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ADJUSTING TARGET-DATE FUND GLIDE PATH FOR THE RELATIVE VALUATION OF THE S&P 500

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ABSTRACT

This thesis evaluates different equity/bond asset allocations in defined contribution plans over a 45-year time horizon. Specifically, it compares a target-date fund with a traditional glide path to four different static allocations, a heuristic allocation, and a dynamic allocation with a glide path that adjusts based on the relative valuation of the S&P 500 compared to its historical average from December 1971 – November 2016. A bootstrap simulation of theoretical savings accounts invested using these allocations reveals that it is possible to achieve superior risk-adjusted returns when glide path is adjusted for equity valuations, barring no excessive transaction costs of rebalancing.

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Chapter 1

Introduction

American workers' retirement landscape has shifted dramatically in recent years. Decades ago, it was common for employees to be covered by defined benefit pension plans, in which workers would allocate a portion of their salary (oftentimes matched by their employer) to a pool of assets for the retirees of the corporation or union. In return, workers would likely receive a monthly check from their past employers from the month they retired until the month they passed away. This model has since become far more taxing on plan sponsors. Advances in modern medicine and healthcare have added to Americans' longevity significantly since the introduction of defined benefit plans. The Society of Actuaries reports that current trends suggest that 33% of males and 50% of females in their 50's will reach at least 90 years of age.[1] More recently, historically low government bond yields in developed economies have made it even more difficult for defined benefit plan sponsors to grow their assets in such a way that will meet the future liabilities they have guaranteed plan participants.

These phenomena together have given rise to defined contribution (DC) plans. Unlike defined benefit plans, DC plans make it the saver's responsibility to grow his/her nest egg approaching retirement, relieving sponsors of much of the risk. First, workers must choose how much of their salary to contribute, and their sponsors will likely match this contribution up to a certain percentage of salary or total amount per year. Second, employees must make an

[1] "Age Wise." *Society of Actuaries*.

incredibly important decision: choosing how to allocate these savings. They are usually offered an array of options with varying risk, from money market accounts to balanced equity/bond accounts to company stock. Being mindful that many of these savers are not necessarily well-versed in investing and finance, this can be a daunting task for someone like a steelworker or elementary school teacher. A new retirement product tailored for such workers was introduced around the turn of the century, addressing the need for returns while providing convenience and automated decision-making. Today, these are known as target-date funds.

Target-date funds (TDFs) are generally marketed with a target retirement year for every five calendar years. For a 22-year old graduating from college in 2017 and joining the workforce in the same year, he/she would likely choose a 2060 TDF. The graduate creates a retirement target of 65 years old in doing so. Most TDFs on the market will follow a traditional “glide path,” in which the portfolio starts heavily allocated to equities and less so to bonds. Over time, the allocation to equities will shrink as the bonds allocation grows. This path exposes plan participants’ portfolios to higher growth and more volatility early on in the savings process before derisking as retirement approaches and protection of accumulated savings becomes vitally important. While nearly all TDFs follow these general conventions, no one glide path offered by fund managers is exactly like another, making the funds available to DC plan sponsors in the market surprisingly heterogeneous. These variations in the marketplace have generated much scrutiny from academics and others as the assets invested in TDFs have ballooned.

In the past decade, the prevalence of TDFs has risen dramatically. In 2006, the Pension Protection Plan was passed and along with it came sweeping changes to DC plans. It was mandated that all plans have a Qualified Default Investment Alternative (QDIA), in which employees would be automatically enrolled following notification from their sponsor.[2] Just one year later in 2007, 64% of DC plan sponsors already chose to designate TDFs as their QDIA. This number reached 86% in 2014.[3] To give an impression of the dollar size of this market today, mutual fund-based target-date fund assets climbed to $790 billion ($535 billion in DC plans) as of March 31, 2016, the most recent quarter with data available. This breaks the record set in the previous quarter ending December 31, 2015, of $763 billion ($511 billion in DC plans).[4]

[2] Lester, Anne. "Retirement Reset." J.P. Morgan Asset Management.
[3] Willis Towers Watson: *Asset Allocations: How American Workers Are Investing Their Retirement Savings.* (2015, 04).
[4] 401(k) plan assets, target-date funds reach record levels in first quarter. (2016, Jun 25). *Financial Services Monitor Worldwide*.

Chapter 2

Literature Review

Target-Date Funds

Retirement portfolio performance can be difficult to attribute to any one factor. Often, it comes down to two major factors, security selection and asset allocation. While individual investors spend much energy on security selection, it is usually asset allocation that plays the most important role in long-term returns. Brinson et al. (1986) published that pension plans' long-term asset allocation, or investment policy, explained nearly 94% of performance compared to investment strategy, which encompassed security selection and market timing. Ibbotson and Kaplan (2000) largely affirmed the findings of Brinson et al. (1986) and further found that 40% of the variation in performance *between* different funds was also explained by investment policy.

