants, and plan participants to have access to (1) low-cost investment solutions that manage the right risks and balance the tradeoff between growth and risk management, and (2) meaningful information to facilitate decision making. Relevant information about expected retirement spending ("consumption") allows plan sponsors to more effectively implement default savings rates, auto-escalation procedures, and communication initiatives to help improve the retirement readiness of plan participants. In addition, we believe plan sponsors, advisors, and consultants can use tools such as Dimensional's My Retirement Income Calculator to prepare plan reports that include individualized information concerning the retirement readiness of their participants.

Plan sponsors can also provide ongoing resources that help participants evaluate the effect of their decisions on expected outcomes. Participants need to determine when to retire and the level of consumption they may need in retirement. To make these decisions, participants need to know the estimated amount of consumption they can expect from their account balance and future contributions. They also need the degree of uncertainty around those expectations. Armed with this information, plan participants can decide how much to save, when to retire, and how much to consume in retirement. Research shows that providing information to plan participants about the effect of their own choices on expected outcomes helps them make better decisions (EBRI 2014,[1] Levi 2014,[2] Goda et al. 2014[3]). Research also shows that failing to plan properly can lead to costly mistakes in terms of early withdrawals or penalties (Argento et. al. 2013[4]).

There is one important caveat: This type of information is only meaningful if the underlying investment solution manages the right risks and balances the tradeoff for the consumption goal. The risks to be managed are the risks that can affect the level of future retirement consumption that is sustainable with a given level of wealth. The right tradeoff is between the opportunity of asset growth and

1. How Would Defined Contribution Participants React to Lifetime Income Illustrations? Evidence from the 2014 Retirement Confidence Survey, *EBRI Notes*, March 2014. Survey funded in part and underwritten by Dimensional Fund Advisors.
2. Information Architecture and Intertemporal Choice: A Randomized Field Experiment in the United States.
3. What will my account really be worth? Experimental evidence on how retirement income projections affect saving. *Journal of Public Economics* 28, August 2014.
4. Early Withdrawals from Retirement Accounts During the Great Recession, Argento, Robert, Bryant, Victoria L., Sabelhaus, John. www.federalreserve.gov/pubs/feds/2013/201322/201322abs.html.

consumption risk management. Estimates of how much retirement consumption your account balance can sustain are not helpful without the right risk management, since you have no confidence in your ability to achieve that level of consumption when you retire. In our analysis, we assume a plan participant can invest in a solution that manages market, counterparty, inflation, and interest rate risks. By managing these risks, the uncertainty about retirement consumption can be reduced. This means the solution has to have a risk management investment matched to the participant's desired retirement date.

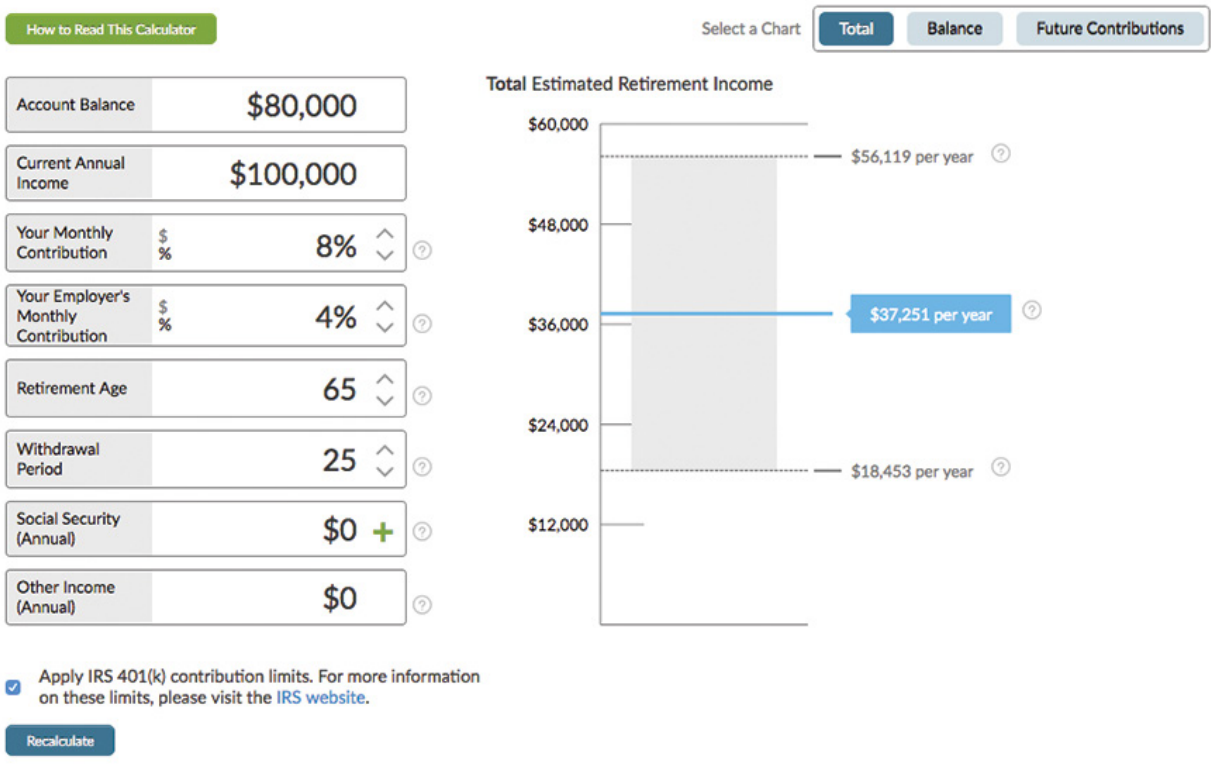
We believe that with the right goal and risk management framework, a retirement solution is more likely to seamlessly transition from accumulation to retirement, when assets will be used to provide real (inflation-adjusted) consumption.

