AN EMPIRICAL PERFORMANCE EVALUATION OF DIFFERENT PORTFOLIO ALLOCATION STRATEGIES

A Thesis

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by

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ABSTRACT

Incorporating Value Averaging portfolio construction method with S&P 500 firms' Aggregate Implied Cost of Capital is an investment strategy that involves undertaking risks during market recessions and recovering strongly in post-recession periods. This strategy outperforms a pure Value Averaging strategy, Dollar Cost Averaging, and Strategic Asset Allocation under different asset class weights under the performance metrics of Internal Rate of Return, Sharpe Ratio, and Maximum Drawdown Ratio. When applying different risk-free borrowing caps, Value Averaging incorporated with Aggregate Implied Cost of Capital results in lower risks. However, it will not yield better returns unless maximum risk-free borrowing caps are relaxed. The strategy also requires a longer portfolio horizon to ensure higher Internal Rate or Return.

BIOGRAPHICAL SKETCH

Xiao Hu was born in 1988 in Yingkou, China, a harbor city by Liao River in Liaoning Province, where he spent most his childhood. Graduated from Yingkou Senior High School in 2007, he enrolled in Renmin University of China for his undergraduate studies, since when he spent five years in Beijing, China.

Xiao majored in Economics earning a B.A. degree in 2011. In Renmin University of China, he had the great fortune to work with many economists who further kindled his love for economic research. One of his professors, Scott Rozelle, was also instrumental in securing Xiao a challenging and enlightening internship in May 2010, which led to a full-time employment after Xiao's graduation. Xiao joined Rural Education Action Project (REAP) in May 2010 as a Field Research Coordinator, which was co-founded by Stanford University and Center for Chinese Agricultural Policy (CCAP) at Chinese Academy of Sciences (CAS). After working two years in Randomized Controlled Trial (RCT) projects on policy initiatives, Xiao decided to continue his education at Cornell University.

Xiao swapped his fast-paced working style in Beijing for the more relaxed charms of Ithaca, New York, in August 2012, for his graduate studies in Dyson School of Applied Economics and Management at Cornell University. His passion about Empirical Finance was sparked by Professor David Ng, when Xiao attended his course of Valuation in Capital Investment. Xiao started working as a Research Assistant for Professor Ng, and exploring broader knowledge of Finance by taking MBA courses at Johnson Graduate School of Management. More than two years, Xiao looks ready to receive his masters.

Recently, Xiao was engaged to his fiancée, Xiaoyang He. Currently Xiao is working in Tampa, Florida; while Xiaoyang is still in Ithaca for her research. When their current works draw a close, Xiao and Xiaoyang will continue following their joint love of life and science, preferably at a place where they could enjoy less winter than Ithaca and less summer than Tampa.

To Parents,

Shidong Hu and Shuang Bai

To Fiancée,

Xiaoyang He

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TABLE OF CONTENTS

BIOGRAPHICAL SKETCH iii
DEDICATION v
ACKNOWLEDGMENTS vi
TABLE OF CONTENTS vii
LIST OF FIGURES ix
LIST OF TABLES x

INTRODUCTION 1
1.1 Asset Allocation Strategy 1
1.2 Market Return Prediction 4
1.3 Methodology and Result Summary 5
PORTFOLIO CONSTRUCTION METHODOLOGY UNDER DIFFERENT ASSET ALLOCATION STRATEGIES 9
2.1 Dollar Cost Averaging (DCA) 10
2.2 Swensen's Strategic Asset Allocation (SAA) 10
2.3 Edleson's Value Averaging (VA) 11
2.4 Value Averaging incorporated with Aggregated Implied Cost of Capital (VA-ICC) 13
DATA AND SUMMARY STATISTICS 15
3.1 Return Variables 15
3.2 Historical Variables 16
3.3 Forecasting Variables 16
3.4 Summary Statistics 18
COMPARATIVE ANALYSIS OF DIFFERENT PORTFOLIO ALLOCATION STRATEGIES 20
4.1 Full Sample Portfolios Comparison 20