The research methodology for this thesis assumes that index-tracking TDFs, even those with imperfectly designed glide paths, can offer superior risk-adjusted returns to a number of other DC vehicles. I follow the findings of Viciera (2007), who argued that declining-equity TDFs (those with traditional glide paths) served a greater number of investors as QDIAs than did money market accounts and personalized managed accounts, which usually come associated with higher fees.

Many pieces of research have attempted to compare different retirement account allocations through bootstrap and Monte Carlo simulations. These studies analyzed varying declining-equity glide paths, fixed debt/equity allocations, heuristic allocations, and even rising-equity glide paths. Prior to the introduction of TDFs, heuristic allocations were common for those who wanted to introduce gradual derisking to their portfolios. The two most implemented were 100% equity less one's age and 120% equity less one's age. A rising-equity glide path, though only advocated by a handful of academics, is a strategy that exposes investors to less equity market volatility in the earlier stages of saving and more in the later stages.

Meyaard and Templeton (2002) conducted the first notable Monte Carlo simulation study and found that a 50/50 fixed equity/debt allocation had comparable risk and return performance metrics to a 100% equity less age heuristic allocation. Years later, researchers' attention shifted to evaluating the glide paths of TDFs as they largely replaced heuristics as a primary retirement savings option. Also using Monte Carlo simulations, both Blanchett (2007) and Spitzer and Singh (2008) argued that a number of fixed asset allocations provided similar results or were superior to TDFs using declining-equity glide paths.

Turning focus to more unconventional allocation approaches, Dolvin, Templeton, and Rieber (2010) found that most market offered TDFs reflect performance similar to the 120% less age heuristic allocation, and they recommended that plan contributors invest 100% of their savings in equity until 10 years prior to retirement when they should begin to allocate more conservatively. Kitces and Pfau (2015) found in their simulation that a rising-equity glide path can reduce both the chances of retirement failure (not accumulating the desired nest egg) and the magnitude of failure.

Dynamically allocated TDFs are the last type to discuss, and these funds will be the focus of this research. Masters and Fontaine (2010) suggested TDFs that implemented volatility management, reducing equity exposure in times of high volatility, may lower the odds of extreme outcomes without sacrificing long-term returns. Kalman (2011) set out to examine the impact of equity risk premium in asset allocation decision-making. Using a bootstrap simulation, he illustrated that a fixed 50/50 equity/debt allocation outperforms TDFs on a historical basis, and when adjusting for equity risk premium, a portfolio with an even higher allocation to debt can still outperform TDFs. Kitces and Pfau (2015) found that a rising-equity glide path will perform especially well when retirement savings begin in overvalued equity market environments. In addition, they concluded that in other valuation markets, a valuation-based asset allocation approach was best in fulfilling historical worst-case scenario withdrawal rates.

Valuation-Based Investing and Dynamic Asset Allocation

Campbell and Shiller (1998) analyzed aggregate U.S. stock market data from 1871-1986 and found that a historical average of stock returns was a good predictor of the present value of future real dividends. They concluded that equity valuations could be used to forecast long-term returns. Campbell and Shiller (2001) revisited their study following the burst of the tech bubble at the turn of the century that caused a steep decline in stock prices. These years were characterized by soaring price-earnings ratios and reinforced their findings from three years earlier.

The research of Campbell and Shiller has been widely adopted by academics and equity investment decision makers. Relevant to this study, their findings have been applied in the construction of dynamically allocated retirement portfolios. These portfolios account for changing market conditions (such as equity valuations relative to historical averages) in allocation decisions. Solow, Kitces, and Locatelli (2011) concluded that a market-valuation-based tactical asset allocation, one in which equities are underweighted relative to bonds in unfavorable valuation conditions and overweighted in favorable conditions, can lead to better risk-adjusted returns. Madhogarhia and Lam (2015) used a strategy that invested in six equity and debt asset classes over a 30-year period. For the last 10 years, they annually identified the most undervalued asset class of the six and shifted allocation to this class proportionate to the undervaluation. The return on this strategy was greater than investing in any lone asset class over the 10-year period.

Post-Crisis Government Scrutiny

Nearly all aspects of the financial world were re-evaluated following the global financial crisis, and target-date funds were no exception. The Special Committee on Aging of the U.S. Senate convened a hearing in October of 2009 to specifically address TDFs. What follows is an excerpt of Chairman of the Committee, Senator Herb Kohl's opening statement:

> In February, our committee raised some concerns about the recent performance of target-date funds. We found that the composition of these funds varied widely across the industry, and many contained an inappropriately high level of risk. Some workers in funds with a 2010 retirement date lost as much as 41 percent of their 401(k) savings in 2008…This afternoon we will discuss three key problems. First, there is a lack of transparency and consistency in the design of target-date funds. Second, many funds charge excessive fees, eroding the value of a worker's assets over time. Third, fund managers have a conflict of interest in constructing target-date funds and must resist the temptation to put their bottom line above the interests of the participants.[5]

[5] "Default nation : are 401(k) target date funds missing the mark? : hearing before the Special Committee on Aging, United States Senate, One Hundred Eleventh Congress, first session, Washington, DC, October 28, 2009. ." *Default nation : are 401(k) target date funds missing the mark? : hearing before the Special Committee on Aging, United States Senate, One Hundred Eleventh Congress, first session, Washington, DC, October 28, 2009.* : I-131.

