

**Red, Yellow, and Green:
A Taxonomy of 401(k) Portfolio Choices**

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Abstract

One measure of financial literacy is the quality of portfolio decision-making in 401(k) plans. Applying a qualitative framework to a dataset of nearly three million 401(k) accounts, we estimate that 43% construct “green” portfolios with balanced exposure to diversified equities, while 26% construct “yellow” portfolios with possibly too-aggressive or too-conservative equity holdings. Another three in ten participants make egregious errors and have “red” portfolios—either holding zero in equities or over concentrating their account in employer stock. Using a subset of our sample, we estimate the costs of portfolio errors (and the potential gain from improved allocations) at roughly 60 to 350 basis points in expected real return per year, depending on the initial portfolio held. Low income, low wealth and female participants are more likely to experience the largest gains from better portfolios, given their tendency to hold less aggressive portfolios.

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Red, Yellow, and Green: Measuring the Quality of 401(k) Portfolio Choices

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The shift over the past quarter century from professionally managed defined benefit (DB) plans to participant-directed defined contribution (DC) plans has meant that employees must take an active role in managing their retirement assets. However, some participants may not be willing or able to manage their assets. Surveys of participants suggest that many are inexperienced and have low levels of financial literacy. Some participants appear to make obvious portfolio errors, such as concentrating their portfolio in employer stock or holding too-conservative portfolio. Many make subtle construction errors, failing to diversify their equity portfolio more broadly with small-capitalization or international stocks.¹ In response to these concerns, the 2006 Pension Protection Act (PPA) in the US envisions a new type of 401(k) plan – the autopilot or automatic 401(k) – in which more participants are automatically enrolled into qualified default investments designed by investment professionals. The PPA also encourages greater provision of investment advice to participants. Yet even if automatic plan designs or advisory services grow quickly, it remains the case that the vast majority of nearly 60 million private-sector DC plan participants have constructed their portfolios on their own, without professional help.

How well are participants faring in the task of portfolio construction? In this chapter, we assess investment literacy among 401(k) plan participants by measuring the quality of their portfolio decisions compared to professional investment advice. In general, we find that many participants appear to adopt reasonable levels of equity exposure: specifically, nearly 45% participants construct “green” portfolios with equity allocations consistent with expert advice, while just over 25% build “yellow” portfolios that have meaningful equity holdings, but appear

to be invested either too aggressively or conservatively. At the same time, three in ten participants construct “red” portfolios with egregious portfolio errors, including zero participation in the equity markets or overexposure to single-stock risk. At a finer level of detail, many participants fail to take advantage of additional opportunities for diversification, such as diversifying holdings with international or small-capitalization stocks or high-quality bonds when they are offered. Few participants own more specialized asset classes (e.g., high-yield bonds), which are not made available by plan sponsors in the first place.

Besides assessing the quality of portfolio choices, we are also able to estimate the cost of portfolio errors. Portfolio errors can be costly—anywhere from roughly 60 to 350 basis points in expected real return per year based on our estimates. Our demographic models also suggest that lower income, lower wealth, and less financially sophisticated participants incur the largest costs, in terms of reduced expected returns, because they are more likely to invest in an ultra-conservative manner. This same population would be the largest beneficiary of strategies to improve 401(k) portfolio diversification. At the other extreme, older, affluent and male participants, who typically invest quite aggressively, may see expected portfolio returns fall if they were to shift to “better” portfolios. But overall portfolio efficiency levels would still rise.

Plan sponsors and policymakers overseeing defined contribution programs have several remedial strategies for improving participant portfolio allocations. These include: greater reliance on professionally managed default investment funds; the introduction of managed account advisory services; and the “mapping” of existing participant accounts to new default funds. Investment education may also be effective, but the impact of education on actual behavior is highly debated. Regardless of the remedial strategy adopted, our research suggests

that through such approaches, a meaningful group of participants could improve expected returns or diversification levels (or both), thus enhancing their prospects for retirement security.

In this chapter, after reviewing the prior research on 401(k) investment decisions and describing our data set, we first assess the quality of portfolio decisions, and then turn to estimating the costs of poor portfolio choices. We conclude by discussing implications for sponsors and policymakers overseeing defined contribution retirement programs.

Prior research

Prior research on 401(k) investment decision-making falls broadly under three themes: behavioral biases, portfolio allocations and trading activity, and financial literacy.

One of the most important themes of the behavioral finance research has been the impact on the employer-designed 401(k) menu on participant investment choices. With small menus, participants appear to follow a naïve “1/n” heuristic, allocating their savings evenly among menu options; in larger menus, this effect appears in the form of a “conditional 1/n” heuristic, where participants tend to divide their savings equally among a subset of funds they select from the menu. Also, menus with a higher proportion of equity funds tend to result in participant allocations with higher equity exposure. The same is true if the menu has more high-cost active equity funds. Meanwhile, 401(k) investment menus with many options appear to give rise to “choice overload,” either leading to lower plan participation or to reliance on familiar, conservative investment choices. One possible explanation for these effects is that, contrary to neoclassical models of revealed preferences and portfolio choice, participants may have unstable preferences – perhaps due in part to deficiencies in financial education – that are easily subject to framing effects.²

