MORNINGSTAR®

The Impact of Managed Accounts on Participant Savings and Investment Decisions

Morningstar Research
2022 Update

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Introduction

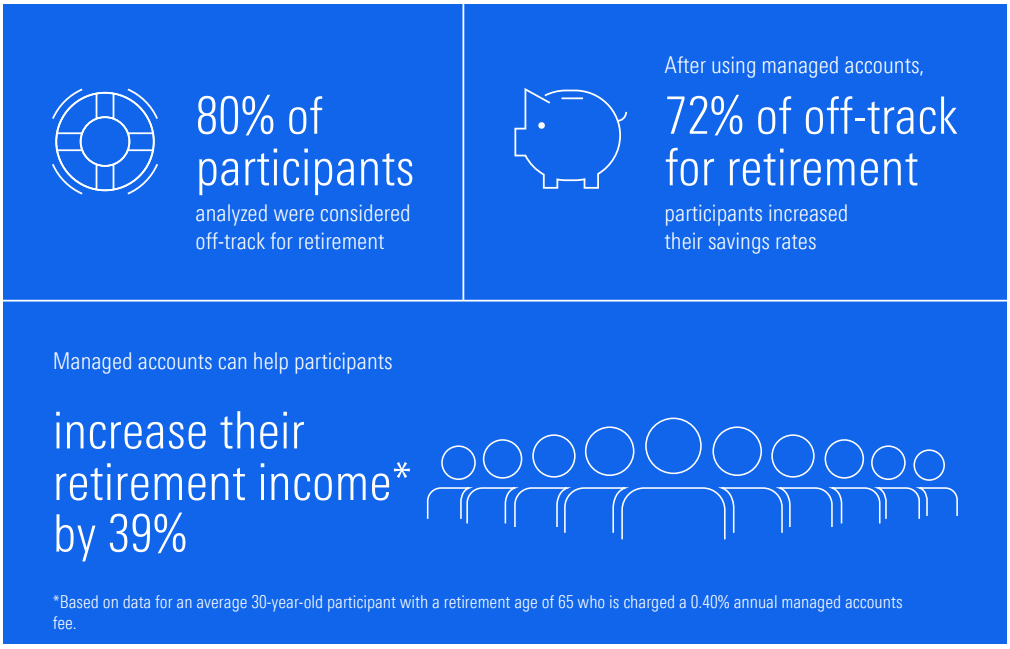
Since Morningstar Investment Management LLC published our original report, "The Impact of Managed Accounts on Participant Savings and Investment Decisions" in 2014, we have been committed to investigating the extent to which retirement-focused managed accounts services impact investors' readiness for retirement. What follows is an update to our previous reports with data that reflects trends current through the end of 2021.

The original report, along with its subsequent update in 2018, found that managed accounts provided value to individuals preparing for retirement in two domains: saving and investing for retirement. The analysis within the original report strongly suggested that managed accounts has the potential to improve retirement outcomes for defined contribution (DC) participants, with not-on-track, self-directed retirement savers reaping the greatest benefits. The new data in this report, updated in 2022, has analyzed data from 60,218 participants in Morningstar® Retirement Manager℠ and still upholds the original findings, demonstrating that the results of managed accounts have been consistently strong over the past several years.

Summary of 2022 Findings[1]

Our most recent analysis indicates that managed accounts continue to provide value to DC plan participants in terms of saving and investing for retirement. The most recent analysis sustains this view. The vast majority (80%) of participants analyzed were considered off-track for retirement, given that they had a projected retirement income of less than 70% of their salary at the time they opted into the service. 82% of participants analyzed were considered self-directors in their investment choices, or individuals with less than 90% of their portfolio in an 'allocation' fund, such as a target-date fund. Those identified as both off-track and self-directors were the most in need of the personalized advice offered by a managed accounts service.

After using managed accounts, 72% of off-track participants increased their savings rates. The median deferral rate was found to be a 33% increase from what individuals were saving prior to opting into the service, or about an average of 2% of their salaries. Additionally, a greater number of off-track participants began maximizing their employer match after entering a managed accounts service, with 12% more making the most of their match.



These outcomes will not be representative of each individual participant's experience with a managed accounts service. Actual results may differ substantially and could include an individual client incurring a loss or having less income in retirement. Please refer to the methodology for important information about the assumptions and limitations of this analysis.

Participants' usage of managed accounts also affected their investment strategies. After using managed accounts, participants' assets were placed into more efficient and more risk-appropriate portfolios. For both self-directors and allocation fund users, we observed improved expected annual returns both in nominal and risk-adjusted terms. Participants experienced increased utility because of the more risk-appropriate portfolios.

With the combined impact of improved saving and investment decisions, managed accounts appears to create better retirement income projections for individuals who use it. Assuming an annual fee of 0.40% for managed accounts, wealth at retirement increased by an average of 30% for off-track participants who previously managed their own investments. An average 30-year-old participant could have nearly 39% more retirement income using a managed accounts service. Therefore, by making adjustments to individuals' saving and investing decisions, managed accounts can have a positive impact on a participant's retirement outlook.

A notable aspect of this 2022 analysis is that the above-mentioned findings support previous reports released in 2014 and 2018. These supported findings remain true despite some limitations to our analysis—namely, a potential skewed population set of individuals who opted into Morningstar® Retirement Manager℠ and our results being based on only the point at which these individuals enrolled, rather than tracking them over a period of time. Nevertheless, our replicable findings from 2014 to 2018 to 2022 indicate that these analyses remain true over time, further suggesting that managed accounts may play a role in bolstering DC plan participants' retirement outlooks, solidifying a positive track record of managed accounts' usefulness in the retirement advice marketplace.

Conclusion

The updated data of this report reflects trends current through the end of 2021, making it relevant to the ever-changing financial landscape as of this writing in 2022. The fact that these findings consistently show the value of managed accounts—namely, that it has a positive impact in helping participants to save and invest for retirement—indicates that managed accounts remain a positive force in increasing participants' abilities to remain on-track for their retirement goals.

We believe that managed accounts can have a tremendous impact on the everyday investor who may not be aware that they are off-track and/or are unable or unwilling to hire a personal financial advisor. As such, managed accounts may continue to bring value to today's retirement advice landscape.

Methodology

Appendix 1: Methodology

Data Set

The data for this analysis comes from recordkeepers of participants using Morningstar Investment Management's automated advice service (i.e., managed accounts) Morningstar Retirement Manager from January 5, 2007 to December 31, 2021. Participants have access to the managed accounts service through an employer-sponsored DC plan, most often a 401(k) plan. For those unfamiliar with managed accounts, it is a service provided by a registered investment adviser which provides ongoing discretionary asset allocation and typically retirement advice for participants. Savings and investment recommendations can be implemented within a managed accounts service, which is different from other robo-solutions that may only provide guidance on optimal investor actions. Portfolio allocations are customized based on information about the participant, which is provided by the recordkeeper or the participant. The cost of the Morningstar Retirement Manager managed accounts service varies by provider and is assessed based on assets.

When a participant self-enrolls into the Morningstar Retirement Manager managed account service, upon the first interaction, they will be asked to specify retirement age and spending expectations, spousal, and outside account information, etc. The Morningstar Retirement Manager managed account service will then provide savings rate and portfolio advice. The participant can choose to accept the advice or revise the certain aspects of the advice. Every time the participant visits the Morningstar Retirement Manager portal, they will be provided with updated advice based on their updated profile. Additionally, the Morningstar Retirement Manager managed accounts service performs a quarterly portfolio rebalance. In this study, we focus on changes in the savings rate and investment decision when the participant enrolled in the managed account service and made the savings and investment decision for the first time.

Six filters are applied to the initial available data. First, there must be data available on the age, salary, deferral rate (both before and after receiving robo-advice) for the participant. Second, the participant must have a minimum annual salary of $10,000 (in December 2021 dollars). Third, the individual must have a deferral rate greater than zero before and after the robo-advice session. Fourth, the change in deferral rates cannot be greater than 25 percentage points (positive or negative[2]). Fifth, the individual must be provided with an opportunity to change both the deferral rate and investment allocation as part of the managed accounts enrollment process. Sixth, only participants who opted into the service are included (i.e., this analysis excludes participants who were defaulted into managed accounts). These filters resulted in a dataset of 60,218 participants.

Exhibit 1 includes descriptive statistics for the variables included in the analysis.

[2]For example, a participant that increases the savings rate from 5% to 35% would be excluded.