Senator Kohl and the Committee's concerns are shared by many of the academics and researchers cited in the previous sections of this chapter. The Great Recession exposed the issues of heterogeneity across the TDF market. The Senator cites the extreme circumstance of some workers retiring the following year losing 41% of their savings in 2008, but it is entirely possible that workers invested in vehicles with the same target date but different glide paths lost only 20%, or perhaps even less. In February of 2011, the U.S. Government Accountability Office followed up with another report focused on TDFs and had similar findings:

> Target date funds vary considerably in asset structures and in other ways, largely as a result of the different objectives and investment philosophies of fund managers. In the years approaching the retirement date, for example, some TDFs have a relatively low equity allocation--35 percent or less--so that plan participants will be insulated from excessive losses near retirement. Other TDFs have an equity allocation of 60 percent or more in the belief that relatively high equity returns will help ensure that retirees do not deplete savings in old age. TDFs also vary considerably in other respects, such as in the use of alternative assets and complex investment techniques.

Together, these two government inquiries reiterate the importance of this study. Table 1 on the following page shows three years' worth of cyclically adjusted price-to-earnings (CAPE) ratio figures that were used in the data simulation of this analysis. The ratio was above its 45-year average in the months leading up to the financial crisis, and underweighting equity in TDFs could have potentially saved countless dollars for American workers.

Table 1: Monthly CAPE Over/undervaluation Surrounding Financial Crisis

Month	% CAPE over/undervalued	Month	% CAPE o/u	Month	% CAPE o/u
Jan-06	33.13%	**Jan-07**	36.84%	**Jan-08**	20.82%
Feb-06	32.03%	**Feb-07**	37.39%	**Feb-08**	18.17%
Mar-06	32.42%	**Mar-07**	31.92%	**Mar-08**	13.70%
Apr-06	31.51%	**Apr-07**	35.68%	**Apr-08**	17.47%
May-06	29.01%	**May-07**	38.56%	**May-08**	19.18%
Jun-06	24.48%	**Jun-07**	37.90%	**Jun-08**	12.75%
Jul-06	24.22%	**Jul-07**	37.86%	**Jul-08**	5.16%
Aug-06	26.00%	**Aug-07**	31.52%	**Aug-08**	7.64%
Sep-06	28.98%	**Sep-07**	34.42%	**Sep-08**	2.42%
Oct-06	33.48%	**Oct-07**	37.41%	**Oct-08**	-17.58%
Nov-06	35.44%	**Nov-07**	29.41%	**Nov-08**	-23.25%
Dec-06	37.22%	**Dec-07**	30.55%	**Dec-08**	-22.66%

Chapter 3

Data Analysis and Methodology

Data Description

The asset return data I used in my simulation was leveraged from Wharton Research Data Services. Specifically, equity returns were based upon WRDS monthly value-weighted return (including dividends) of the S&P 500 from January 1972 to December 2016, and bond returns data was taken from WRDS monthly return of 10-year U.S. Treasuries over the same time span. All returns used were nominal values, and thus, the simulation output is also measured in nominal dollars.

S&P 500 valuation and CAPE data from December 1971 to November 2016 was taken from Dr. Robert Shiller's homepage located at Yale University's Department of Economics website.

Account Construction and Methodology

Accounts #1-4 were allocated statically. The equity/bond allocation is explained by the account title. For example, Account #2 was allocated 70% to equity and 30% to bonds for the entirety of the 45 years leading to retirement.

Account #5 used a "heuristic" allocation. As I mentioned in the Literature Review, these types of allocations were popular before the invention of target-date funds because they represent a very gradual, consistent glide path. The most common was an equity allocation of 120% less one's age. I chose to do a 100% less years of saving, which would correspond to 122% less one's age assuming the individual begins savings when he/she is 22. Since I used monthly data, the equity allocation for each month was 100% - (*months of saving**0.0833%), and the bond allocation was *months of saving**0.0833%, in which .0833% represents 12 increments of 1%.

Account #6 is meant to represent a common TDF available to savers. As discussed earlier in this thesis, there really is no such thing as a "common TDF" with the heterogeneity of fund construction in the market, but using data provided in Dolvin, Templeton, and Rieber (2010) on the TDF allocations of T. Rowe Price, Fidelity, American Funds, TIAA-CREF, and Vanguard, I chose to use the following glide path.