4.1.1 IRR Comparison 20
4.1.2 Value Path Comparison 22
4.1.3 Asset Allocation Comparison 24
4.2 Portfolio Risk Analysis 27
4.2.1 Sharpe Ratio 27
4.2.2 Drawdown Analysis 28
4.2.3 Risk Analysis Results 30
4.3 Sensitivity Test for Different Asset Class Weights 30
4.4 Sensitivity Test for Risk-Free Borrowing Limitation 31
4.4.1 IRR Comparison under Different Borrowing Caps 31
4.4.2 Stock-Money Ratio Comparison 32
4.4.3 Risk Analytic Comparison 33
4.5 Sensitivity Test of Different Market Timing and Portfolio Horizons 34
4.5.1 IRR Comparison for Different Portfolio Horizons 34
4.5.2 Average Portfolio Ending Stock-Money Ratio 36
RETURN AND RISK COMPARISONS IN OUT-OF-SAMPLE PREDICTIONS 37
5.1 Econometric Specification 37
5.2 Forecast Evaluation 38
5.3. Forecasting Results 40
5.3.1 IRR Comparison of Different Strategies 40
5.3.2 Out-of-Sample Test Results 40
5.3.3 Portfolio Comparison under Different Asset Weights 41
5.3.4 Comparison of VA Portfolios Incorporating Different Market Predictors 42
CONCLUSION 44

REFERENCES 49
APPENDICES 53

LIST OF FIGURES

Figure 1 – Value Path Comparison of Different Asset Allocation Strategies 56

Figure 2 – Value Path Breakdown of Different Portfolio Allocation Strategies.....58

Figure 3 – Stock-Money Ratio in Different Portfolios 60

Figure 4 – Portfolio Risk Premium and Drawdown Analysis.................................63

Figure 5 – IRR Curves of Different Market Timings and Portfolio Horizons 74

LIST OF TABLES

Table 1 – Summary Statistics for Forecasting Variables 54
Table 2 – IRR Comparison of Different Portfolio Allocation Strategies 55
Table 3 – Stock-Money Ratio in Different Portfolios 62
Table 4 – Risk Analysis of Different Portfolio Allocation Strategies 65
Table 5 – Sensitivity Test for Portfolio Weights 66
Table 6 – IRR Comparison under Maximum Borrowing Limitation 67
Table 7 – Ending Stock-Money Ratio under Maximum Borrowing Limitation 68
Table 8 – Risk Analytic Results under Maximum Borrowing Limitation 70
Table 9 – Sensitivity Test for Portfolio Horizons 73
Table 10 – Average Ending Stock-Money Ratio 78
Table 11 – Out-of-Sample IRR Comparison of Different Asset Allocation Strategies 79
Table 12 – Out-of-Sample Test 80
Table 13 – Out-of-Sample Comparison under Different Asset Weights 81
Table 14 – Out-of-Sample Comparison of VA Portfolio Incorporating Different Market Predictors 82

CHAPTER 1

INTRODUCTION

This paper conducts empirical evaluations comparing relative performance of the most popular asset allocation strategies. In its comparisons, different variables of market return forecasting are incorporated and tested.

1.1 Asset Allocation Strategy

Asset allocation is one of the key investment decisions for both individual and institutional investors. It is considered to play the central role in investors' returns from the three sources provided by capital markets: asset allocation, market timing, and security selection (Swensen, 2005). According to a series of well-known studies (Brinson, Hood, and Beebower, 1986; Brinson, Singer, and Beebower, 1991), approximately 90 percent of the variability of portfolio return is determined by investor's asset allocation policy. Other research suggests that 100% of investors' returns, on average, stem from asset allocation across institutional investors (Ibbotson and Kaplan, 2000). Nowadays, academic conclusions concerning the importance of asset management continue to support its dominant effect on portfolio returns (Hood, 2005; Ibbotson, 2010).