Exhibit 1: Descriptive Statistics

Variable		Percentile						
		.05	.25	.5	.75	.95	Mean	Std. Deviation
	Age	25.00	33.00	43.00	52.00	62.00	42.96	11.85
	Salary	29,120	47,224	65,666	97,506	180,000	81,320	60,453
	Account Balance	399	4,824	23,123	83,336	339,701	78,694	154,312
	Deferral Rate (Before)	2.00	5.00	6.00	10.00	18.00	8.01	5.42
	Deferral Rate (After)	3.00	6.00	8.00	12.00	20.00	9.68	5.41
	Deferral Rate Change	0.00	0.00	2.00	2.00	6.00	1.67	3.00
	Savings Rate (Before)	4.50	9.00	12.00	15.00	24.00	12.63	6.09
	Savings Rate (After)	7.00	10.00	14.00	17.00	26.00	14.54	6.07
	Savings Rate Change	-1.00	0.00	1.50	2.00	10.00	1.92	3.84
	On-Track For Retirement (Before)	0.00	0.00	0.00	0.00	1.00	0.20	0.40
	Equity % (Before)	14.97	60.40	76.59	87.17	96.63	70.83	22.83
	Equity % (After)	41.62	61.73	76.69	88.32	95.79	73.45	18.13
	Allocation-Fund User (Before)	0.00	0.00	0.00	0.00	1.00	0.18	0.38

The median age for the participants in the data is similar to average U.S. workforce demographics. For example, the Bureau of Labor Statistics noted a median age of 42.0[3] while the median age for our participant data is 43. The median participant age in this dataset is one year younger than the median age among Vanguard's 4.7 million defined contribution participants, which is 44 (Vanguard 2021). The median and average balances of the participants are lower than those noted by Vanguard (2021) at $33,472 and $129,157, respectively.

The individuals in this analysis have higher incomes than the average American but are generally consistent with participants in Vanguard's defined contribution plans. The median income in this data set falls at approximately the 60th percentile among personal incomes in U.S. among those making at least $10,000 (i.e., working approximately full-time) in 2020 based on the data from the U.S. Census Bureau.[4] The median income is lower than the median income of individuals participating in Vanguard's defined contribution plan, which is $73,000. Based on the statistics in Vanguard (2021), defined contribution participants tend to have significantly higher wages than both all eligible employees (at $64,000) and all non-participating employees (at $34,000).

[3] https://www.bls.gov/emp/tables/median-age-labor-force.htm
[4] https://www.census.gov/data/tables/time-series/demo/income-poverty/cps-pinc/pinc-01.html

Deferral rates for these participants were also consistent with those noted by Vanguard (2021), which notes a median deferral rate of 6.0% and average deferral rate of 7.2%. Total savings rate, including both employee deferral and employer matching contribution were slightly higher than Vanguard's participants, which had a median savings rate of 10.2% and average savings rate of 11.1%.

By design, our dataset contains participant data that could be dated as early as 2007. For example, participants who entered our managed accounts service in 2007 would be recorded in our dataset with age and balance in 2007. Vanguard (2021) instead investigate their participant data based on 2021 values. So even if Exhibit 1 shows younger age, lower income and account balance comparing to the participants in Vanguard (2021), the actual differences could be much smaller even reverse. Overall, we conclude that the demographics of the individuals included in this data set appear to be reasonably consistent with investors participating in DC plans, based on comparisons to data available from Vanguard (2021); however, these individuals appear to be different from the average American. Therefore, this analysis should be viewed within the context of the average DC investor rather than the average American.

Test Groups

This analysis focuses on changes in participant behaviors after enrolling in managed accounts by comparing participant decisions before managed accounts (e.g., savings rate and portfolio allocation) to behaviors after implementation. Changes across two key domains, investing and saving, are considered. For each of these two domains, participants are sorted into two groups.

For the investing analysis, participants are sorted based on whether they were building their own portfolio (i.e., were "Self-Directors") or were using a prepackaged multi-asset strategy, such as a target-date fund (i.e., were "Allocation-Fund Users"). More precisely, a participant is classified as a Self-Director if less than 90% of the portfolio was allocated to an "Allocation" fund, while an Allocation-Fund User is defined as having of 90% or more to an Allocation fund. Morningstar, Inc. uses a broad asset classification group for investments called "Allocation," which includes multi-asset strategies such as balanced funds and target-date funds (TDF). This classification approach would not catch plans using a custom target-date fund, built from the plan's underlying investments, although these are relatively rare among the plans considered. Within the context of this analysis, participants using Allocation funds would predominately be using TDFs, since TDFs are the most popular default in DC plans. For example, Vanguard (2021) showed that 95% of their retirement plans offered TDFs.

Classifying participants by who is effectively responsible for making asset allocation decisions is important when attempting to understand the "quality" of the investing decisions made by the participant (i.e., portfolio efficiency). DC participants are generally considered to be relatively unsophisticated investors (on average); therefore, we would expect the portfolios constructed by "do-it-yourself" investors (i.e., Self-Directors) to be different from the portfolios built by professional investment managers (e.g., TDFs).

Among participants studied, 82% were classified as Self-Directors versus 18% as Allocation-Fund Users, although the distribution evolved over the test period. The percentage of Allocation-Fund Users (i.e., participants who were using prepackaged investment products before entering managed accounts) increased over the test period, from approximately 20% in 2007 to 27% by 2021.

For the savings analysis, participants are estimated to be "Not-on-Track" or "On-Track" for retirement. A participant forecasted to be on-track has a projected retirement income over 70% of current salary, which indicates an ability to maintaining a similar level of after-tax income or lifestyle during retirement. The projected retirement income is from a Monte Carlo simulation performed by Morningstar Retirement Manager's engine, which incorporates additional information provided by the participants about outside assets, savings at the time of enrollment, projected Social Security Retirement benefit and Defined Benefit Plan benefit. The projected retirement income is the income level that could achieve 70% of probability of success in the Monte Carlo simulation.

Segmenting participants based on whether they're on-track for retirement is important because not all participants need to save more for retirement. Participants using Morningstar Retirement Manager's managed accounts who are not-on-track will be communicated to increase savings rates, while those who are on-track may not need to make any changes to savings (so long as they are receiving the maximum employer match). On-track participants tended to be younger, with lower salaries, higher balances, and higher deferral rates.

Investment Impact Analysis

The impact of managed accounts on investor portfolios is viewed through a variety of lenses, including:

- **Portfolio Risk Level:** How did the risk level of a portfolio, defined as its allocation to equities, change after the participant enrolled in managed accounts?
- **Efficiency of Portfolio:** How did the efficiency of the portfolios differ before and after managed accounts?
- **Risk Appropriateness:** How consistent was the risk level of the portfolio before managed accounts with the target allocation?

The target equity allocation for each investor is determined using Morningstar Investment Management's managed accounts engine, which uses a total wealth methodology. Using this total wealth approach, a participant's DC assets are viewed as a "completion portfolio" that is invested so as to help the investor achieve the overall desired target risk level across all of their financial and nonfinancial assets. Investors with riskier financial assets (e.g., an IRA invested heavily in stocks) or nonfinancial assets (e.g., human capital) would get a more conservative recommendation, holding everything else constant. Similarly, investors with more conservative assets outside the DC plan portfolio would get a more aggressive recommendation for their DC plan assets. The methodology is described in greater detail in Appendix 2.

The style exposures of portfolios are determined using a returns-based style analysis. RBSA was introduced by William Sharpe (1988) as a low-cost solution to analyzing mutual funds compared to holdings-based style analysis (HBSA). The concept behind RBSA is best paraphrased by the folk saying (used by Sharpe in his original research paper), "if it acts like a duck, assume it's a duck." RBSA uses constrained optimization to classify an investment by comparing the performance of an investment to a number of passive benchmark indexes. RBSA searches for some combination of index returns that best mimics the portfolio performance over the test period, by minimizing the variance of the residuals. RBSA is useful when underlying holdings data is not available for many of the investments, which is the case for our data set.

The index proxies included in the RBSA are noted in Appendix 3. The RBSA is performed at the portfolio level (not the individual fund level) using historical returns for the 36 months prior to receiving advice as of the last month-end. For example, a participant who entered managed accounts on March 12, 2015, the RBSA would use returns from March 1, 2012 to February 28, 2015. Aggregate portfolio returns are created using the underlying weights to the individual funds held by the participant, where the portfolio is assumed to be rebalanced monthly. For those investments that did not have available historical returns for the entire period, the Morningstar Category Average value is used as the return for that investment. There were 8,280 unique investments held across the participants.

The RBSA is run for portfolio allocations before and after entering managed accounts. Given the resulting asset class weights, a variety of metrics are estimated. The first is the equity allocation of the respective portfolios, which is the sum of the weights to all noncash and nonbond asset classes—i.e., the equity weight includes an allocation to commodities. Next, the expected return and risk characteristics of the portfolios are estimated using the capital market assumptions noted in Appendix 4. These are forward-looking capital market assumptions estimated by Morningstar Investment Management. We also estimate the future hypothetical performance one year after enrolling in managed accounts.[5] Additional information about these tests is included in the respective subsection.