The role of procrastination or inertia as a decision heuristic is also evident in 401(k) portfolios. The inertia effects are best known in the context of automatic enrollment in 401(k) plans. But they also apply to the tendency of participants to fail to revisit their ongoing investment allocations. For example, 45% of higher-education plan participants never changed their asset allocation over a 10-year period. Research on 401(k) trading underscores this finding. These studies demonstrate that only 10% of participants trade in any given year, far below the rate that might be expected from periodic rebalancing of portfolios.³

A third strand of research places 401(k) portfolio choices in the context of overall questions of participant financial literacy or experience. According to one national survey, 42% of 401(k) participants describe themselves as “novice” or “beginner” investors and a similar percentage as “little or somewhat experienced.” Only 15% say they are knowledgeable or experienced investors. Another survey demonstrates that some 401(k) participants believe money market funds include stock investments; few understand the inverse relationship of bond prices and yields; and many find their employer stock to be a safer investment than a diversified portfolio. More broadly, one of the substantive “investment mistakes” made by some American households, particularly lower-income or lower-wealth households, is the failure to participate in the equity markets—the failure to take any equity risk whatsoever. In addition, while many older Americans understand basic percentages, they struggled with basic financial calculations such as compound interest or the division of a lottery prize among four individuals. Low levels of financial literacy tend to be associated with younger age, lower income, lower levels of educational attainment, female sex and lower wealth.⁴

Approach and Data

In our analysis of 401(k) portfolios, we first develop a set of qualitative measures of portfolio construction. The result is our “red, green and yellow” taxonomy reflecting the relative quality of portfolio decisions. This analysis is based on a large data set drawn from Vanguard’s 401(k) recordkeeping systems, which we refer to as our full sample. The full sample encompasses over 2,000 defined contribution plans and nearly 2.9 million 401(k) participants as of December 31, 2005.

The second part of our analysis develops first-order estimates of the cost of portfolio choices—both in terms of forfeited return or reduced diversification levels. This analysis is based on a much smaller dataset, called the managed account sample. It consists of nearly 12,000 participants drawn from the full sample who adopted a managed account service in the twelve months prior to September 2005.⁵ A managed account service is a third party, professional advisory service authorized for 401(k) plans by the US Department of Labor in its 2001 “SunAmerica” advisory opinion. Participants who sign up for the managed account cede all investment control to the advisor, which reallocates the participant’s plan balance to conform to the advisor’s investment recommendations. The advisor also assumes control for ongoing management and rebalancing of the portfolio. For this sample, we were able to obtain portfolio risk and return measures from the third party adviser, Financial Engines, both before and after the adoption of a professional advisory service. The managed account sample is by definition not a random sample of the broader dataset. But the results from our analysis of this smaller data set are in our view at least a good first-order approximation of the costs associated with various suboptimal portfolio strategies for a larger group of participants.

Table 1 summarizes characteristics of the two data sets. In the full sample, the median participant was 44 years old, was male, worked for his employer for 8.5 years, had a household income of \$87,500, and had accumulated of nearly \$24,000 in 401(k) savings at year-end 2005. Half of participants in the sample were registered for online access to their 401(k) accounts. The managed account sample is broadly similar to the full sample, but with some marked differences. Participants in the managed account sample were somewhat older, longer tenured, and more female, and somewhat more likely to be registered for internet access. They also tended to hold less in diversified equities overall and in company stock. They obviously differ from other participants in their willingness to adopt an advisory service when it was first offered.

Table 1 here

Quality of Portfolio Decisions

The first part of our analysis examines the degree to which participants in the full sample conform to simple portfolio construction rules provided by portfolio experts. We begin by assessing the quality of “gross” portfolio construction—namely, participants’ overall risk exposure to equities, and their willingness to expose themselves to single-stock rather than diversified equity market risk. Specifically, we determine to what degree participant portfolios conform to the following three rules:

1. *The diversified equities rule.* We assume that portfolios with between 40% and 95% equity exposure are consistent with well-accepted standards of portfolio practice based on two independent investment methodologies. In our managed account sample, Financial Engines (Vanguard’s managed account provider) generally recommends overall portfolio allocations to equities ranging from 40% to 95% of 401(k) account assets.⁶ In addition, the equity allocations for Vanguard age-based lifecycle funds range from approximately 45% to 90%

for individuals in their working years. Thus, we define as “green” diversified equity exposure ranging from 40% to 95%.

2. *The zero-equity error rule.* A common portfolio error cited in the financial economics literature is a household’s decision to hold zero percent of financial wealth in equities. An approximation of this rule for 401(k) plans is for participants to hold zero percent of their 401(k) assets in equities.⁷ As such, we define portfolios with zero equity exposure as making an egregious or “red” portfolio error.
3. *The company stock rule.* While neoclassical models of portfolio choice would suggest a zero allocation to single-stock risk, there are mixed findings on the motivational aspects of employer stock. As a result, we define as egregious or “red” any portfolio with more than 20% of assets in company stock. This rule is consistent with the limit also imposed by the Vanguard managed account service; it is also the rule included in mandatory disclosure to participants regarding company stock risk under the 2006 Pension Protection Act.⁸

These portfolio construction rules, applied to our 2.9 million account sample, result in five investor segments shown in Table 2. We use a simple stoplight color scheme to reflect the extent to which participant portfolios conform to our three rules of portfolio construction. Forty-three percent of portfolios are in the Green segment, with equity allocations ranging from 40% to 95% and company stock exposure less than 20%.⁹ Twenty five percent of portfolios are in the Yellow segment because their equity exposure is outside our Green 40-95% range, but non-zero. Thirty percent are in one of two Red segments, with either zero in equities or a concentrated stock position exceeding 20%.