Various asset allocation strategies have been proposed.

The Dollar Cost Averaging (DCA) strategy is an investment technique that involves putting a fixed amount of money into a portfolio, rather than putting an up-front investment all into a portfolio at once, which is termed as the Lump Sum (LS) strategy. The invention of DCA is untraceable; however, it is widely recommended by personal financial advisors and referenced by researchers. It is believed that DCA outperforms a LS investment strategy regardless of investors' risk profiles (Brennan, Li, and Torous, 2005). Even though such is only the case under certain circumstances (e.g. Atra and Mann, 2001; Bierman and Hass, 2004), DCA continues to be viewed as protecting for investors from bad decision making during market ups-and-downs (Bierman and Hass, 2004). Additionally, multiple adjusted-DCA strategies have been widely developed to better apply the concept of DCA in real investment (e.g. Richardson and Bagamery, 2011; Dunham and Freisen, 2011).

The Strategic Asset Allocation (SAA) is a portfolio allocation strategy that involves setting target allocations initially for various asset classes. During the portfolio horizon, percentages of different asset classes change due to different returns. SAA requires periodically rebalancing to set the allocations back to the targets. A similar strategy is called the Tactical Asset Allocation (TAA). A TAA portfolio manager also has targets for different asset classes, but it is much more flexible than SAA for two reasons. First, the targets are floating, as in the case of holding foreign emerging market stocks at 20%-30% of a portfolio's value. Second, TAA investors may not rebalance back to the targets.

The literature indicates pros and cons of SAA versus TAA. Generally, SAA relies more on portfolio allocation and is less volatile than TAA due to its "buy-and-hold" approach. Due to their complexity, SAA and TAA are commonly adopted by institutional investors only. The Chief Investment Officer of the Yale University Endowment, David Swensen, implemented a Strategic Asset Allocation strategy and gained impressive success. He recommends placing SAA at the center of the portfolio management process to increase the likelihood of investment success (Swensen, 2009). Swensen also introduces a simplified and easy-to-follow Strategic Asset Allocation approach for individual investors (Swensen, 2005). In his book Unconventional Success, a famous portfolio allocation is introduced that involves holding different asset classes with different policy targets: domestic equity (30%), foreign developed equity (15%), emerging market equity (5%), real estate (20%), US T-Bonds (15%), and US TIPS (15%). The portfolio construction is then summarized as a "60-40 Rule" involving holding 60% of assets in stock equities and 40% in fixed incomes. 50-50 and 70-30 rules are also widely adopted and tested.

Value Averaging (VA) was firstly introduced by Michael Edleson (2005) in his book Value Averaging as a replacement for the widely adopted Dollar Cost Averaging strategy among individual investors. Instead of the investment cost in each period, VA focuses on the ending values of portfolios. A VA investor will set a value path for a portfolio based on the expected return and growth of the portfolio, and meet portfolio value target at the end of each period. Periodic investment may vary considerably due to market ups-and-downs. VA has gained academic attention since its first printing in 1991. The general consensus is that Value Averaging is a better alternative to Dollar Cost Averaging since it adjusts frequently to market risks (e.g. Chen, 2009; Marshall, 2000). The success of Value Averaging strongly relies on the "expected return" used to establish the value path. Usually, expected market returns can be predicted based on historical data or forecasting variables, which provide the possibility of incorporating market forecasting with portfolio allocation construction.

1.2 Market Return Prediction

Previous research tested different asset allocation strategies using market returns or individual equity returns. There was no application of using forecasting variables in these allocation strategies. Market return forecasting is another key issue in portfolio management. Theoretically, valuation ratios, such as P/E, B/M, Dividend Yield, etc., and business cycle variables, such as Term Spread, Default Spread, Long-Term/Short-Term T-bill Yields, etc., could somehow predict future market returns or major market indices returns (e.g., Fama and Schwert, 1977; Campbell, 1987; Campbell and Shiller, 1988; Fama and French, 1988; Fama and French 1989; Kothari and Shanken, 1997; Boudoukh, Michaely, Richardson, and Roberts, 2007).