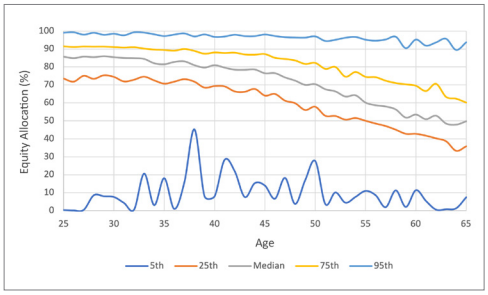
[5]This analysis is described as being "hypothetical" because we do not know what the actual portfolio decisions would have been for the investor over the year following entering advice, or how the portfolio might have changed after entering managed accounts.

Portfolio Risk Level

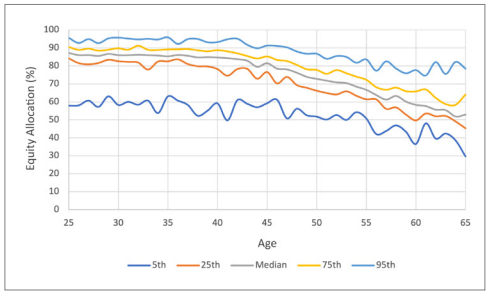
For our first test, we estimate the equity allocations for portfolios before and after the participant enrolled in managed accounts. The median (average) equity allocation for all users before managed accounts was 77% (71%) versus 77% (74%) after managed accounts. Self-Directors had slightly more conservative allocations before using managed accounts, with a median (average) equity allocation of 75% (70%) versus 81% (77%) for Allocation-Fund Users. In Exhibit 2 we provide information about how the equity allocations differed by age before entering managed accounts for Self-Directors and Allocation-Fund Users, in Panels A and B, respectively.

Exhibit 2: Equity Allocations Before Enrollment in Managed Accounts

Panel A: Self-Directors



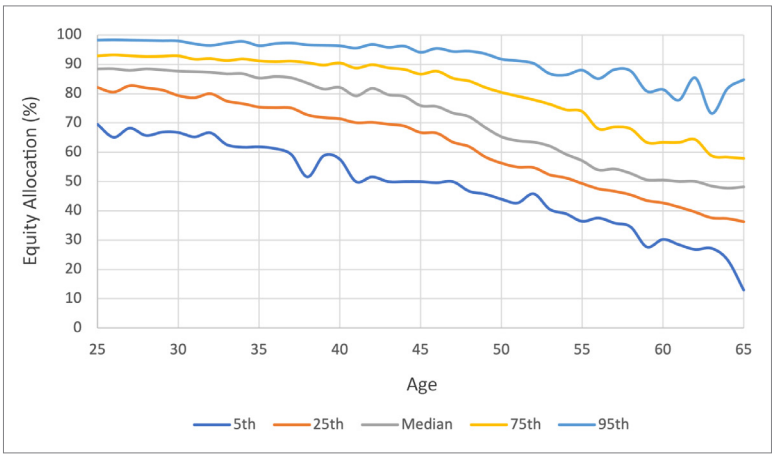
Panel B: Allocation-Fund Users



The median equity allocations for Self-Directors (Exhibit 2, Panel A) and Allocation-Fund Users (Exhibit 2, Panel B), before managed accounts, were relatively similar. This suggests the "average" participant had a similar level of risk before managed accounts across the two types. However, while the most conservative 1 in 20 (i.e., 5th percentile) Allocation-Fund User still had a relatively aggressive portfolio, the most conservative 1 in 20 Self-Director had a very conservative portfolio compared to the most conservative allocation users. This suggests focusing on the median participant may yield a different conclusion than considering all participants (i.e., the entire distribution).

In Exhibit 3 we include the participant equity allocations after managed accounts. We do not break these out by participant type (i.e., by Self-Director or Allocation-Fund User) because it doesn't affect the recommended portfolio allocation and thus the distributions for the two groups are effectively the same.

Exhibit 3: Equity Allocations After Enrollment in Managed Accounts



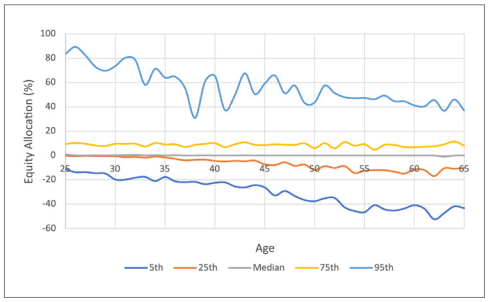
The distribution of participant equity allocations for participants after entering managed accounts looks different from the pre-managed-accounts distributions of both Self-Directors and Allocation-Fund Users. Overall, the equity allocations after entering managed accounts widen as participants age, with the difference between the 95th percentile and 5th percentile being relatively narrow at age 25 (29 percentage points) and increasing significantly by age 65 (to 73 percentage points).

Equity allocations increasingly diverge for older participants for a variety of reasons, but a key driver is the increasingly diverse circumstances of participants at older ages. Participants also increasingly have other outside assets that could significantly affect the equity recommendation for a managed accounts user. For example, if a 60-year-old participant has a large IRA invested conservatively and relatively small DC balance, the DC account may be invested aggressively (e.g., 97% equities) in an attempt to get the investor's overall risk level more in line with the total wealth target.

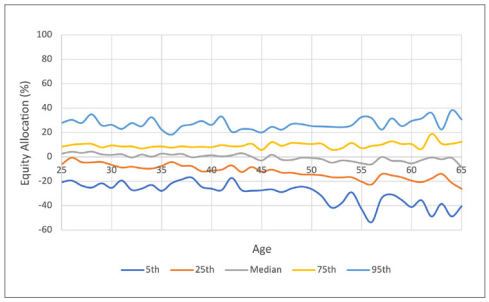
In Exhibit 4 we provide some insight into how equity allocations changed after enrolling in managed accounts for Self-Directors and Allocation-Fund Users, in Panels A and B, respectively. This is effectively the difference in Exhibits 3 and 2 for the respective groups.

Exhibit 4: Change in Equity Allocations After Enrollment in Managed Accounts

Panel A: Self-Directors



Panel B: Allocation-Fund Users



The distribution of equity allocation changes is relatively compressed across most percentiles (especially the median); however, there were considerable changes in risk levels for some participants, in particular a subset of Self-Directors who were invested heavily in fixed income before entering managed accounts. These participants were generally invested too conservatively and had significant increase in their equity allocations after entering managed accounts.

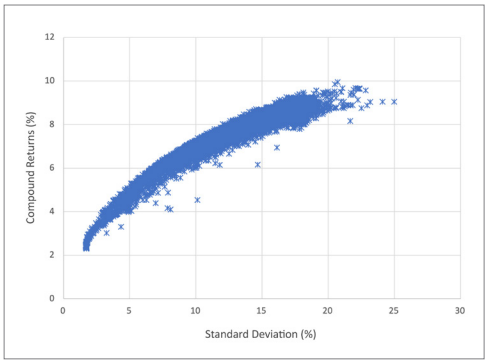
A number of participants, especially older participants, ended up in more conservative portfolios after entering managed accounts. Assuming a positive risk premium, these participants may end up with less wealth at retirement in their DC plan due to the more conservative allocation (depending on portfolio efficiency, fund quality, etc.). While less wealth may seem like a worse outcome, virtually every target-date mutual fund de-risks as it approaches retirement. The key, therefore, is ensuring the risk level for a portfolio is appropriate given the participant's (or investor's) situation, especially given the risk of assets outside the DC plan. We quantify the potential benefit of more-appropriate portfolios in a later section of this paper.

Portfolio Efficiency

The next analysis explores the efficiency, which is the expected risk-adjusted returns of the respective portfolios, before and after enrollment in managed accounts. As noted previously, to estimate the portfolio risk exposures, we perform a returns-based style analysis (RBSA) using the historical return of indexes listed in Appendix 3. We then estimate the risk and return for portfolios using the asset class weights obtained from the RBSA and the capital market assumptions included in Appendix 4[6]. These are forward-looking capital market assumptions estimated by Morningstar Investment Management. In detail, we estimate the expected arithmetic return and standard deviation for each participant's portfolio, and then estimate expected compounded (i.e., geometric) return based on arithmetic return and standard deviation using equation 5.1 in Appendix 5. We do this for the allocations both before and after enrollment in managed accounts.

Exhibit 5: Portfolio Efficiency Before Enrolling in Managed Accounts, by Investor-Type

Panel A: Self-Directors



Panel B: Allocation-Fund Users

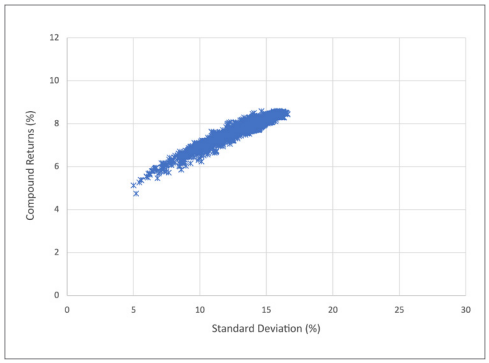


Exhibit 5 offers a scatterplot of the standard deviation and compounded (i.e., geometric) returns for the Self-Director and Allocation-Fund User portfolios, in Panels A and B, respectively, before enrolling in managed accounts. The dispersion of portfolios is significantly greater for the Self-Directors (Panel A) compared to the Allocation-Fund Users (Panel B). This is consistent with our expectations. Studies like Kramer (2012) and Lei and Yao (2016) have documented that individual investors often build undiversified portfolios and end up with lower risk-adjusted returns compared to professionally managed portfolios. We would expect professionally constructed portfolios (e.g., target-date funds) to be relatively efficient and have similar risk/return attributes across providers.