Table 2: Traditional Glide Path Chosen

Years (months) to retirement	Equity/bond allocation chosen
45-25 (540-301)	90% / 10%
25-20 (300-241)	85% / 15%
20-15 (240-181)	75% / 25%
15-10 (180-121)	70% / 30%
10-5 (120-161)	60% / 40%
5-0 (60-0)	50% / 50%

Account #7 follows the same target allocations as Account #6. However, I allow the equity allocation to slide 5% higher or lower based on the relative valuation of the S&P 500 the *previous month*. For example, if the bootstrap simulation randomly selects March 2001 data to be used for any of the 540 months, the valuation of the S&P 500 in February 2001 will determine the slide position for this month. In this example, equity is underweighted 4.01% in the month using the March 2001 return data because the February 2001 CAPE ratio was 35.83, an 80.24% overvaluation compared to the average CAPE of 19.88 from December 1971 to November 2016. The underweight of 4.01% is calculated from taking 80.24% of 5%. I chose to use the previous month's equity allocation to make it more realistic for an asset manager using this allocation strategy to have time to rebalance the portfolio. I also chose to cap the equity slide at 5% for any months that had overvaluations or undervaluations of greater than 100% to avoid any unrealistic monthly rebalancing in the event that the simulation pulls a highly overvalued month followed by a highly undervalued month, or vice versa, in consecutive months.

Simulation Methodology

I conducted a bootstrap simulation using Microsoft Excel and its VBA add-in to analyze seven different theoretical savings accounts with the allocations and glide paths described in the previous section. The simulation pulls return data of a random month from January 1972 to December 2016 (allowing repeats) for 540 months, or 45 years, of retirement savings accumulation. Using the assumption that most individuals begin contributing to their 401k plans upon graduation from college around age 22, the saver in the simulation makes the following monthly contributions to their portfolio.

Table 3: Monthly Contribution to Account by Saver

Age (months of saving)	Monthly contribution to portfolio
22-30 (1-96)	$500
30-50 (97-336)	$1,000
50-67 (337-540)	$1,500

The accumulation of wealth in the simulation assumes continuous compounding. After each of the seven accounts went through 1000 iterations of the simulation, results were compiled and analyzed.

Chapter 4

Simulation Results

Table 4: Bootstrap Simulation Output Summary

Account	1. 100/0 static	2. 70/30 static	3. 60/40 static	4. 50/50 static	5. Heuristic 100 – years of saving	6. Traditional glide path	7. Valuation-adjusted glide path
Average	15,346,593	8,788,826	7,417,792	6,421,268	9,289,934	9,478,191	9,914,238
Std Dev	17,341,853	5,619,032	4,045,823	3,034,077	5,904,136	6,804,056	6,746,532
10th pcntl	4,079,250	3,689,372	3,516,519	3,283,552	3,752,930	3,814,347	3,967,717
25th pcntl	6,156,285	5,006,715	4,630,349	4,423,972	5,350,438	5,210,565	5,552,634
Median	10,593,387	7,308,571	6,556,456	5,837,866	7,672,818	8,070,771	7,963,397
75th pcntl	18,679,494	10,887,462	9,022,629	7,821,305	11,542,967	11,400,518	12,329,562
90th pcntl	30,136,167	15,762,337	12,531,142	9,825,002	16,896,014	16,522,787	18,089,347