One additional market predictor is implied cost of capital (ICC). Traditionally, individual ICC was considered a market predictor with limitations (e.g. Easton and Monahan, 2005; Lee, So and Wang, 2010; Richardson, Tuna, and Wysocki, 2010; Hou, van Dijk, and Zhang, 2012). A few recent studies show the market return predictability of aggregated implied cost of capital (Pastor, Sinha and Swaminathan, 2008; Li, Ng and Swaminathan, 2013), which is the weighted average ICC at market level.

However, these market forecasting variables have not yet been combined with any of the asset allocation strategies.

Out-of-sample testing has recently gained attention and popularity in market return predictions (e.g. Welch and Goyal, 2008). The importance of out-of-sample forecasting is said to be in testing individual predictors (Rapach, Strauss, and Zhou, 2010). It has not been used in comparing investment strategies.

1.3 Methodology and Result Summary

This paper conducts empirical evaluations of the asset allocation strategies of Dollar Cost Averaging (DCA), Swensen's Strategic Asset Allocation (SAA), Edleson's Value Averaging (VA), and Value Averaging using different forecasting variables, primarily aggregated implied cost of capital (ICC). Aggregated ICC could be used in a Value Averaging strategy as the predicted return to set the value path. Value Averaging incorporating aggregated ICC, hereafter VA-ICC, is an independent portfolio strategy tested in this paper.

First, the various strategies are compared using portfolio internal rate of return (IRR) in the full sample horizon of 37 years, from 1976 to 2012, using monthly data from WRDS. Monthly investment and rebalancing rules are applied under different strategies. Asset allocations between the equity market and money market are also tested by comparing the stock-money ratio of each portfolio. The stock-money ratio is the ratio of stock market account value divided by the money market account ratio, which introduces the potential risk level of portfolios.

Second, a further portfolio risk analysis is done by using the Sharpe Ratio and Maximum Drawdown analysis. Both overall risks and downside risks are captured by the measurements. The risk analytic results are also based on the full sample size portfolio. Portfolio risk is of the same importance as portfolio return, IRR, thereafter in the paper. Both IRR and Risk Ratios are compared in the following subsections of sensitivity tests.

Third, sensitivity tests are conducted under three dimensions: asset allocation, maximum risk-free borrowing, and market timing. In the asset allocation test, percentages of equity and risk-free assets change in the 37-year portfolios under different strategies. In the maximum risk-free borrowing test, a cap on borrowing from the money market in each month is applied. In the marketing time test, the portfolio horizon is fixed at 1-year, 2-year, 5-year or 10-year, while the time to enter the market changes from January 1976 to December 2012.

Fourth, an out-of-sample forecasting test is conducted from 1998 to 2012, using historical data for future predictions. The out-of-sample tests have three focuses: utility gains, assets weights, and market predictors incorporated with the Value Averaging (VA) method. Several other market predicting variables are tested with aggregated ICC for portfolio IRR and utility gains, such as Dividend Payout, P/E ratio, and Shiller's Cyclically Adjusted PE ratio (CAPE). Assets weights of mean-variance investors' out-of-sample stock percentages in

VA portfolios are compared with an investor using historical data, as well as the "60-40" in Strategic Asset Allocation (SAA) method. In addition, all market predictors are used to replace the historical market return (r) in VA methods. A comparison is also conducted along with this dimension.

In this paper, the primary result shows that Value Averaging incorporating aggregated ICC (VA-ICC) provides the best portfolio IRR over the 37-year horizon. This result is robust among various asset allocations and dynamic market timing. Additionally, VA-ICC is at a low risk level under all measurements. In the out-of-sample test, aggregated ICC is the best in providing utility gain for mean-variance investors. It is also one of the best forecasting variables for providing market returns for the highest portfolio IRR using the Value Averaging strategy.