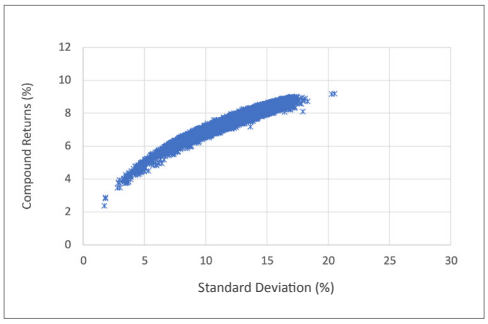
[6]It worth noting that, the enrollment data of participants in our sample range between 2007 and 2021. The asset class weights for each participant's portfolio are determined based on the prior 36 months prior to enrolling into manage accounts as of the last month-end. However, we estimate the risk and return for each participant's portfolio based on the same set of capital market assumptions, regardless of actual enrollment date. This is to ensure the comparability of these portfolios, as actual portfolio efficiency changes over time due to changes in expected returns and covariance.

One notable difference in the risk/return profiles for the Self-Directors and Allocation-Fund Users is the wider distribution of Self-Directors. This is as expected, as Self-Directors wouldn't be expected to create portfolios that are as efficient as professionally managed allocation funds. The Self-Directors also create a wider range on the risk spectrum creating portfolios. This indicates that Self-Directors take on too much or too little risk compared to the Allocation-Fund users, which might be a conscious choice, or a misunderstanding of their risk capacity.

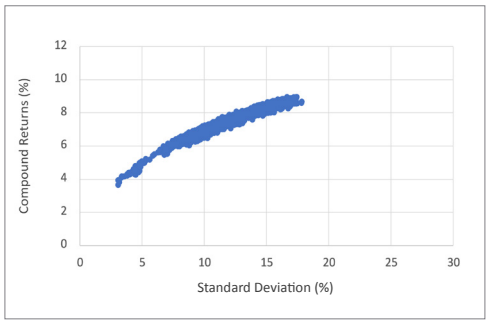
Information on portfolio efficiency for portfolios after enrolling in managed accounts is included in Exhibit 6.

Exhibit 6: Portfolio Efficiency After Enrollment in Managed Accounts

Panel A: Self-Directors



Panel B: Allocation-Fund Users

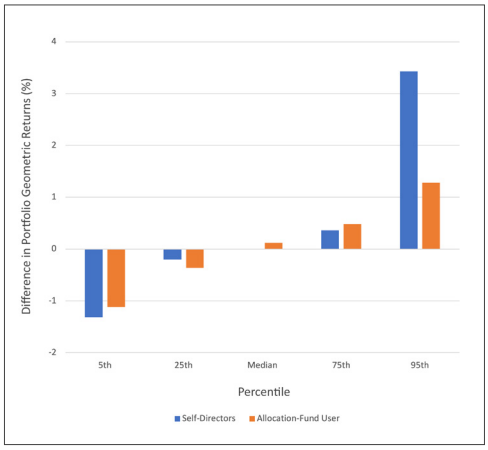


The efficiency of the portfolios after enrolling in managed accounts is certainly better for Self-Directors, but not as pronounced for Allocation-Fund Users. A key reason for this is that some participants can continue holding some employer stock after enrolling in managed accounts. Participants do not always sell out of employer securities completely after enrolling in managed accounts and may instead enter a sell-off plan.

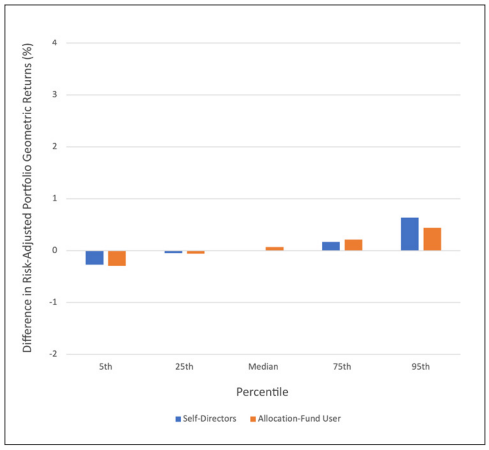
Next, we compare the expected compound returns for participant portfolios before and after enrolling in managed accounts. We compare pure returns in Panel A of Exhibit 7 and do so on a risk-adjusted basis in Panel B of Exhibit 7. For the risk-adjusted calculation, we compare the performance of each portfolio to a risk-adjusted benchmark and compare these respective differences to each other. The risk-adjusted calculation is explained in detail in Appendix 5.

Exhibit 7: Change in Expected Geometric Return

Panel A: Difference in Portfolio Geometric Returns



Panel B: Difference in Risk-Adjusted Portfolio Geometric Returns



The differences in pure performance before and after managed accounts (Exhibit 7, Panel A) are significantly greater than the risk-adjust differences (Exhibit 7, Panel B). This should not be surprising. For example, a participant who has an allocation of all cash before enrolling in managed accounts, who then gets invested in a relatively aggressive portfolio, would have a significant change (i.e., increase) in return (Panel A). However, the difference in the risk-adjusted efficiency is unlikely to be nearly as significant (Panel B), assuming both portfolios were reasonably efficient.

Looking at the results of Panel A, the change (or difference) in return is positive for the median participant. For example, the median (average) change in expected compounded returns for Self-Directors was +0 bps (+24 bps) and +11 bps (6 bps) for Allocation-Fund users. The average is so much higher than the median among Self-Directors due to those participants that went from very conservative portfolios to allocations with greater risk. On a risk-adjusted basis, the median (average) change in expected compounded returns was +0 bps (+8 bps) for Self-Directors and +7 bps (+7 bps) for Allocation-Fund Users.

Overall, the findings in this section suggest participants who were self-directing their portfolios realized a wide range of differences before and after enrolling in managed accounts. The best Self-Directors are likely to realize a small negative expected return, while the worst Self-Directors were likely to see a greater efficiency benefit for enrolling in managed accounts. The difficulty of course, is identifying the Self-Directors who need the most help prior to them making their own investment decisions.

Risk Appropriateness

An important component of financial advice is helping ensure an investor has a portfolio with a risk level appropriate for the investor's facts and circumstances. Each participant in managed accounts receives a personalized portfolio recommendation that could be significantly different than portfolio the individual selected for him- or herself before enrolling in managed accounts, even if the investor was using a TDF. For example, while TDFs would be expected to have risk levels appropriate for the average participant, they are, by definition, a "one-size-fits-all" investment that can result in situations where the risk level (i.e., glide path) is not appropriate for certain participants given their facts and circumstances. For example, if the participant has a large IRA that is invested aggressively (conservatively) the DC monies may need to be invested relatively conservatively (aggressively) to ensure consistency with the target risk level of the participant's total wealth. A TDF is unable to incorporate outside assets or other information about the participant into the portfolio assignment process.

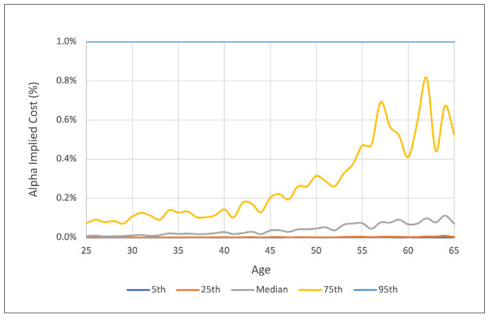
For this analysis we attempt to estimate the "cost" of being invested in a portfolio that is not consistent with the ideal risk level for the investor. We do so by first assuming the recommended equity allocation for managed accounts is the optimal target risk level for the investor. This allocation is determined using all information provided by the investor as part of the managed accounts enrollment process. Next, we compare this target equity allocation to the investor's pre-managed accounts portfolio. We use utility theory to quantify the "cost" associated with being invested sub-optimally (assuming the equity allocations before and after managed accounts differ).

This approach allows us to estimate the additional return (i.e., alpha) that would be required to compensate an investor to be indifferent between being invested in the managed accounts portfolio compared with their previous portfolio, which may have had a different risk level. The further the risk level of the portfolio before enrolling in managed accounts is from the target risk level, the larger the "cost" associated with being invested sub-optimally would be. These costs are noted in "alpha" terms for ease of reference purposes. Additional details on the exact calculations are included in Appendix 6.