Table 2 here

This color scheme refers only to our three basic rules of portfolio construction. What about finer levels of portfolio construction—such as the decision to diversify equity holdings more broadly, or to hold volatile bonds over principal-stable investments like guaranteed investment contracts (GICs) or money market funds? Table 3 demonstrates that most plans offer, and most participants in our full sample are offered, the opportunity to diversify their equity holdings using mid- and small-capitalization US stocks and international developed market stocks, and to diversify their fixed income holdings with high-quality bonds. Yet less than three in ten participants avail themselves of these three classes. Other specialized asset classes – such as emerging market stocks¹⁰, non-US bonds, real estate investment trusts, and Treasury Inflation Protected Securities (TIPS) – are by and large not widely offered by sponsors in the first place. When offered, few participants take up these specialized options.

Table 3 here

Overall our results suggest that at a gross portfolio construction level, many participants have healthy portfolios. Forty-five percent construct portfolios consistent with third-party expert rules, while another 25%, while assuming equity market risk, take levels that are either too aggressive or too conservative by the rules we set forth. An important minority fail at the extremes by constructing “red” portfolios that are too conservatively invested, or too concentrated in employer stock. Of course, participants may be in a given portfolio for several reasons. For example, they may understand rudimentary investment principles or have well-developed preferences; they may have been defaulted into a given portfolio; or they may have applied some naive decision heuristic, like the “1/n” rule. In terms of finer levels of portfolio construction, only three in ten appear to utilize more sophisticated diversification strategies.¹¹

Table 4 summarizes the main investment patterns for each of the five segments identified above. Not surprisingly, Red (Zero Equity) investors invest almost exclusively in stable-principal investments such as money market funds and guaranteed investment contract (GICs) funds and to a limited extent in bonds. Yellow (Conservative Equity) investors have a high weighting to stable-principal investments as well. Both of these segments no doubt reflect either high levels of risk aversion and a preference for capital stability—or a lack of knowledge about the benefits, even for cautious investors, of investing in high-quality bond funds relative to shorter duration instruments. The participants who take on extended levels of diversification with international or mid- and small-capitalization US stocks are largely in two segments, Green and Yellow (Aggressive Equity). One noteworthy finding is the high use of balanced, life-cycle, and life-style funds among the Green segment—no doubt a reflection of the growing popularity of these funds and their increasing as default investment options in 401(k) plans.¹²

Table 4 here

For our five investor segments, which demographic characteristics are associated with membership in each segment? Figure 1 graphically summarizes the relationship between demographic characteristics and investor type (see the Appendix for technical details). After controlling for various demographic variables, the conservatively invested segments—that is, participant portfolios classified as Red (No Equity) and Yellow (Conservative)—are more likely to be held by older, less affluent, or unengaged participants.¹³ This finding is consistent with studies that show financial literacy is particularly low for the less educated, those with low income, and minorities.¹⁴ The more aggressively invested Yellow segment tends to have younger, more affluent, and engaged participants. Since financial literacy is associated with affluence, it would appear at broad brush that affluence, financial literacy and equity risk-taking

go hand in hand. Yet in our analysis, even these affluent and aggressive Yellow investors may be taking too much risk according to our portfolio construction rules.

Figure 1 here

The Cost of Portfolio Choices

We next turn to developing first-order estimates of the costs associated with suboptimal portfolio decisions. This analysis relies on our managed account sample described earlier.

For the nearly 12,000 participants who signed up for the program, the managed account advisory service dramatically changed their portfolio allocations. Figure 2 depicts the “before” and “after” equity allocations for these participants. Prior to the adoption of the advisory service, 42% of participants were at three focal points: zero equities, 100% equities, and 50% equities (which represented the presence of a balanced default investment option in several of the large plans in this sample). The remaining participants were scattered across the equity allocation spectrum, with anywhere from 10% to 90% or more of account holdings invested in equities. After the advisory service took control of participant accounts, extreme equity holdings were entirely eliminated. Moreover, in a quite dramatic way, portfolio equity holdings became more normally distributed, with a mean equity exposure of 76% and a standard deviation of 12%.

Figure 2 here

To evaluate the impact of these dramatic changes, we first classified the participants in the managed account sample using our five red/green/yellow “investor segment” methodology described above. In turn, using data provided by the third party adviser, Financial Engines, we estimated portfolio returns and Sharpe ratios both before and after adoption of the service.¹⁵ The returns reported are real returns—expected returns after projected inflation. The returns are also net of fund expenses, but the cost of the managed account service has not been deducted

from any of the returns. The Vanguard managed account service has a base fee of 0.40% per year (with a sliding scale for high-asset accounts), but fees vary widely depending on the sponsor of the managed account program.

Table 5 presents “before” and “after” expected returns and Sharpe ratios for each of the five segments in the managed account sample. These results provide estimates of the costs or inefficiencies associated with a given type of portfolio strategy chosen by the participant compared to a portfolio selected by a professional adviser. For Red (Zero Equity) participants, not surprisingly, the costs in terms of lower expected returns are dramatic: these participants forfeit 358 basis points in expected return. Even Green portfolios experience gains in expected return of 63 basis points due to improvements in portfolio strategy. However, note that the adoption of professional advice does not lead to improvements in expected real returns across the board. The most aggressive investors – Yellow (Aggressive Equity) and Red (Company Stock) – actually see expected returns fall as their portfolios are diversified away from high levels of, respectively, diversified equities and company stock specific risk. In both groups, however, expected returns per unit of risk improve. For all investor segments, Sharpe ratios (as a measure of portfolio efficiency) improve. The largest gains in Sharpe ratios occur for zero-equity holders and for those eliminating company stock risk.