DIMENSIONAL'S MY RETIREMENT INCOME CALCULATOR AND ITS BENEFITS

The Dimensional My Retirement Income Calculator provides perspective on an individual's expected retirement outcome by assessing an investor's ability to fund future retirement consumption goals with his/her savings. By using market data to estimate the future cost of a consumption stream, the calculator allows plan sponsors, advisors, consultants, and plan participants to estimate the ability of today's balance and contribution rate to support future retirement consumption.

It is important to consider current balance and contributions in terms of future consumption. The calculator provides participants the ability to see how present and future consumption are related. For financial planning purposes,

Exhibit 1 Dimensional's My Retirement Income Calculator: A Hypothetical 35-Year-Old



As of March 31, 2016. For illustrative purposes only.

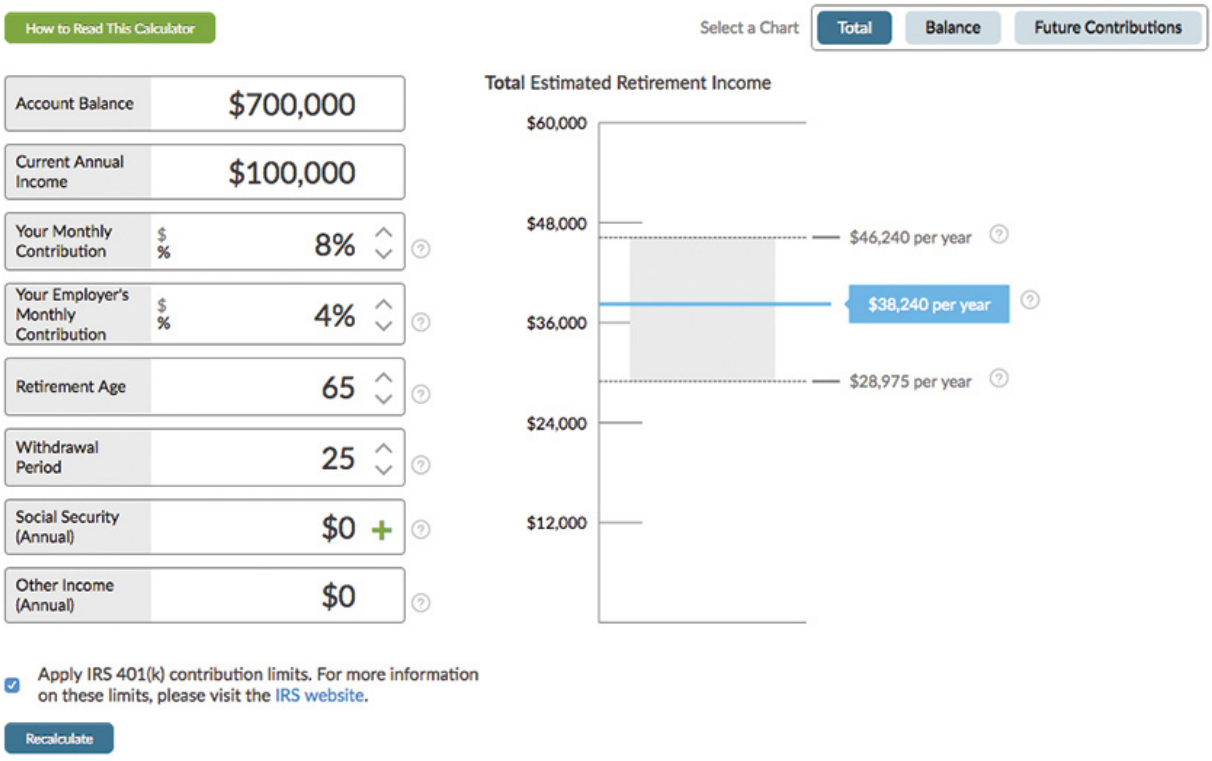
we believe this is a better comparison and can be more meaningful for a person's financial decisions.