*All values in nominal USD

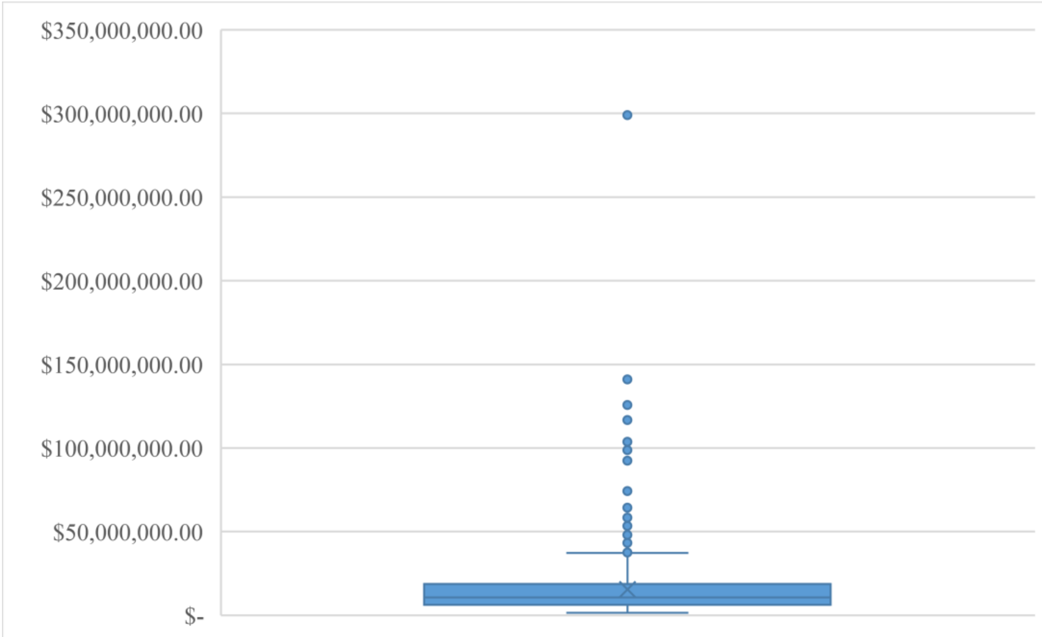

Figure 1: 100/0 Static Allocation Box and Whiskers Plot

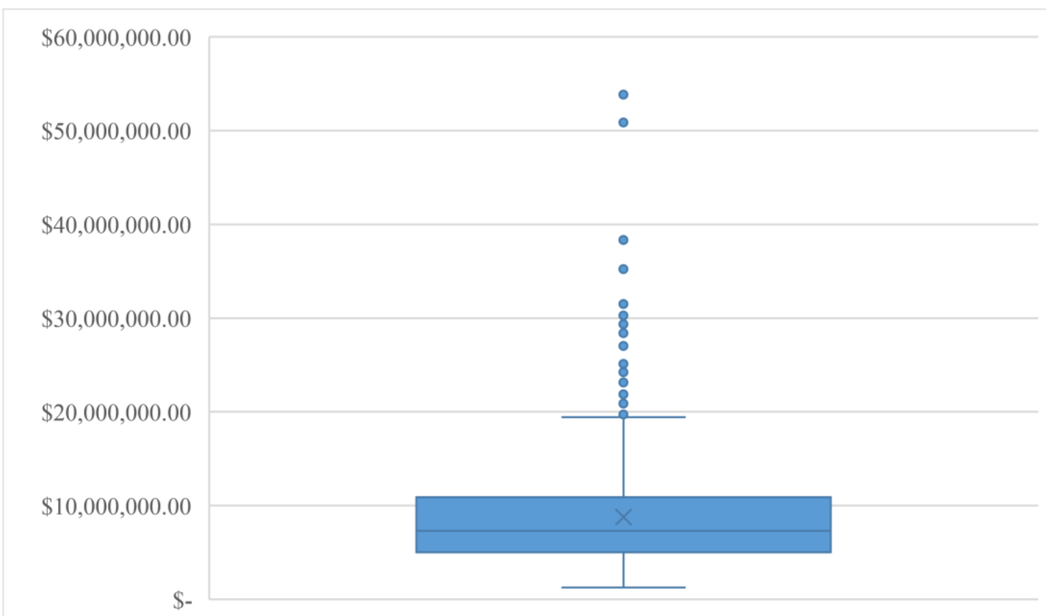

Figure 2: 70/30 Static Allocation Box and Whiskers Plot

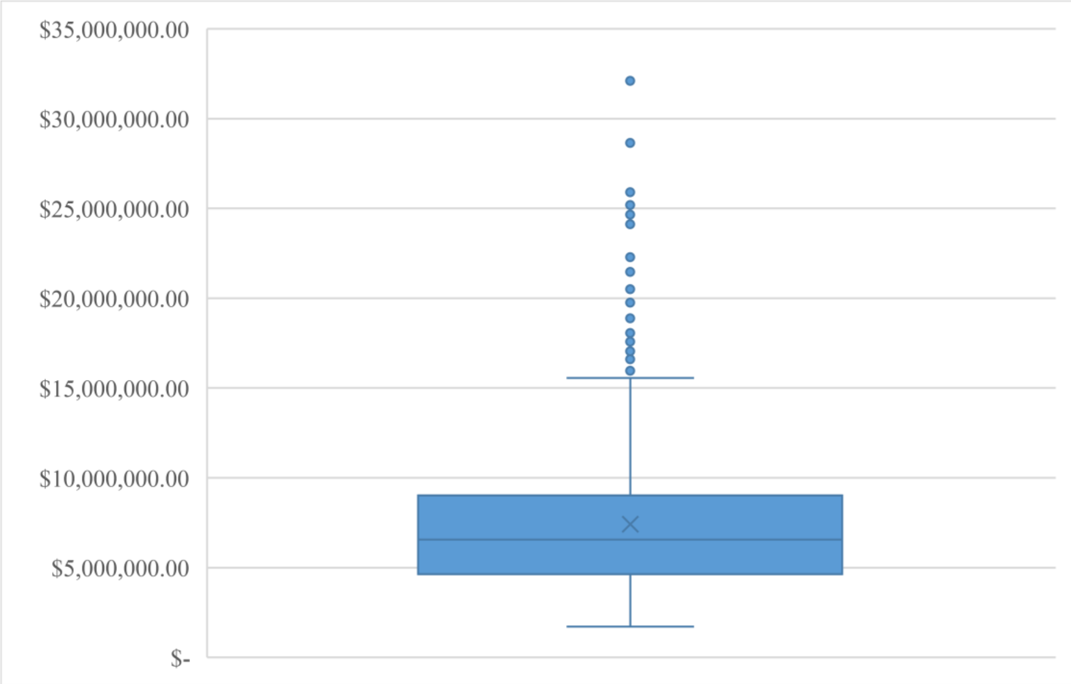

Figure 3: 60/40 Static Allocation Box and Whiskers Plot

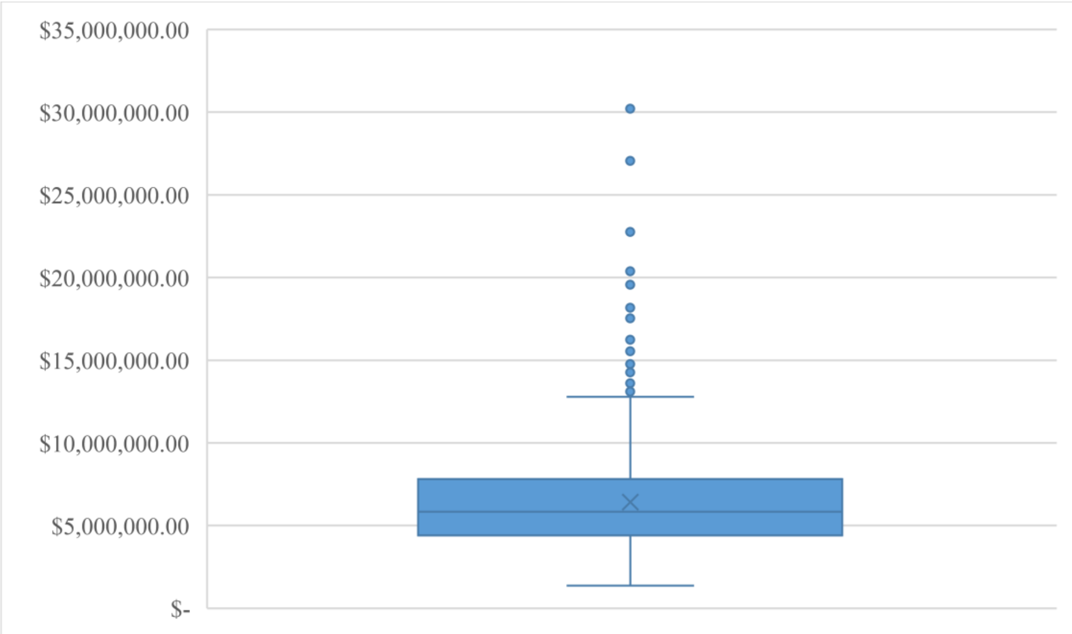

Figure 4: 50/50 Static Allocation Box and Whiskers Plot

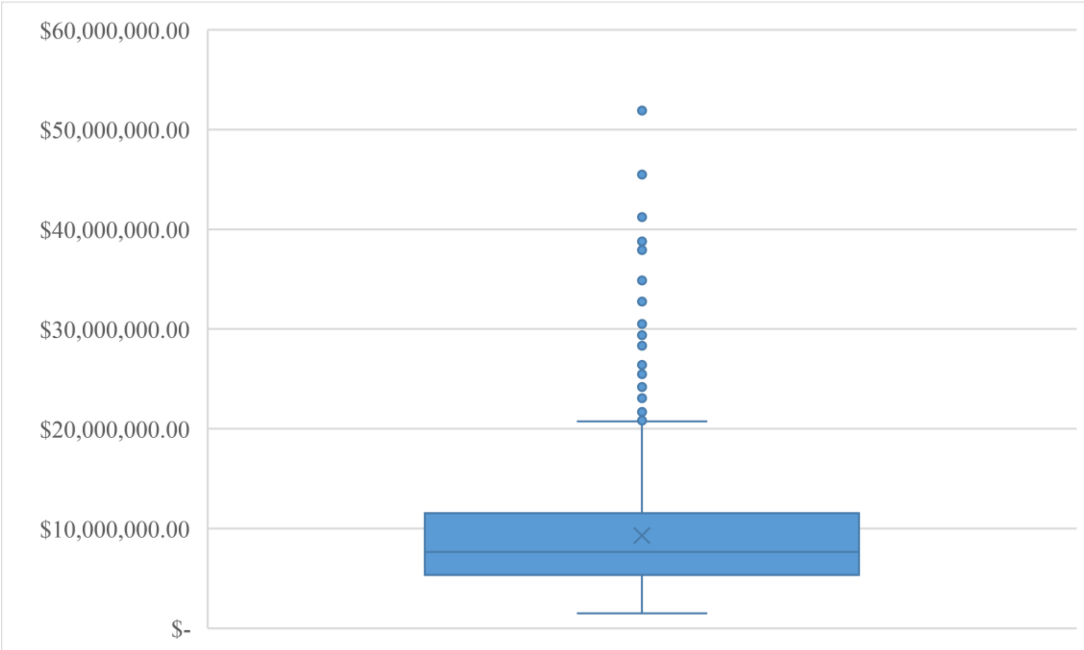

Figure 5: Heuristic 100 - Years to Retirement Allocation Box and Whiskers Plot

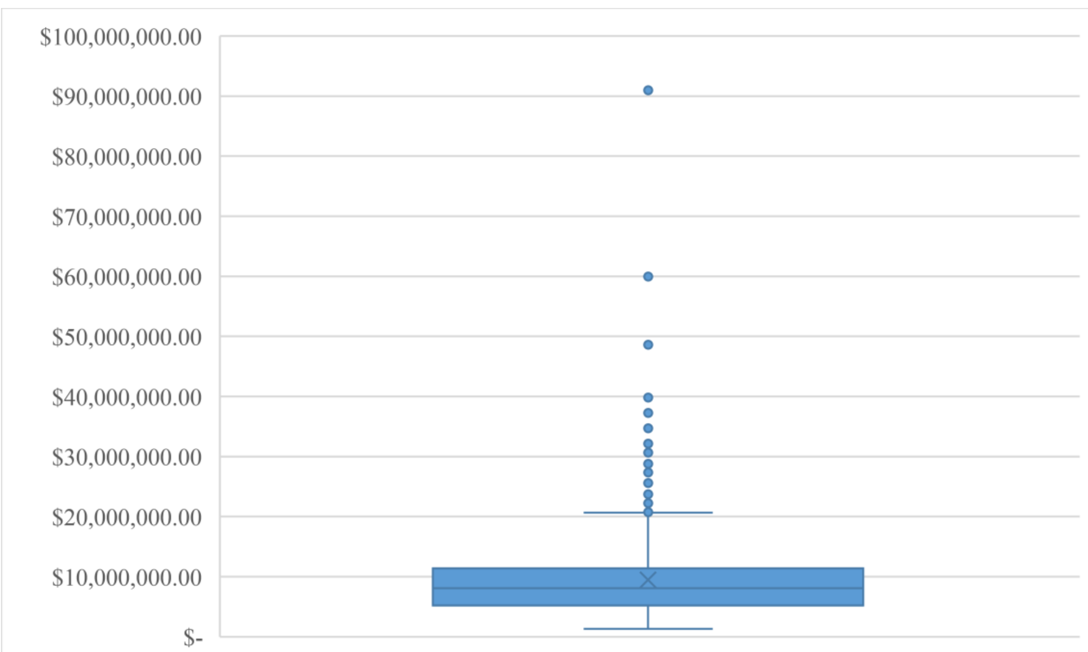

Figure 6: Traditional Glide Path Allocation Box and Whiskers Plot

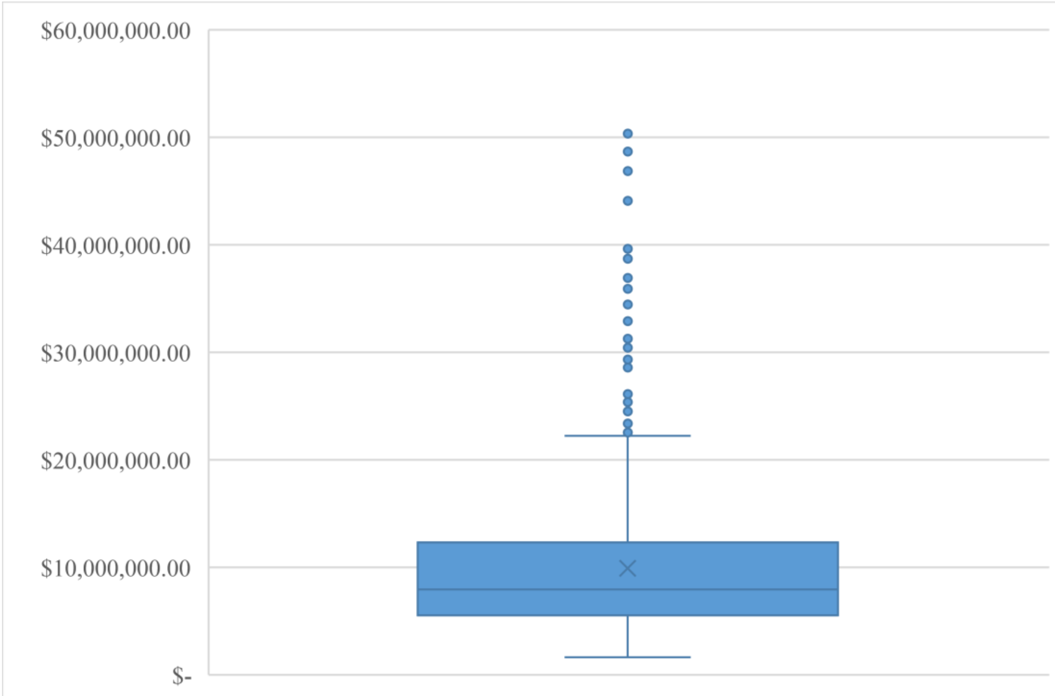

Figure 7: Valuation-adjusted Glide Path Allocation Box and Whiskers Plot

Results Analysis

The results I compiled support many aspects of my hypothesis. As seen in the results table for Account #1 and its box and whiskers plot, an account allocated strictly to equity will generate the highest return on average. In one extreme case in the simulation, Account #1's nest egg reached nearly $300 million! However, it is clear that a retirement account allocated only to equity comes associated with a much higher degree of risk, represented by the standard deviation. If a near-retirement worker had such an allocation ahead of the financial crisis, the consequences would have been dire.