Table 5 here

In addition, we examined which demographic segments might benefit the most – in terms of improved portfolio risk and return characteristics – if they were to adopt “greener” portfolio strategies. Results from our model are showed in Figure 3 (with details in Table 6 in the Appendix). All demographic groups experienced an improvement in performance after managed account adoption, but the relative size of the improvement varied. As shown in the Figure, a

hypothetical managed account adopter—in this case defined as non-high-wealth, medium household income, non-web registered, female of average age, account balance, and tenure—experiences a 1.50% increase in her expected return. However, if we hold everything constant about this average participant but change her sex to male, this hypothetical participant experiences a 0.91% increase in expected return after managed account adoption—an improvement in performance significantly greater than zero but also significantly less than that of a female participant. Similarly, if we hold everything constant but change the hypothetical participant to a high wealth participant, they experience a 1.65% increase in expected return instead of 1.50%.

Figure 3 here

Summary and Implications

Our analysis of participant portfolio choice indicates that nearly 45% of participants construct “green” portfolios based on their overall exposure to a diversified level of equity market risk, while another 25% or so construct “yellow” portfolios with possibly too-aggressive or too-conservative equity holdings. Another three in ten make egregious or “red” portfolio errors, either by not investing in equities at all, or by over-concentrating their portfolio in employer stock. At a finer level of portfolio detail, most participants (with some exceptions) do not appear to engage in additional levels of portfolio diversification, such as holding mid- and small-capitalization US, non-US stocks or high-quality bonds, despite the widespread availability of these options and the potential for increased portfolio efficiency that they offer. Some portfolio diversification errors are clearly related to employer plan design (e.g., the availability of company stock or the lack of specialized diversification options), though many participants in our sample have access to a wide range of broad asset classes.

Our estimates suggest that portfolio errors can be costly. The most costly errors are made by Red (Zero Equity) participants, those who hold no equities in their 401(k) account; the potential gain from improving their portfolios is estimated at over 350 basis points in real return per year. Yet even Green investors can improve portfolio performance by 60 basis points or more through better portfolio construction. Gains are also possible in terms of portfolio efficiency as measured by Sharpe ratios. For plan sponsors overseeing a given defined contribution plan, the potential gains at the plan level will of course depend on the proportion of investor segments in the plan population. For example, a plan with a large Red (Zero Equity) will experience more dramatic improvements in expected returns than, say, a population with more Green or Yellow (Aggressive Equity) investors. Similarly, a plan with many aggressively oriented participants is likely to see expected returns fall, while efficiency measures improve.

The participants most likely to experience improvements in expected returns and Sharpe ratios from better portfolio strategies are those whose characteristics are typically associated with low levels of financial literacy—namely, lower income and less engaged participants. More aggressive investors, who are more often affluent men, may experience reductions in returns, but still see improvements in overall portfolio efficiency.

There are a variety of strategies that sponsors and policymakers might pursue in order to improve participant portfolios and reduce the costs of portfolio errors. Continued financial education is one avenue, and indeed, investor education materials are already quite common within the 401(k) marketplace. However, their main drawback is that education programs appear to yield few actual changes in portfolio strategy, due to the widespread prevalence of inertia among participants. Educational programs can alter people's attitudes and intentions regarding investment planning; the challenge arises with follow through and executing on intentions.¹⁶ An

alternative approach is to promote automatic enrollment of participants into well-designed default funds. This is the premise underlying the Pension Protection Act (PPA), and in keeping with its provisions, the U.S. Department of Labor has proposed new regulations encouraging the greater use of “qualified default investment alternatives” (QDIAs). Advice programs may also improve portfolios. They typically come with incremental costs for the advisory service, although those costs must be compared with the potential gains in portfolio expected returns and/or diversification levels that may occur, at least for some segments of participants.

Another possible strategy is the notion of mapping plan participants to “better” investment allocations. Under U.S. fiduciary law, plan sponsors generally remain the ultimate party responsible for the investment of plan assets. If they so choose, they are able to “map” (or shift) all plan participants balances into other investment funds, such as professionally managed default investments.¹⁷ Such a strategy could potentially improve portfolio allocations quickly, given the tendency of most participants to rely on default choices made by others. And by including a right to opt-out of the mapping, such a strategy could address the needs of those participants who have strong preferences to retain their existing choices.

Addressing over-concentration of company stock is more difficult due to the fact that some companies match in company stock, and such matching contributions appear to be the principal determinant of concentrated stock holdings. One option is for sponsors to match “in cash” (i.e., into the funds the employee has selected) rather than in employer stock. A second strategy is to impose limits on concentrated holdings by employees. Advice programs like managed accounts are a third approach, as the advisory service takes responsibility for the liquidation of employer stock, and the employer is not responsible for encouraging the sale of shares of employer stock. A final option is the “sell more tomorrow” program, in which

participants are defaulted into a reverse dollar-cost averaging service that gradually liquidates their stock holdings down to a reduced level over time.¹⁸

One consideration in interpreting the results of our study is that we are assessing participant holdings based on a single 401(k) account, whereas participants could be constructing portfolios at the household level. For example, we might classify a participant portfolio as Red (Zero Equity), but the participant or the participant's spouse or partner may have assets invested in equities in other accounts that we do not observe. In total, their household portfolio could be Green. While we acknowledge that this is a possibility, our research suggests that for many participants their current 401(k) account is their only meaningful financial investment. Nearly 50% of our participants have less than \$10,000 in non-retirement assets. Furthermore, a 2006 study from the Employee Benefit Research Institute found that for nearly a third of participants, their retirement savings in their employer plan represented "all or almost all" of their total retirement savings and for another 15%, their employer plan represented three-quarters of their total retirement savings.¹⁹ Given that most participants have no or few assets outside their plan, our belief is that this problem may be limited in scope—and confined to the more affluent participants in our sample, who already construct Yellow or Green portfolios anyway.