One reason participants may have low savings rates is that while they understand the opportunity cost of a dollar saved today, they cannot easily quantify the benefit of that dollar for retirement (see Bernheim et al. 2011,[5] Choi et al. 2012,[6] and Levi 2014).

Exhibit 1 shows a simple example of a 35-year-old plan participant with an income of $100,000, an 8% savings rate, and an employer contribution of 4%, bringing her total savings per year to $12,000. She has a current balance of $80,000. These saving behaviors are estimated to yield, starting at age 65, $37,251 per year (expected median income at retirement) for a withdrawal period of 25 years.[7]

To estimate the effect of uncertain market returns, the calculator shows an uncertainty around the estimated median income. The upper level is an estimate of the 75th percentile of projected income (if market returns are greater than expected), while the lower level is an estimate of the 10th percentile of projected income (to give participants an estimate of the tail risk they may face in case of poor market performance). Participants further from retirement may see much larger uncertainty in those projections because they are likely to have a greater allocation to growth assets. Such assets increase their exposure to equity markets and do not seek to hedge the potential impact of future interest rate movements or inflation on their projected income. The range between the upper and lower estimate helps reflect these sources of uncertainty. Exhibit 1 shows that the range of the uncertainty band is wide (approximately 100% of the median estimate),

Exhibit 2 An Example Participant at Age 60



As of March 31, 2016. For illustrative purposes only.

5. Bernheim, B. Douglas, Andrey Fradkin, and Igor Popov 2011. "The Welfare Economics of Default Options: A Theoretical and Empirical Analysis of 401(k) Plans." NBER Working Paper 17587. National Bureau of Economic Research.
6. Choi, James J., Emily Haisley, Jennifer Kurkoski, and Cade Massey. 2012. "Small Cues Change Savings Choices." NBER Working Paper 17843. National Bureau of Economic Research.
7. See Appendix for methodology detail and assumptions.

highlighting the fact that many potential market outcomes are possible over a 30-year period. The median can serve as an indicator of whether participants are on track with their goals, and, if properly monitored, the median estimate can help participants stay on track.

The participant in our example shows an estimated median replacement rate of 37% of the final salary of $100,000. Adding a Social Security estimate of approximately $27,000 (which the calculator can incorporate using the amount estimated from the Social Security Administration's calculator), the overall replacement rate is 64%.[8] Participants can use these calculations to see if they are on track for their own replacement rate. Adjustments to contribution amounts in the calculator (from the employee or employer) can help participants consider the impact of adjustments to their savings plan.[9]

Exhibit 2 shows a 60-year-old participant with an account balance of $700,000. Contributions are still 8% and 4% (employee and employer contribution, respectively). The median income estimate is $38,240, very similar to the median in Exhibit 1. We can think of this example as the participant in Exhibit 1 at age 60 with an additional 25 years of savings and an accumulated balance of $700,000. Since most of the invested assets are focused on investments that seek to manage the risks relevant to retirement income, the range of outcomes has substantially narrowed to within 45% of the median estimate.

If the example participant retires at 65 with an account balance of $860,000, this balance yields a median income of $37,286, on track with previous estimates. At this stage, the range of uncertainty is within 29% of the median.

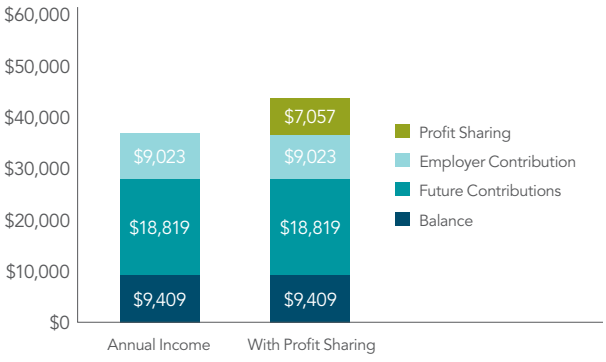
As retirement approaches, the participant is assumed to have an increasing allocation to inflation-protected bonds. This strategy is designed to manage the uncertainty around how much retirement consumption the participant can afford from his or her savings. Because of this, the range around the median retirement consumption estimate narrows. Why? The assumed asset allocation is less exposed to equity risk and seeks to hedge the effects that future interest rate changes or inflation can have on expected retirement consumption. This approach to risk management also implies the retirement consumption estimates can depend more on market data and less on assumptions about expected global equity and bond returns as retirement approaches.[10]