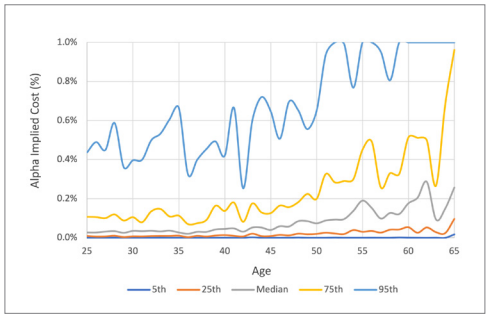
The distribution of the estimated alpha misfit costs, by age, for Self-Directors and Allocation-Fund Users are noted in Panel A and Panel B of Exhibit 8, respectively.

Exhibit 8: Alpha Implied Cost of Suboptimal Risk Portfolio Level

Panel A: Self-Directors



Panel B: Allocation-Fund Users



As a reminder, the "alpha misfit costs" noted in Exhibit 8 quantify the "cost" associated with being invested suboptimally (as defined by utility theory), when comparing the risk level of the portfolio before enrolling in managed accounts versus the target risk level recommended for the managed accounts solution. These values provide some context as to what the potential value of receiving personalized advice or guidance on portfolio assignment would be, versus investors making these decisions themselves. Personalization usually comes with an additional cost; therefore, the values in Exhibit 8 provide an estimate of the value managed accounts can provide by focusing only on helping participants be invested more appropriately. This assessment is independent from other potential gains, such as more-efficient portfolios (noted previously). For example, it's possible for a participant to be invested in an efficient portfolio, but one that is inappropriate given that investor's facts and circumstances.

Overall, the analysis suggests the median (average) benefit associated with more-approximate portfolios is 3 bps (20 bps) for Self-Directors and 5 bps (15 bps) for Allocation-Fund Users. The impact clearly differed by ages, though, where the benefit of a more-appropriate portfolio increases at older ages (where more benefit equals a higher implied alpha misfit cost). These age differences reflect, to some extent, how the target equity allocations diverged for managed accounts participants at older ages (see Exhibit 2-4).

Savings Impact Analysis

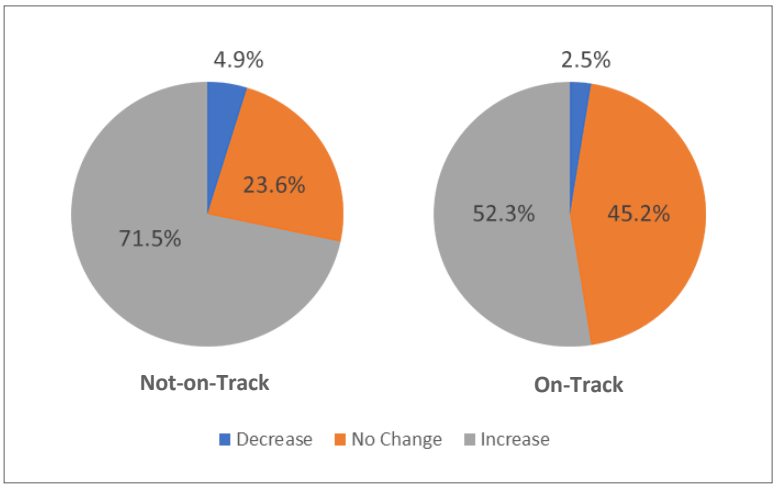
In this section we explore how savings rates changed for participants after entering managed accounts. The savings rate analysis is more straightforward than the investment analysis since there are less domains to consider.

As noted previously, for the savings-rate analysis participants are segmented into two groups, based on whether the participant was forecasted to be on-track for retirement. This calculation includes additional information provided about the participant's situation, which would include information about outside savings and investments, as long as Social Security Retirement benefit and Defined Benefit plan benefit. Overall, 80% of participants were forecasted to be not-on-track, while 20% were on-track.

Segmenting participants by whether they were on-track to retire is an important distinction because savings rate recommendations will differ based on the participant's situation. Participants using Morningstar Retirement Manager who are forecasted to not be on-track for retirement will be urged to increase their savings rates, while those who are on-track would only receive a recommendation to increase savings rates if the participant was not fully realizing the employer match. However, for those who don't receive a recommendation to increase savings, they can still increase their savings and override the saving advice.

We expect that whether or not the participant is on-track for retirement has a significant impact on the resulting potential changes in savings behaviors after enrolling in managed accounts. The differences in savings rate changes for the two groups are included in Exhibit 9, where the changes are grouped into whether the change in savings rate is positive (i.e., increases), negative (i.e., decreases), or does not change.

Exhibit 9: Changes in Savings Rates Based on Whether the Participant is On-Track for Retirement



Savings-rate behaviors were significantly different based on whether the participant was on-track for retirement. The majority of participants who were not-on-track decided to increase savings rates (71.5%), while less participants who were on-track increased savings rates (52.3%). Out of the participants who were on-track but increased their savings rate, more than half of them revised the managed accounts advice and decided to increase their savings.

This savings-rate difference is notable because the savings impact of managed accounts is likely to vary significantly based on the retirement readiness of the participant population. For example, a plan with participants that are well-funded for retirement (e.g., with a generous defined benefit plan or large retirement account balance) will be less likely to realize savings-rate increases compared to a plan where participants are poorly funded (e.g., in a plan with no employer match).

It's also worth noting that, the participants who were not-on-track for retirement could receive a recommendation to delay retirement age, which prepares them for retirement but not necessarily increase savings rate. So the percentage of participants who were not-on-track for retirement and decided to make positive changes to improve their retirement readiness could be higher.

In Exhibit 10, we provide some perspective on the distribution of changes in savings levels. We include information on both deferral rate and total savings rate. Total savings rates include employer matching contributions. If for some reason an employer's matching schedule information is not available for a plan, we don't include these participants in the savings rate calculation.

Exhibit 10: Distribution of Changes in Participant Savings Levels

Deferral Rates

	Not-on-Track				On-Track				
	Before	After	Absolute Change	Relative Change		Before	After	Absolute Change	Relative Change
5th	2.0	3.0	1.0	50.0	**5th**	3.0	4.0	1.0	33.3
25th	5.0	6.0	1.0	20.0	**25th**	5.0	6.0	1.0	20.0
Median	6.0	8.0	2.0	33.3	**Median**	7.0	9.0	2.0	28.6
75th	10.0	12.0	2.0	20.0	**75th**	11.0	12.0	1.0	9.1
95th	18.0	20.0	2.0	11.1	**95th**	20.0	22.0	2.0	10.0
Average	7.8	9.5	1.8	23.0	**Average**	9.1	10.3	1.2	13.7

Total Savings Rate

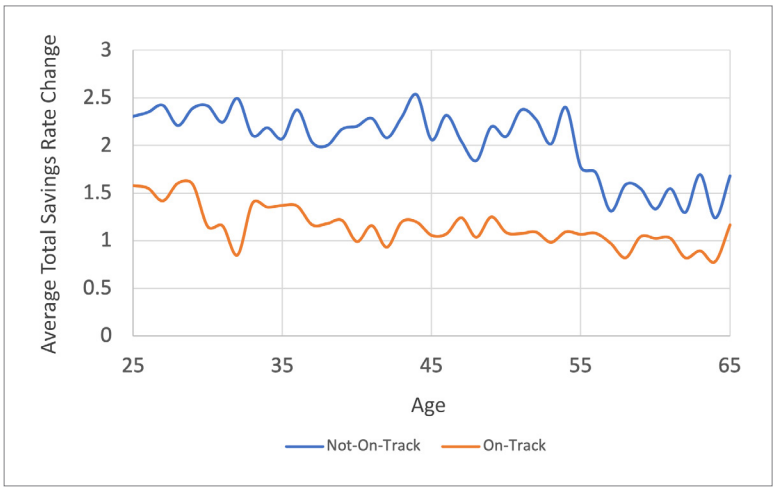
	Not-on-Track				On-Track				
	Before	After	Absolute Change	Relative Change		Before	After	Absolute Change	Relative Change
5th	5.0	7.0	2.0	40.0	**5th**	6.0	7.0	1.0	16.7
25th	8.0	10.0	2.0	25.0	**25th**	10.0	12.0	2.0	20.0
Median	12.0	14.0	2.0	16.7	**Median**	13.0	14.0	1.0	7.7
75th	15.0	17.0	2.0	13.3	**75th**	17.0	18.0	1.0	5.9
95th	23.0	26.0	3.0	12.9	**95th**	26.0	28.0	2.0	7.7
Average	12.3	14.3	2.1	16.7	**Average**	13.9	15.3	1.4	10.2

Consistent with the results in Exhibit 9, there were notable differences in the impact of managed accounts on savings behaviors depending on the retirement readiness status of participants. The median (average) absolute change in deferral rates for those who were not-on-track was +2 percentage points (+1.8 percentage points) with a relative change of +33.3% (+23%). The change in deferral rate is consistent with the base recommendation used by Morningstar Retirement Manager's managed accounts if the participant was estimated to not be on-track to retire, which is to increase deferral rates by 2 percentage points. For the participants who were not-on-track, the savings rates were higher than the deferral rates at all percentiles because savings rates include employee deferral and employer matching. The changes in total savings rates were higher than the changes in deferrals an absolute basis, but lower on a relative basis because the total savings rates were higher.