An intriguing question raised by our research is whether or not informing participants of their color-coded segment (through their quarterly statements or on the web) would influence their investment behavior. Given the widely demonstrated power of inertia in defined-contribution investing and the fairly limited effects of investor education, we believe that this knowledge would not impact participant investment behavior in a meaningful manner. However, informing a plan sponsor that 30% of their participants are in the Red segment could motivate the sponsor to alter the design of the plan. In any event, future research might explore the impact

of informing participants about their investor segment or plan sponsors about the distribution of segments within their plan.

Overall it seems that participant portfolios are quite heterogeneous, and efforts to improve portfolio allocations by sponsors will depend on the specific segments that predominate in a given plan. Any gains in expected real returns from improvements in portfolio strategy are likely to be largest among populations typically associated with low levels of financial literacy, especially low-wealth and unengaged participants. Meanwhile, participants who invest in an overly aggressive manner, such as affluent male investors, may benefit from greater portfolio efficiency and diversification.

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Table 1. Sample Characteristics

	Full Sample	Managed Account Sample
<i>n</i> =	2,857,089	11,729
<i>Demographics</i>		
Median age	44.0	50.0
Percent male	64%	48%
Median job tenure	8.5	13.2
Median household income	\$ 87,500	\$ 95,951
Percent high wealth*	21%	20%
Percent web registered	49%	56%
<i>Investment</i>		
Median plan assets	\$ 23,784	\$ 38,572
Percent equity exposure	67%	57%
Percent company stock exposure	11%	7%

* Data from the IXI company were used to impute nonretirement plan household financial wealth at the ZIP+4 level. High wealth participants are defined as participants with over \$50,000 in non-retirement household wealth (the top 20%).

Table 2. Investor Segments**Panel A. Summary of Segments**

Investor Segment	Percent
A. Green	43.1%
B. Yellow (conservative equity)	6.9%
C. Yellow (aggressive equity)	19.3%
D. Red (zero equity)	13.4%
E. Red (company stock)	17.2%

Panel B. Segments in Detail

	<u>Company Stock Exposure</u>					<u>TOTAL</u>
<u>Equity Exposure</u>	<u>1) Zero</u>	<u>2) 1 to 19</u>	<u>3) 20 to 39</u>	<u>4) 40 to 99</u>	<u>5) 100</u>	
1) Zero	D 13.4%					13.4%
2) 1 to 39	B 5.2%	1.7%	E 0.8%			7.7%
3) 40 to 94	A 37.5%	5.7%	3.7%	3.9%		50.7%
4) 95 to 99	3.3%	1.0%	0.6%	1.6%		6.6%
5) 100	C 13.7%	1.3%	1.1%	1.4%	4.2%	21.7%
TOTAL	73.1%	9.6%	6.1%	6.9%	4.2%	100.0%

Note: Based on full sample.

Table 3. Type of Investment Options Used

Category	Percent of Plans Offering	Percent of Participants Offered	Percent of Participants Offered and Using
Large Cap US equities	99%	98%	65%
Money Market/GIC	98%	98%	44%
Balanced/Life-Cycle/Life-Style	97%	95%	43%
High quality bond	97%	95%	26%
International equities	95%	96%	25%
Small/Midcap US equities	93%	96%	29%
REITs	21%	15%	8%
Speciality/Sector	19%	13%	12%
High-yield bonds	16%	15%	8%
TIPS	16%	20%	4%
Emerging markets	13%	15%	6%
Company stock	12%	46%	58%
World bonds	0%	2%	1%

Note: Based on full sample.

Table 4. Participant Asset Allocations by Investor Segment

Percent of assets

Category	Red (Zero Equity)	Yellow (Conservative Equity)	Green	Yellow (Aggressive Equity)	Red (Company Stock)
Large Cap	0%	8%	36%	68%	16%
Balanced/Life-Cycle/Life-Style	0%	16%	34%	1%	6%
Small & Mid Cap	0%	1%	7%	16%	4%
Money Market/GIC	92%	55%	7%	0%	8%
Bond	7%	14%	7%	0%	3%
International	0%	1%	5%	9%	2%
Company Stock	0%	2%	1%	1%	61%
Other	<u>1%</u>	<u>2%</u>	<u>2%</u>	<u>4%</u>	<u>0%</u>
TOTAL	100%	100%	100%	100%	100%
<i>Percent Equity Exposure</i>	0%	21%	73%	99%	87%

Note: Based on full sample.