Having the right risk management is crucial to striving toward a successful outcome since retirees need confidence about the level of consumption they can afford in retirement. In some cases, these constraints are especially binding, such as workers with mandated retirement ages or health issues. The framework provided by the calculator gives participants the tools and information needed to calibrate their retirement expectations.

PLAN DESIGN CONSIDERATIONS

Dimensional's My Retirement Income Calculator is also useful for taking a bottom-up approach to retirement planning in that it can be used to break down the estimated retirement income by different sources of savings. In **Exhibit 3**, we can look at how the carried balance, employee contributions, and employer contributions work to create a combined retirement income for the participant.

Exhibit 3: Sources of Projected Retirement Income Estimates for an Example Participant



As of March 31, 2016. For illustrative purposes only.

8. The Social Security quick calculator can be accessed at www.ssa.gov/oact/quickcalc/.

9. As an additional help to plan for their goals, the calculator allows the breakdown of income estimates into its component pieces: estimated income from current account balance and estimated income from future contributions.

10. Assumptions about expected growth and expected volatility of the consumption growth assets are needed to make projections. With a longer time to retirement and a greater fraction devoted to growth assets, the estimates are relatively more sensitive to assumptions made. Closer to retirement, a greater fraction is devoted to risk management assets; income estimates from this allocation use market interest rates. See Appendix for methodological details.

These calculations show that the employer contribution accounts for over 25% of the estimated median income for our 35-year-old example participant.

Plan sponsors, advisors, and consultants can also use the calculator to evaluate the effect of plan changes on expected outcomes. As an example, Exhibit 3 shows the potential impact for the 35-year-old participant if the employer decided to provide additional support by implementing a profit-sharing program at around 3% of employee salary. Applying the 3% contribution to the calculator adds about $7,000 per year in retirement, bringing the replacement rate to around 44% before accounting for Social Security. These are tangible impacts that a plan sponsor, conscious of their employee retirement needs, can turn to for the purpose of designing or calibrating their plan to best fit their employee's needs.

CONCLUSIONS

Dimensional's My Retirement Income Calculator provides an innovative and intuitive approach for examining and planning for retirement. By integrating projected retirement income estimates with an appropriately relevant risk management framework, the calculator can provide investors with a retirement planning tool designed to help them monitor and track progress toward retirement readiness. By assuming investments in a combination of growth assets (equities and global bonds) and consumption risk-management assets (inflation-protected bonds matched to a target retirement date), the projections can give plan participants insight about the level of retirement consumption that their savings may support. We believe participants will find this information more useful than a simple account balance on their quarterly statement.

Plan sponsors, advisors, and consultants can use the calculator to design plans that help estimate the effect of changing the design of the employer contribution, auto-enrollment, and auto-escalation features and assessing the retirement readiness of their employees. This valuable information can help plan sponsors to improve participant outcomes and to communicate the entire value of the plan to their employees.

APPENDIX

Key Assumptions

Estimated retirement income projections are based on assumptions about returns using current and historical data, and income is generated through drawing down principal. The My Retirement Income Calculator ("the calculator") uses current interest rates on Treasury Inflation-Protected Securities (TIPS), expected to be updated quarterly. Global Equities are assumed to have a 5% expected real return with a 20% annual standard deviation, and Global Bonds are assumed to have a 1% expected real return with a 5% annual standard deviation. The covariance between Global Equities and Global Bonds is assumed to be zero. (Covariance measures how two asset classes move together.) These assumptions are net of expenses, which are assumed to be 0.30% annually. Annual expected returns are presented in excess of inflation and will be reviewed periodically.

The calculator uses the retirement year to select the appropriate corresponding asset allocation. The asset allocation shifts over time, with a larger portion of assets assumed to be invested in inflation-protected bonds as the retirement year approaches (see **Table 1** below for details).

Table 1: Assumed Asset Allocation by Years to Retirement

Years to Retirement	Global Equities	Global Bonds	Inflation-Protected Bonds
>25	95%	5%	0%
25	92%	8%	0%
20	79%	21%	0%
15	65%	16%	19%
10	52%	11%	38%
5	38%	5%	56%
Retirement year to 10 years post retirement	25%	0%	75%
>=15	20%	0%	80%

Percentages may not add to 100% due to rounding.