The deferral and saving rates by those who were on-track were mostly higher than those who were not-on-track. However, the absolute and relative changes in deferral rates and savings rate were lower than those who were not-on-track at all percentiles. The median (average) absolute change in deferral rates for those who were on-track was +2 percentage points (+1.2 percentage points) with a relative change of +28.6% (+13.7%).

Changes in savings rates were not constant across ages. In Exhibit 11 we provide information about average changes in total savings rates by age.

Exhibit 11: Average Change in Total Savings Rates by Age



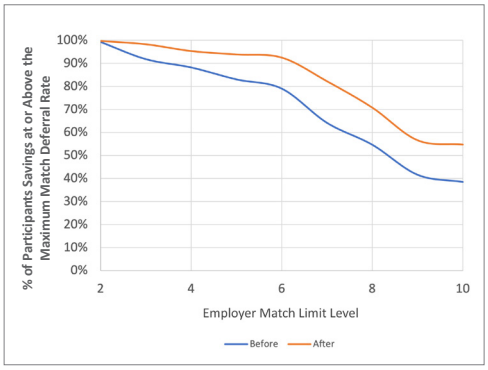
Average changes in savings rates were larger for younger participants. These were participants who, on average, were saving less for retirement before enrolling in managed accounts. This is important since higher savings rates are going to have a greater impact on retirement outcomes for younger participants, given the longer time period available for the wealth to compound (compared to older participants). Average changes in savings rates were smaller for older participants, especially for those who were not-on-track for retirement. Morningstar Retirement Manager's managed accounts could recommend increasing savings rate and/or delaying retirement age to improve retirement outcome. For older participants, delaying retirement age will be more effective in improving retirement outcomes. Therefore, participants who were age 55 and older most likely decided to delay retirement age before increasing savings rate.

Total savings rates increased more than deferral rates because the managed accounts savings rate recommendation used by Morningstar Retirement Manager's managed accounts always considered whether the participant was achieving the maximum employer match (and total savings rates include employer contributions). Even if the participant were forecasted to be on-track for retirement, the participant would receive a recommendation to increase savings up to the match since the employer match is effectively "free money."

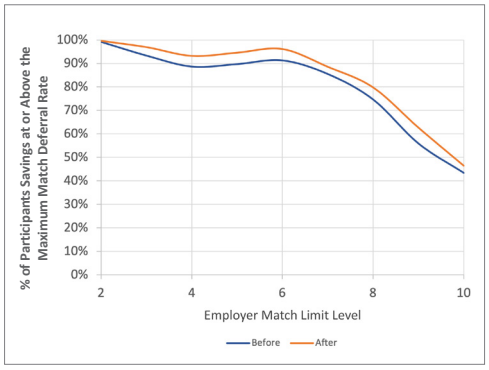
In Exhibit 12 we provide some perspective on participants saving up to the maximum employer match limit, for different match limit levels, before and after enrolling in managed accounts, for not-on-track and on-track participants, in Panels A and B, respectively. We only include plans that offered an employer match in this analysis.

Exhibit 12: Participants Receiving the Maximum Employer Match Before and After Enrolling in Managed Accounts

Panel A: Not-on-Track Participants



Panel B: On-Track Participants



On average, 12% more participants increased their deferral rate to receive the maximum match, when a match was available, among not-on-track participants, versus 4% among on-track participants. The fact the improvement among on-track participants wasn't as strong is not surprising, because savings rates for on-track participants were so much higher on average; therefore, they were more likely to already be receiving the maximum employer match.

From the plan design perspective, plans with higher threshold for employees to receive the maximum employer match, had fewer participants who saved enough to receive the maximum match. While the purpose of a higher threshold might be to lure employees to make more retirement savings, the reality is that participants, especially those who were not-on-track, were not that responsive to this incentive. Morningstar Retirement Manager's managed accounts effectively increased their deferral rate and in turn increased the percentage of employees who received the maximum employer match. The impact is greater for plans with higher maximum matches.

Combined Savings and Investment Impact

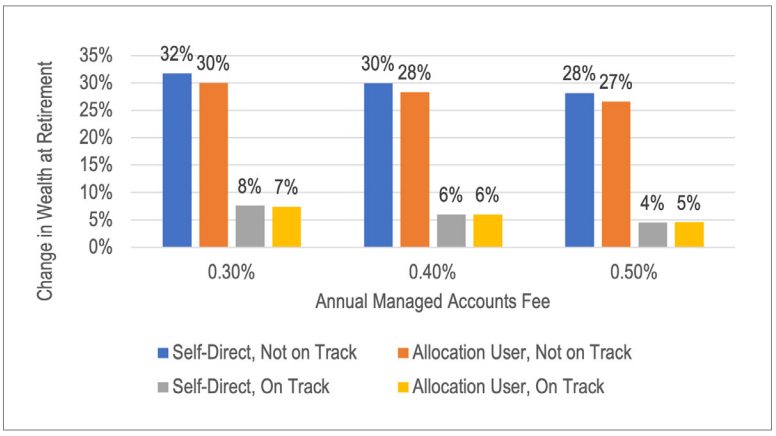
The analysis conducted so far suggests that participants who enroll in managed accounts are likely to experience higher returns and save more for retirement, on average, although the likely impact varies based on participant attributes (e.g., whether the participant is on-track to retire). In order to determine the combined impact of these changes we analyze expected wealth at retirement. The analysis uses a time value of money (i.e., future value) calculation, using as inputs the years to retirement at age 65, the expected compounded/geometric return of the portfolio (estimated in the prior sections), the total savings amount (which is the total savings rate times the income level), and the current balance. We estimate these values for participants both before enrolling in managed accounts (e.g., the pre-managed accounts savings amounts and geometric returns) and after managed accounts, and focus on the difference between the two values.

This analysis effectively assumes that the income, savings rate (or amounts), and portfolio risk level remain constant until retirement. In reality, these would each likely change over time. For example, income and savings rates would generally be expected to increase with age, while portfolio risk levels would generally be expected to decrease. These changes would likely differ by individual participants and assuming these values remain constant until retirement is obviously a simplifying assumption; however, it's not clear to what extent a more complex approach would improve the projection.

For the combined analysis, participants are segmented into one of four groups, based on whether the participant is self-directing his or her portfolio and whether the participant is on-track for retirement. If we average the groups by age, so that each age has the same impact on the overall results, the largest group of participants was Not-on-Track Self-Directors (66.3%), followed by Not-on-Track Allocation-Fund Users (15.0%), On-Track Self-Directors (13.8%), and On-Track Allocation-Fund Users (4.9%).

Fees are an important aspect to consider when attempting to estimate the value of any type of advice service. There are typically fees associated with managed account services, so it's important to understand how the potential value changes for different fee levels. Therefore, we perform this combined analysis based on three fee levels for managed accounts: 30 bps, 40 bps, and 50 bps. While fees vary significantly by provider, 40 bps is a reasonable proxy for the average fee assessed by managed accounts providers today. All fees for the analysis are assumed to be assessed annually against the current employer's plan balance each year until retirement. These results are included in Exhibit 13.

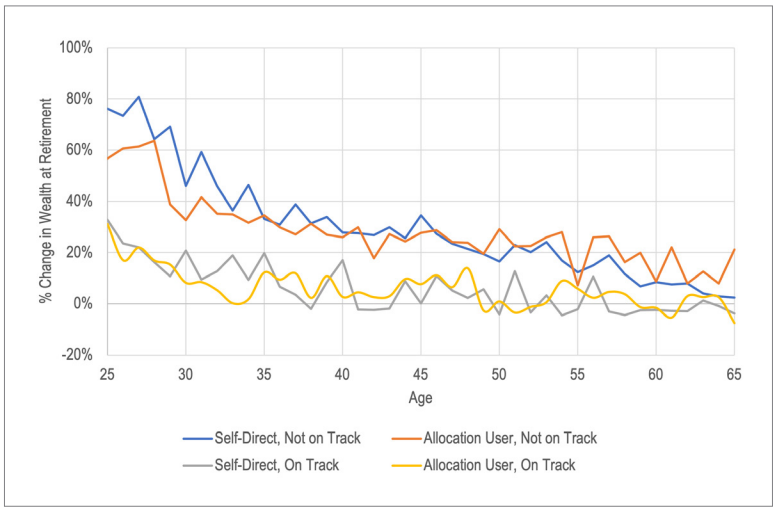
Exhibit 13: Change in Retirement Wealth by Managed Accounts Fee



With a 40-basis-point fee, which is an approximation of the average fee today assess for managed accounts services, the average change in wealth was positive for each of the four groups. The expected median (average) change in wealth at retirement is +19% (+30%) for Not-on-Track Self-Directors, +16% (28%) for Not-on-Track Allocation-Fund Users, +4% (+6%) for On-Track Allocation-Fund Users, and -1% (+6%) for On-Track Self-Directors.