Table 5. Portfolio Return and Risk Characteristics by Investor Segment**Panel A. Expected Real Returns After Fund Expenses (1)**

Segment	Before Managed Account	After Managed Account	Methodology Adjustment (2)	Change in Expected Return	Percent Change
Red (Zero Equity)	1.76%	5.41%	-0.07%	3.58%	203%
Yellow (Conservative Equity)	3.02%	5.70%	-0.10%	2.58%	85%
Green	5.09%	5.87%	-0.15%	0.63%	12%
Yellow (Aggressive Equity)	6.63%	6.00%	-0.19%	-0.82%	-12%
Red (Company Stock)	7.68%	6.14%	-0.21%	-1.75%	-23%
Total	4.86%	5.83%	-0.15%	0.82%	17%

Panel B. Sharpe Ratios

Segment	Before Managed Account	After Managed Account	Methodology Adjustment (2)	Change in Sharpe Ratio	Percent Change in Sharpe Ratio
Red (Zero Equity)	0.111	0.316	-0.0064	0.198	179%
Yellow (Conservative Equity)	0.250	0.318	-0.0025	0.066	26%
Green	0.304	0.319	-0.0043	0.011	4%
Yellow (Aggressive Equity)	0.289	0.318	-0.0049	0.024	8%
Red (Company Stock)	0.233	0.313	-0.0081	0.072	31%
Total	0.256	0.318	-0.0049	0.057	22%

Projected returns are based upon Financial Engines' forecasting methodology, which projects the likelihood of various investment outcomes that are hypothetical in nature. The expected returns do not reflect actual results and are not guarantees of future results.

Note: Based on managed account sample.

(1) Expected returns are after fund expenses but before the separate fee charged by the managed account service.

(2) These adjustments reflect changes over time in the sub-adviser's expected returns and/or covariance matrix. See text.

Figure 1. Relationship Between Demographics and Investor Segment Membership
Relative Marginal Probabilities

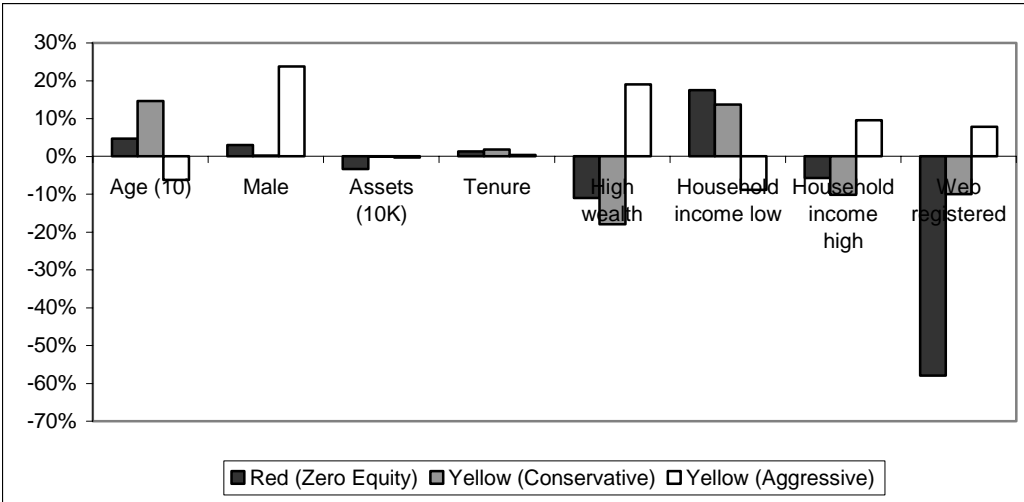
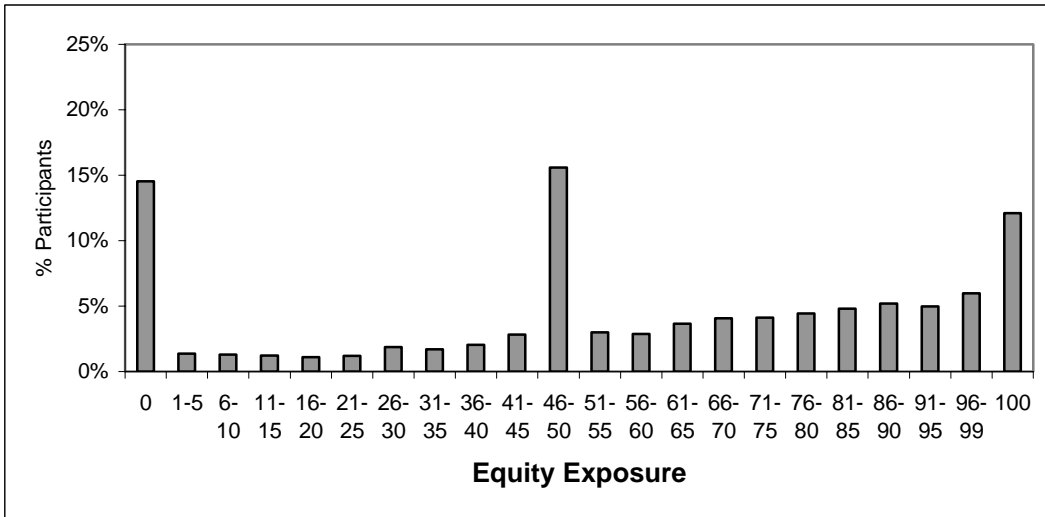
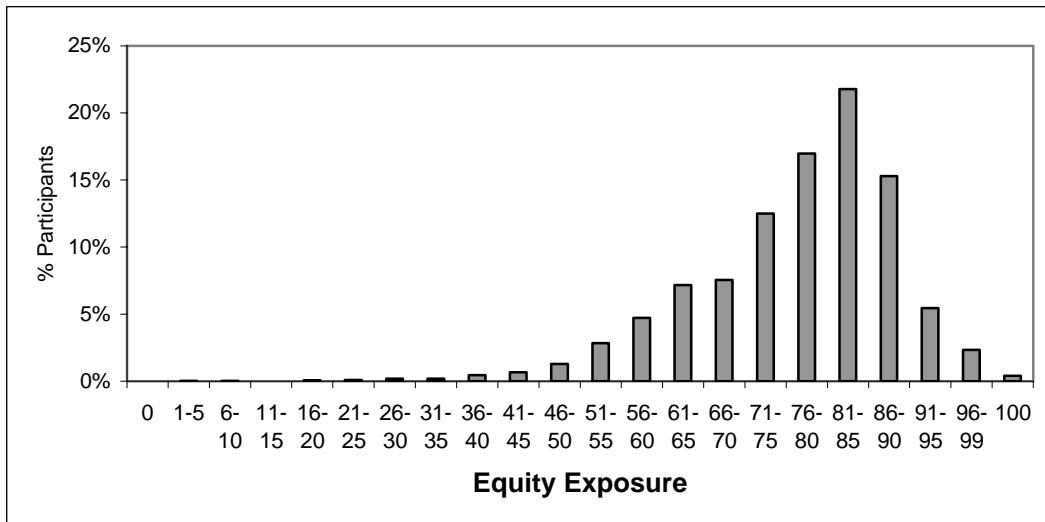