This paper potentially makes the following contributions to the literature. (1) It provides a more robust comparison between different asset allocation strategies, including IRR, market timing, and risk analysis. (2) It introduces a new technique for using market return forecasting variables in portfolio asset allocation strategies. (3) It further proves the applicability of Aggregate ICC as a market return predictor and useful combination of portfolio allocation strategies.

The paper proceeds as follows. The methodology of constructing portfolios under different asset allocation strategies is described in Section 2. Section 3 presents sources for data and descriptive statistics. Section 4 and Section 5 provide in- and out-of-sample evaluations of portfolio performance. Section 6 concludes the paper.

CHAPTER 2

PORTFOLIO CONSTRUCTION METHODOLOGY UNDER DIFFERENT ASSET ALLOCATION STRATEGIES

In this section, Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA) and Value Averaging incorporated with aggregated ICC (VA-ICC) will be explained in detail in terms of how to use them in constructing portfolios. Lump Sum (LS) and Tactical Asset Allocation (TAA) are not included in this paper. The Lump Sum strategy is not very realistic for individual investors as it is difficult to have all of the investment upfront. The return of LS is highly dependent on the market timing and portfolio horizon. The key success factor of LS investors is to avoid entering the market at low and exiting at high. Tactical Asset Allocation (TAA) is hard to model because it requires portfolio managers' immediate judgments at all times. Under the concept of TAA, investors consider different qualitative factors and make opposite calls, which makes their TAA strategies rather diversified.

In order to make these four strategies comparable with the others, all portfolios will be invested and rebalanced monthly from January 1976 to December 2012. The monthly investment is $100, so that the ending value of the portfolios in December 2012 and monthly IRRs in the 37-year investment horizon can be calculated. In this paper, asset allocations are distributed between the stock equity market and money market. The asset in the money market is the 30-day U.S. Treasury Bill, which is also viewed as a risk-free asset. The reason for not using the traditional and popular stock-vs.-bond approach is that this paper's key concern is to test the stock market return by applying different portfolio construction strategies and test different market predictors. The results are benchmarked with the risk-free asset, without incorporating fluctuation from bond markets. Additionally, due to monthly investment frequency, the 30-day T-bill is comparable to the portfolio IRRs.

The initial asset allocation is set at 60% in the stock market and 40% in the 30-day T-Bill, in order to test the famous "60-40" rule of David Swensen's Strategic Asset Allocation method. The percentage of stock assets is then changeable from 0% to 100% in the sensitivity test. The initial rule for the risk-free borrowing amount is unlimited; then, different caps are applied to test the risk factors of portfolios. Other assumptions are free borrowing from the money market and no transaction costs for rebalancing.

2.1 Dollar Cost Averaging (DCA)

As discussed in Section 1.1, Dollar Cost Averaging (DCA) focuses on a fixed periodic investment cost. A DCA investor in this paper will invest $100 in the portfolio from January 1976 to December 2012. $60 goes to the stock market and $40 purchases a 30-days T-Bill in the money market.

2.2 Swensen's Strategic Asset Allocation (SAA)

Similarly, an SAA investor, in the first month, invests $60 in the stock market and $40 in the money market. At the end of the first month, the investor will rebalance the portfolio within stock and money markets, to ensure that the asset allocation is 60-40 between stocks and risk-free assets. The rebalancing is either selling stocks and buying risk-free assets, or vice versa. At the beginning of the second month, the investor will add $100 to the portfolio with $60 in stocks and $40 in the money market.

2.3 Edleson's Value Averaging (VA)

Value Averaging is a strategy focusing on the result, the ending value of the portfolio in each time period, rather than the amount of the investment cost. The basic VA method aims at the portfolio's ending value increasing the same amount after each month, say $100. A more complicated and powerful method requires that the ending value increases by a certain rate rather than an amount, which is called a "value path".