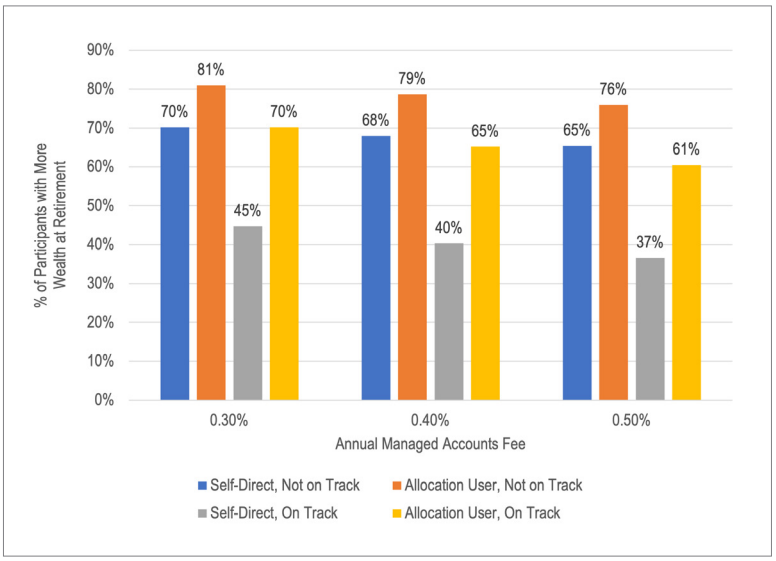
The average estimated difference in wealth at retirement for each of the four groups, by participant's age upon enrollment, is included in Exhibit 14. The results in Exhibit 14 include a 40-basis-point fee for managed accounts. Younger participants would be expected to realize the greatest benefit from managed accounts, although the impact clearly varied by participant group.

Exhibit 14: Change in Retirement Wealth by Participant Age (40 bps Fee)



In Exhibit 15 we estimate the percentage of participants who had more wealth at retirement for different fee levels. We find that most participants would be expected to have more wealth at retirement, especially participants who were not-on-track for retirement. This is primarily due to the increases in savings levels noted among participants who were not-on-track for retirement when entering managed accounts. Not surprisingly, the percentage of participants who are better off declines at higher assumed fee levels.

Exhibit 15: % of Participants with More Wealth at Retirement



Greater wealth at retirement should result in greater retirement income. To provide some perspective on the potential impact of managed accounts on retirement income, we convert the expected wealth differences into income values. For this calculation, we simply divide the difference in wealth at retirement by 25 and assume that is the difference in income the participant would receive during retirement. This factor (25) is roughly assuming the participant takes a 4% initial withdrawal from the portfolio at retirement, where that amount is increased annually for inflation. While the 4% rule may be less prudent today given lower expected returns compared to historical long-term averages (Blanchett 2017, Benz, Ptak and Rekenthaler 2021), it is still a reasonable income assumption for the purposes of this analysis. For example, Benz, Ptak and Rekenthaler (2021) find that by releasing the conservative assumptions that the 4% rule was based on when it was initial proposed (Bengen 1994), the sustainable withdrawal rate could be significantly improved with the forward-looking market expectation.

The average impact of managed accounts on annual retirement income is estimated for various age groups and fee levels for the four participant groups noted previously and the results are included in Exhibit 16.

Exhibit 16: Annual Retirement Income Impact of Managed Accounts

30 bps Managed Accounts Fee

	Self-Direct, Not-on-Track	Allocation User, Not-on-Track	Self-Direct, On-Track	Allocation User, On-Track	All Participants
Age 25-34	$6,862	$5,472	$2,185	$2,803	$5,182
Age 35-44	$2,526	$1,883	-$951	$676	$1,914
Age 45-54	$568	$840	-$1,401	-$411	$390
Age 55-65	$143	$82	-$594	-$10	$52

40 bps Managed Accounts Fee

	Self-Direct, Not-on-Track	Allocation User, Not-on-Track	Self-Direct, On-Track	Allocation User, On-Track	All Participants
Age 25-34	$5,990	$4,791	$1,224	$1,952	$4,321
Age 35-44	$2,025	$1,508	-$1,535	$219	$1,426
Age 45-54	$360	$700	-$1,644	-$610	$190
Age 55-65	$99	$52	-$679	-$35	$6

50 bps Managed Accounts Fee

	Self-Direct, Not on Track	Allocation User, Not on Track	Self-Direct, On Track	Allocation User, On Track	All Participants
Age 25-34	$5,141	$4,128	$289	$1,124	$3,483
Age 35-44	$1,534	$1,141	-$2,107	-$230	$947
Age 45-54	$154	$561	-$1,883	-$808	-$8
Age 55-65	$54	$22	-$763	-$60	-$40

Consistent with the results in Exhibit 14, younger participants are likely to realize more annual in retirement from managed accounts than older participants. If we focus on the youngest age group (25 to 34), we could generally assume that the average 30-year-old participant using a managed accounts service would increase his or her retirement income by $4,321 assuming a 40-basis-point managed accounts fee. This corresponds to average increase of 39% in retirement income.

Limitations of Analysis

While the updated data outlined above upholds the clear value of managed accounts, we do want to acknowledge a few limitations in this analysis. First, potential bias may exist in the sample population. Of the 60,218 participants analyzed, 100% of them were enrolled in Morningstar® Retirement Manager℠ via 'opt-in,' meaning they actively chose to enroll instead of being defaulted into the service. This sample could skew the results toward people who value personal investing advice enough to pay for it, as well as those who may possibly start out with insufficient retirement savings (given that 80% of participants analyzed in this dataset were not-on-track for retirement). As such, they likely do not fully reflect the general population at large.

Further, this analysis only examines the participants' initial enrollment interaction. We chose this as the moment on which to focus our analysis because this is when the most significant change to participants' retirement saving and investing strategies occurs and is therefore most reflective of how managed accounts can take off-track participants and make changes to put them on-track to reach their goals. However, by not following participants over time, we are assuming that they will stay on the course set out for them by managed accounts, and that they will remain enrolled. It is likely that this will not remain true for all participants, as they move in and out of the service by changing jobs or seeking more personal control over their investment elections. However, should a participant deviate from the advice managed accounts provides or unenroll from the service, then the value of managed accounts would be rendered moot, as its value lies in the participant following the advice it provides.

Appendix 2: Portfolio Assignment Approach

The approach to determining the appropriate risk level for an investor's optimal portfolio allocation (i.e., portfolio assignment) is based on taking a holistic view of an investor's assets. This approach incorporates the total value and risk attributes of assets that are often overlooked, such as human capital and pension wealth, and uses the financial assets in the DC plan as the "completion portfolio" to ensure diversification of the individual's total wealth.

A fundamental part of the total wealth process is modeling and understanding how an individual's wealth changes over the lifecycle. For younger individuals, human capital is typically the dominant household asset. Human capital can be thought of as the mortality-weighted net present value of an individual's future wage income. As individuals age, they tend to save money for retirement, thereby accumulating financial assets (both inside the DC as well as potentially outside it), along with accruing benefits in pension plans (such as Social Security). In other words, over time, investors convert a portion of their salary (i.e., human capital) into financial capital by saving and accruing pension benefits, both of which can be used to fund retirement.

Research by Blanchett and Straehl (2015), among others, has noted that human capital is generally a relatively bond-like asset—it usually pays a steady "coupon" in the form of a paycheck, but its risk varies considerably across business cycles, by job skills, as well as the specific occupation and industry of the worker. Because human capital is bond-like and untradeable, a younger investor's financial assets should be invested more aggressively to achieve a more balanced risk level from a total wealth perspective. As the relative value of human capital (as a percentage of total wealth) declines as the individual ages, financial capital should be invested more conservatively to ensure the risk of the total wealth remains balanced throughout the lifecycle. This is the economic rationale underpinning the shape of many glide paths today.

The final two considerations when determining the optimal risk level for a participant's portfolio. The first is how "on-track" that individual/household is for retirement. Within the portfolio assignment process, individuals who are better funded (i.e., have higher funded ratios) can potentially take on more risk in their portfolio based on their target risk level using the total wealth approach. Second, other nonadviseable portfolios (e.g., an IRA or really any monies outside the DC plan) must be considered. For example, if an investor has a large IRA that is invested very aggressively, yet the overall total wealth target risk level is more balanced, the monies in DC plan should be invested more conservatively (and vice versa).