Figure 2. Impact of Managed Account on Equity Exposure
Before managed account adoption



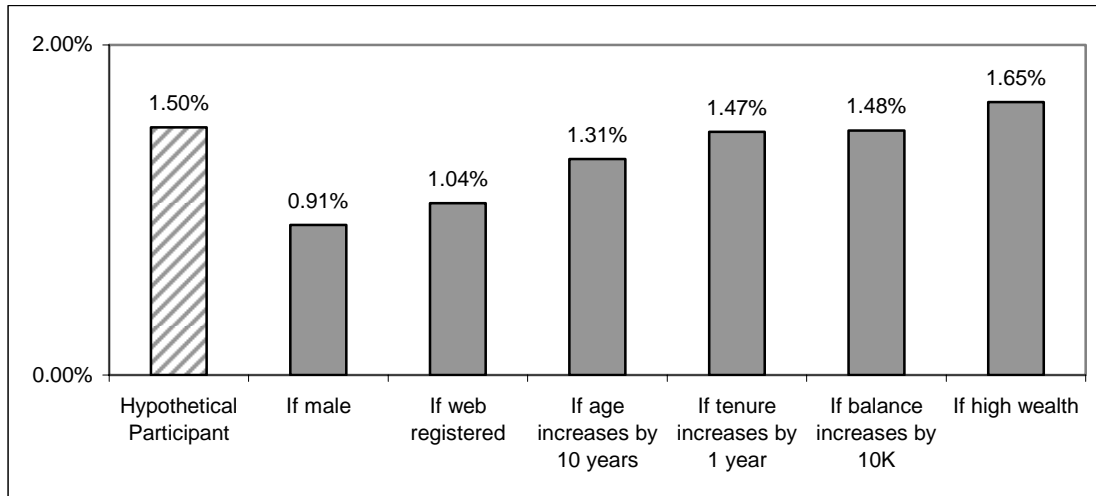
After managed account adoption



Note: Based on managed account sample.

Figure 3. Relationship Between Demographics and Portfolio Improvement

Change in expected return pre/post managed account implementation



Appendix

Investor Segments

Figure 1 summarizes marginal effects from a multinomial logit regression analyzing the impact of participant demographics on membership in a given investor segment in Table 1. The general form of the model is $\Pr(\text{Segment}_{i,j}) = \beta_0 + \beta_1 \mathbf{X}_{i,j} + \varepsilon_{i,j}$, where the dependent variable is the probability of being in one of the investor segments shown, with the “green” segment as the reference category. We excluded “red (company stock)” participants from the analysis since their holdings of company stock were not influenced by demographic factors but by the plan sponsor’s decision to place company stock in the 401(k) menu.

Portfolio Changes and Demographics

Figure 3 summarizes changes from a “difference in difference” ordinary least squares model relating portfolio expected returns and Sharpe ratios to demographic characteristics. The sample is our managed account sample. The empirical model for $E(r_{i,j,t})$, the expected returns for the i th participant account in the j th plan at time t , is as follows:

$E(r_{i,j,t}) = \beta_0 + \beta_1 \text{Treatment}_{i,j,t} + \beta_2 \mathbf{Y}_{i,j,t} + \beta_3 \mathbf{Z}_{i,j,t} + \varepsilon_{i,j,t}$. We observe each participant portfolio at two points in time: prior to the managed account adoption (September 2004) and after (December 2005). Our independent variables include a within-subject *Treatment* variable (i.e., set to 1 if after adoption of the managed account and 0 before adoption) and a vector of demographic variables $\mathbf{Y}_{i,j,t}$. Furthermore, we interact the *Treatment* variable with the between-group demographic variables such as gender, age, and web registration in $\mathbf{Z}_{i,j,t}$. Observations are clustered at the participant level to ensure robust errors. The complete regression results are shown in Table 6.