In Accounts #2-4, it is observed that both risk and return fall in statically allocated funds as equity allocation falls. This direct relationship supports the work of researchers highlighted in my Literature Review and the basic principles of asset allocation.

Table 5: Static Account Side-by-side Comparison

Account	**#1: 100/0 static**	**#2: 70/30 static**	**#3: 60/40 static**	**#4: 50/50 static**
Average	$15,346,593.10	$ 8,788,826.04	$ 7,417,791.63	$6,421,267.67
Std Dev	$17,341,852.87	$ 5,619,031.87	$ 4,045,823.47	$3,034,076.57
10th percentile	$ 4,079,249.51	$ 3,689,371.52	$ 3,516,519.40	$3,283,552.11
25th percentile	$ 6,156,284.85	$ 5,006,715.06	$ 4,630,349.11	$4,423,972.37
Median	$10,593,387.39	$ 7,308,570.80	$ 6,556,455.65	$5,837,865.52
75th percentile	$18,679,493.79	$10,887,461.94	$ 9,022,628.64	$7,821,304.84
90th percentile	$30,136,167.14	$15,762,337.45	$12,531,142.42	$9,825,002.02

Analyzing the simulation results of Accounts #5-7 leads to a number of interesting conclusions. Account #5 has a slightly lower average than Accounts #6 and #7 but comes with significantly less risk. This