For example, if the computed retirement year is 2045, the calculator will select an asset allocation similar to the point in the table that corresponds with the number of years until 2045. The user's current age and retirement age (default of 65) are used to compute a retirement year. If the computed number of years until retirement falls between the five-year increments listed below, a blended allocation of the two nearest increments is used.

These assumptions are used to compute expected future wealth assuming a lognormal distribution of returns. The lognormal distribution is a standard statistical distribution used to represent outcomes from a random process and is commonly used to represent the distribution of returns. Estimated future wealth is divided by the estimated cost of $1 of inflation-adjusted income for the length of a user's withdrawal period. The cost of $1 of annual inflation-adjusted income during retirement is estimated using current interest rates on TIPS.

Using this methodology, we calculate two estimated distributions of income, one from a user's current account balance and the other from future contributions. The estimated retirement income projection from the current balance illustrates the expected income from a user's current account balance (meaning no additional future contributions are considered). The estimated retirement income projection from future contributions illustrates the expected income from future savings until retirement. It considers your total annual contribution and assumes the same amount (adjusted for inflation) is contributed each year until you retire.

The resulting estimated distributions of income, approximated by a lognormal distribution, are used to compute the median value of estimated retirement income, the 10th percentile of estimated retirement income, and the 75th percentile of estimated retirement income from the current balance and from future contributions. The median of a distribution represents the amount at which half of the expected outcomes are greater than the amount and half of the expected outcomes are lower than that amount. The 75th percentile of a distribution represents the amount at which 25% (or one out of every four) of the expected outcomes are larger than or equal to that amount. The 10th percentile of a distribution represents the amount at which 90% (or nine out of every 10) of the expected outcomes are larger than or equal to that amount.

The total value of the estimated retirement income projection is the sum of the estimated retirement income projections from the current balance and future contributions entered by the user. Taxes, penalties, and other fees or expenses that may be due upon withdrawal are not considered. The estimate is presented in today's dollars. For years past the retirement date, contributions are assumed to be zero, and the total projected retirement income shown represents the income that can be expected from a user's current account balance over the remaining withdrawal period.

Prior to the retirement year, the default withdrawal period is 25 years and can be adjusted by the user. After the retirement year, the default withdrawal period is 25 years minus the number of years since the retirement year and can be adjusted by the user. If the user adjusts the withdrawal period, the estimated retirement income projection is proportionally adjusted to account for the new number of withdrawals.

No representation or warranty is made as to the reasonableness of the assumptions or that all assumptions used in achieving the returns have been stated or fully considered. Changes in the assumptions may have a material impact on the estimated retirement income projections presented.

The assumptions are subject to change as subsequent conditions vary. Assumptions used for the estimated retirement income projections are subject to high levels of uncertainty regarding future economic and market factors that may affect actual future performance. There is no guarantee that these assumptions will be achieved, and actual returns or retirement income could be significantly higher or lower than those shown. These assumptions should not be relied upon as a forecast or prediction of future events, and they should not be construed as guarantees of returns that may be realized in the future from any asset class described herein.

Material Limitations

Because of the inherent limitations associated with the use of illustrative asset allocations based on the above assumptions, investors should not rely on the information shown in the My Retirement Income Calculator when making an investment decision. The illustrative retirement income projections cannot account for the impact that economic, market, and other factors may have on an actual investment portfolio. Unlike actual portfolios, the projections shown in the My Retirement Income Calculator do not reflect actual trading, liquidity constraints, fees, expenses, taxes, and other factors that could impact an investor's realized future returns and retirement income.

The estimated retirement income projections are hypothetical in nature and are not a guarantee of future results. Since past performance is not an accurate predictor of the future and reliance on historical and current data involves inherent limitations, you must understand that the estimates are only a tool to be used in evaluating your retirement portfolio. Actual results will vary.

Investments in stocks and bonds are subject to risk of economic, political, and issuer-specific events that cause the value of these securities to fluctuate. International investments are subject to additional risks such as currency fluctuation, political instability, and adverse economic conditions. The estimated retirement income projections are based on hypothetical investments in global equities, global bonds, and Treasury Inflation-Protected Securities. Other investments not considered may have characteristics similar or superior to those being analyzed.

IMPORTANT: The projections or other information generated by the My Retirement Income Calculator regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results may vary with each use and over time. Actual retirement incomes may vary significantly. Past performance is no guarantee of future results.

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