Table 6. Multinomial Regression Results

	Dependent Variable: Expected Real Return	Dependent Variable: Sharpe ratio
	Mean	Mean
	Before=.0486 After=.0583 Difference=.0090	Before=.256 After=.318 Difference=.062
Main Effects	<i>Estimates</i>	<i>Estimates</i>
Intercept	0.0479 **	0.2639 **
Treatment	0.0299 **	0.0535 **
Age (10)	-0.0023 **	-0.0014
Male	0.0073 **	0.0010
Balance (\$10K)	0.0002 **	0.0010 **
Tenure	0.0003 **	-0.0010 **
High wealth	-0.0020 **	0.0010
Household income low	0.0003	-0.0016
Household income high	0.0010 *	0.0024
Web registered	0.0051 **	0.0121 **
Interaction Terms		
Treatment*Age (10)	-0.0019 **	0.0018
Treatment*Male	-0.0059 **	-0.0017
Treatment*Balance (\$10K)	-0.0002 **	-0.0009 **
Treatment*Tenure	-0.0003 **	0.0009 **
Treatment*High wealth	0.0015 **	-0.0011
Treatment*Household income low	-0.0004	0.0016
Treatment*Household income high	-0.0007	-0.0022
Treatment*Web registered	-0.0046 **	-0.0123 **
Clustering at Participant-level	Yes	Yes
Observations	20,590	20,590
# of Participants	10,295	10,295
R Squared	20%	27%

Notes:

Significant at .05 (**) or .10 (*) level.

Clustering at the participant level to ensure robust standard errors.

Results do not account for the "methodology adjustment" described in Endnotes.

Endnotes

¹ See Hancock (2002) and Vanguard (2002) for measures of financial literacy. For information on participant allocation patterns, see Vanguard (2006a) and Munnell and Sundén (2004).

² For a discussion of behavioral biases in defined contribution plans, see: Thaler and Benartzi (2001); Benartzi and Thaler (2002); Iyengar, Huberman and Jiang (2004); Brown, Liang and Weisbenner (2006); and Iyengar and Jiang (2006).

³ For a discussion of the role of procrastination and inertia in financial decision-making, see Madrian and Shea (2001); Ameriks and Zeldes (2004); and Choi, Laibson, Madrian and Metrick (forthcoming). For 401(k) trading research, see: Agnew, Balduzzi and Sundén (2003); Mitchell, Mottola, Utkus and Yamaguchi (2006); and Yamaguchi, Mitchell, Mottola and Utkus (2006).

⁴ See Hancock (2002) and Vanguard (2002) for measures of financial literacy. For common household financial mistakes, see Campbell (2006). For a discussion of financial literacy among older Americans, see Lusardi and Mitchell (2007).

⁵ These participants were drawn from 19 organizations with 37 plans and 242,412 unique participant accounts.

⁶ In total, 95% of participant portfolios fell in this range after managed account implementation. See Vanguard (2006b) for full details about adoption of the managed account service.

⁷ This 401(k) approximation is a good measure of the overall market participation rule, since equity exposure in 401(k) plans can be obtained with no minimum balance constraints and with no transaction costs (such as sales loans) in our sample.

⁸ The PPA requires that plans offering company stock notify participants of their “right to diversify.” The Internal Revenue Service builds on this provision with Notice 2006-1-7—which

states that “if you invest more than 20% of your retirement savings in any one company or industry, your savings may not be properly diversified.”

⁹ Company stock classification superseded equity exposure classification, so, for example, a participant with between 40 and 95% equity exposure but over 20% company stock exposure would be classified as Red (Company Stock).

¹⁰ In our sample, many international stock funds included an allocation to emerging market stocks.

¹¹ Even among the participants diversifying their portfolios more broadly, we are not assessing whether their portfolios conform to detailed asset allocation rules, such as the proportion to be invested internationally, that our experts might recommend.

¹² See Viceira (Chapter X, this volume).

¹³ We use registration for 401(k) internet access used as a proxy for degree of financial engagement.

¹⁴ See Smith and Stewart (Chapter X, this volume).

¹⁵ We estimated portfolio expected returns and variances at two points in time: September 2004, prior to the introduction of the managed account service in late 2004, and December 2005, the end point of our analysis. Expected real returns for the i th participant account at time t are simply

the weighted average of expected real returns for the k assets in the plan:
$$E(r_i) = \sum_{k=1}^N \omega_{k,t} E(r_k).$$

Portfolio variances based on the variance-covariance matrix $\hat{\Sigma}$ are: $\hat{\Sigma}_i = \omega'_{i,k,t} \hat{\Sigma} \omega_{i,k,t}$. Each i th account's Sharpe ratio is its excess return over the risk-free rate divided its portfolio standard deviation, $r_i - r_f / \sigma_i$. Other details about the calculations, including the “methodology

adjustment” needed to capture the “drift” in the Financial Engines return-covariance matrix, is summarized in Vanguard (2006b).

¹⁶ See Clark and d’Ambrosio (Chapter X, this volume).

¹⁷ Sponsors may forfeit so-called 404(c) fiduciary protection in doing so. But they may choose to map the plan if, as plan fiduciaries, they judge such a move to be in the best interests of plan participants. There is anecdotal evidence that some sponsors have undertaken such mappings, usually providing participants with the right to “opt out” of such changes and retain their existing holdings.

¹⁸ See Benartzi, Thaler, Utkus and Sunstein (2007).

¹⁹ Helman, Copeland, and VanDerhei (2006).