is likely explained by its very gradual glide path when compared to the other two, which have a higher equity allocation for nearly the entire first half of the simulation before decreasing it in five-year increments as the saver approaches retirement. This would also explain why the heuristic account underperforms the traditional glide path at the tenth percentile.

The most important comparison is of Accounts #6 and #7, which was the main subject of this study. The results show that Account #7 outperforms #6 on a risk-adjusted return basis, with a higher average and lower standard deviation. It also outperforms at each percentile with the exception of the median, suggesting the possibility of less downside risk and more upside risk.

Table 6: Glide Path Account Side-by-side Comparison

Account	**#5: Heuristic**	**#6: Traditional**	**#7: Valuation-adjusted**
Average	$ 9,289,934.39	$ 9,478,190.87	$ 9,914,237.81
Std Dev	$ 5,904,135.67	$ 6,804,055.91	$ 6,746,531.53
10th percentile	$ 3,752,930.10	$ 3,814,347.28	$ 3,967,717.38
25th percentile	$ 5,350,437.70	$ 5,210,565.36	$ 5,552,633.64
Median	$ 7,672,818.07	$ 8,070,771.07	$ 7,963,396.70
75th percentile	$ 11,542,967.34	$ 11,400,518.20	$ 12,329,561.81
90th percentile	$ 16,896,013.77	$ 16,522,786.79	$ 18,089,346.71

Chapter 5

Conclusion

Implications of Study and Remaining Questions

At the glide path outlined in Table 2, the bootstrap simulation output suggests that a TDF that adjusts for the relative valuation of the S&P 500 is capable of outperforming a traditional TDF that sticks to a set glide path. Yet, there are still many questions that surround this result. As I often mentioned in Chapters 1 and 2, there is a significant lack of consistency in glide path construction of funds on the market. It is possible that a valuation-adjusting TDF would underperform if a different glide path was simulated.

External questions remain, as well. In Section 3 of the Literature Review, I discussed the government's increasing scrutiny of TDFs. There may be regulatory concerns about trusting fund managers to rebalance workers' portfolios on a monthly basis. Additionally, rebalancing could come with extra transaction costs that translate into higher fees charged by managers, an outcome that neither workers nor the government would find efficient. As asset flows into target-date funds continue, these questions will have to be addressed and others may arise.

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