Appendix 3: RBSA Index Proxies

Asset Class	Index Proxy
Cash	IA SBBI US 30 Day TBill
Short Bond	BBgBarc US Govt/Credit 1-3 Yr
Long Bond	BBgBarc US Govt/Credit Long
TIPS	BBgBarc Gbl Infl Linked US TIPS
High Yield Bond	BBgBarc US Corporate High Yield
NonUS Bond	BBgBarc Gbl Agg Ex USD
Large Growth	Russell 1000 Growth TR USD
Large Value	Russell 1000 Value TR USD
Small Growth	Russell 2000 Growth TR USD
Small Value	Russell 2000 Value TR USD
International Equity	MSCI EAFE GR USD
Emerging Markets	MSCI EM GR USD
Real Estate	FTSE EPRA/NAREIT Developed TR USD
Commodities	Bloomberg Commodity TR USD

Appendix 4: Capital Market Assumptions

	Return	Std Dev	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cash	2.31%	1.73%	1.00	0.35	0.05	0.02	0.05	0.05	(0.02)	0.03	(0.02)	0.01	(0.01)	(0.05)	0.03	0.05	0.01
Short Bond	3.72%	3.25%	0.35	1.00	0.75	0.58	0.34	0.53	0.11	0.15	0.04	0.08	0.11	(0.03)	0.29	(0.02)	0.13
Long Bond	5.02%	10.12%	0.05	0.75	1.00	0.63	0.35	0.49	0.13	0.15	0.05	0.09	0.11	(0.01)	0.33	(0.01)	0.14
TIPS	4.12%	6.88%	0.02	0.58	0.63	1.00	0.31	0.48	0.16	0.18	0.13	0.15	0.18	0.09	0.34	0.08	0.17
High Yield Bond	6.93%	9.22%	0.05	0.34	0.35	0.31	1.00	0.23	0.50	0.54	0.48	0.54	0.51	0.46	0.58	0.15	0.52
NonUS Bond	4.51%	8.69%	0.05	0.53	0.49	0.48	0.23	1.00	0.15	0.16	0.12	0.11	0.46	0.13	0.40	0.12	0.16
Large Growth	9.50%	18.23%	(0.02)	0.11	0.13	0.16	0.50	0.15	1.00	0.86	0.82	0.74	0.68	0.67	0.59	0.20	0.93
Large Value	9.66%	15.82%	0.03	0.15	0.15	0.18	0.54	0.16	0.86	1.00	0.78	0.87	0.68	0.68	0.70	0.25	0.93
Small Growth	11.82%	25.24%	(0.02)	0.04	0.05	0.13	0.48	0.12	0.82	0.78	1.00	0.89	0.67	0.66	0.62	0.26	0.80
Small Value	11.83%	20.72%	0.01	0.08	0.09	0.15	0.54	0.11	0.74	0.87	0.89	1.00	0.64	0.66	0.74	0.25	0.81
International Equit	9.24%	18.25%	(0.01)	0.11	0.11	0.18	0.51	0.46	0.68	0.68	0.67	0.64	1.00	0.69	0.64	0.25	0.68
Emerging Markets	10.24%	21.90%	(0.05)	(0.03)	(0.01)	0.09	0.46	0.13	0.67	0.68	0.66	0.66	0.69	1.00	0.54	0.25	0.68
Real Estate	9.57%	16.65%	0.03	0.29	0.33	0.34	0.58	0.40	0.59	0.70	0.62	0.74	0.64	0.54	1.00	0.24	0.64
Commodities	4.78%	15.95%	0.05	(0.02)	(0.01)	0.08	0.15	0.12	0.20	0.25	0.26	0.25	0.25	0.25	0.24	1.00	0.23
Company Stock	9.58%	34.05%	0.01	0.13	0.14	0.17	0.52	0.16	0.93	0.93	0.80	0.81	0.68	0.68	0.64	0.23	1.00

Source: Morningstar Investment Management LLC

Appendix 5: Risk-Adjusted Portfolio Efficiency

To estimate the risk-adjusted portfolio efficiency, we use the estimated risk and return values for each portfolio and compare those values to a risk-adjusted benchmark. The benchmark is a two-asset portfolio, consisting of a safe and risky asset. The safe asset is assumed to be 100% Cash, which has an expected return of 2.31% and a standard deviation of 1.73%. For the risky asset, we assume an allocation that is 20% Large Growth, 20% Large Value, 10% Small Growth, 10% Small Value, 25% International Equity, and 15% Emerging Market (i.e., a well-diversified portfolio of risky securities). The risk asset has an expected return of 10.04% and a standard deviation of 16.9%. The correlation between the risky and safe asset is assumed to be zero.

We determine the arithmetic return ($R_{p,a}$) and standard deviation (σ_p) for each combination between the safe and risk asset from 0% to 100% in 1% increments. For each increment we estimate the geometric return ($R_{p,g}$) using equation 5.1.

$$R_{p,g} = e^{\left(\ln(1+R_{p,a}) - .5\ln\left(1+\frac{\sigma_p}{(1+R_{p,a})^2}\right)\right)} - 1 \qquad [5.1]$$

Next, we determine the compounded returns for each increment between the safe and risky asset from 0% to 100% in 1% increments. This gives us target compounded return for each portfolio standard deviation. We determine the portfolio efficiency by subtracting the actual portfolio geometric return to the target compounded return based on the participant portfolios standard deviation.

For example, if the standard deviation of a portfolio (σ_p) was 10% (based on the underlying sub-asset class exposures), the return target (R_t) would be 5.32%. If the expected return of the portfolio was only 5.00% the portfolio efficiency would be -.32%. This calculation is performed for both the allocation before and after entering managed accounts.

Appendix 6: Risk Appropriateness

Harry Markowitz (1952) established the mean-variance optimization framework, which requires three sets of inputs: returns, standard deviations, and pair-wise correlations for the assets in question. When seeking the optimal mix (the utility maximizing mix) for a specific investor, the mean-variance optimization framework can be determined using equation 6.1, where U is the investor's utility for the asset allocation, (R_p) is the return of the asset allocation, λ is the investor's risk aversion coefficient, and σ_p^2 is expected variance of return of the asset allocation.

$$U = E(R_p) - .5\lambda\sigma_p^2 \qquad [6.1]$$

In a two-asset portfolio, we can determine the target risk aversion level for a portfolio using equation 6.2

$$\lambda = \frac{R_e - R_b}{(\sigma_e^2 + \sigma_b^2 - 2\sigma_{e,b}) * (wt_e - \sigma_{e,b} - \sigma_b^2)} \qquad [6.2]$$

The two-asset portfolio is assumed to consist of a safe and risky asset. We use the same assumptions for the safe and risky asset as those used for the risk-adjusted efficiency test, as noted in Appendix 5.

For this test, the ideal equity allocation is assumed to be the managed accounts recommended portfolios. This ideal allocation would be assumed to result in zero utility loss, since it represents the utility-maximizing asset allocation. We can use this target equity allocation, which is assumed to be target allocation to the risky asset, in conjunction with equation 6.2 to estimate the implied target risk-aversion (λt) coefficient that would make the recommended stock/bond asset allocation the utility-maximizing mix. Unless the asset allocation of both the recommended and existing allocations are identical, there is a potential loss associated with being invested sub-optimally.

Next, given the risk of the target equity allocation (σ_t^2) and the participant's portfolio before managed accounts (σ_c^2) we can determine the "utility cost" for being invested sub-optimally, using equation 6.3

$$Utility\ Cost = (E(R_t) - .5\lambda_t\sigma_t^2) - (E(R_c) - .5\lambda_t\sigma_c^2) \qquad [6.3]$$

For readers interested in learning more about this model, we recommend Blanchett (2017) or Idzorek, Blanchett, and Bruns (2018).

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Calculation Methodologies

Performance returns in this report were calculated using a time-weighted, geometrically linked rate of return formula. Returns for periods over one year are annualized.

Time-weighted returns measure the performance (as a percent) of capital at work during each interval between contributions and withdrawals and then linking that performance together to produce a return for a stated period. This calculation is designed to eliminate the effect of cash and/ or securities being added to or taken out of a portfolio (that influences the internal rate of return calculation, for example). The more contributions and withdrawals that occur and the longer the time frame, the more complex the time-weighted return calculation can become.

When the time-weighted return calculation is used, the current allocations for a portfolio's holdings were used to generate historical performance. Taxes, loads, and sales charges and any applicable trading commissions or short-term trading fees are not taken into account. If they were, the returns stated would be reduced.

Monthly total returns for portfolios calculated using the time-weighted return method are calculated by applying the ending period holding allocations to an individual holding's monthly returns. Trailing returns are calculated by geometrically linking these weighted- average monthly returns. Portfolio and holding returns are adjusted for advisory fees.

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Indexes are not available for direct investment and the performance does not reflect costs, fees or expenses associated with investing in the instruments that comprise the benchmark or index. Indexes are created to measure a specified area of the stock market using a representative portfolio of securities and may be used as a proxy for a security or asset class. Please note that indexes vary widely, and it is important to choose an index that has similar characteristics to the security or asset class it is being used to represent. In no way should the performance of an index be considered indicative or a guarantee of the future performance of an actual security, be considered indicative of the actual performance achieved by a security, or viewed as a substitute for a security. Actual results of a security may differ substantially from the historical performance shown for an index and may include an individual investor incurring a loss. Past performance is no guarantee of future results.

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