Edleson's value path formula is built to calculate the target value of a portfolio at the end of each time period (Edleson, 2007). The ending value accounts for the desired initial or average investment $\$C$, the expected return r, and the growth of periodic investment g.

$$V_t = C \times t \times (1+R)^t \qquad where \quad R = \frac{r+g}{2}$$

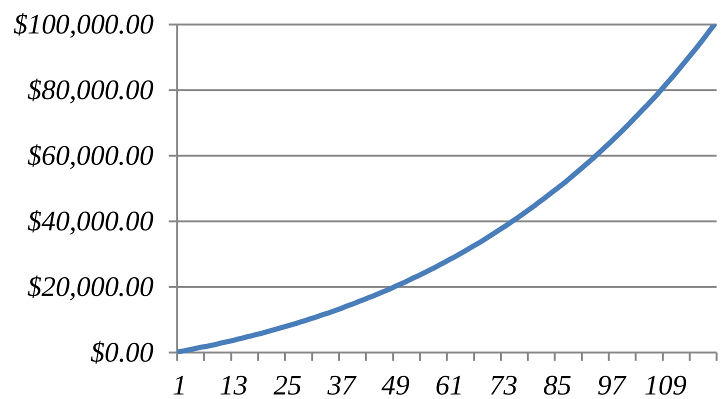
Suppose the desired ending value of a portfolio is $100,000. The investment frequency is monthly over a 10 year horizon (120 months). The investor expects a return at 1% per month, and increases periodic investment at a rate of 1%. Following the formula above, the initial investment is:

$$\$100{,}000 \;= \$C \times 120 \times \left(1 + \frac{1\% + 1\%}{2}\right)^{120} \qquad so \quad C = \$252.50$$

A selected value path is shown in the table:

Month	*1*	*\$255.02*	……		
Month	*2*	*\$515.14*	*Month*	*12*	*\$3,414.22*
Month	*3*	*\$780.44*	*Month*	*24*	*\$7,694.46*
Month	*4*	*\$1,050.99*	*Month*	*60*	*\$27,522.48*
Month	*5*	*\$1,326.88*	*Month*	*120*	*\$100,000.00*

Thereby, the following curve is expected under the Value Averaging method:



In this study, the Value Averaging method is used for the stock market only. The initial/average investment ($\$C$) is set at \$60. In this manner, the 60-40 rule is followed initially. Expected return (r) and desired investment growth (g) are historical market return and historical market dividend per share growth rate, respectively. Thus, the value path for the stock market could be generated. For example, if $r = 1\%$ and $g = 1\%$, the value path for the stock market is as follows:

Month	*1*	*\$60.60*	……		
Month	*2*	*\$122.41*	*Month*	*12*	*\$811.31*
Month	*3*	*\$185.45*	*Month*	*24*	*\$1,828.42*
Month	*4*	*\$249.74*	*Month*	*60*	*\$6,540.11*
Month	*5*	*\$315.30*	*Month*	*120*	*\$23,762.79*

Assume that the stock market return is 4% in the first month. A Value Averaging investor will have an ending stock market value of $\$60.60 \times (1 + 4\%) = \$63.02$. To achieve the value path, only $\$122.41 - \$63.02 = \$59.39$ needs to be invested into the stock market at the beginning of the second month. Consistent with TAA and DCA, \$100 will be invested each month. Therefore, $\$100.00 - \$59.39 = \$40.61$ goes to the money market in the second month.

2.4 Value Averaging incorporated with Aggregated Implied Cost of Capital (VA-ICC)

Initially, in Edleson's Value Averaging method, r and g are historical market data, which are determined before investing and constant throughout the investment horizon. Aggregated Implied Cost of Capital (ICC) for the S&P 500 portfolio is a reliable forecasting variable of market return (Pastor, Sinha and Swaminathan, 2008; Li, Ng and Swaminathan, 2013). ICC varies month to month and is an alternative to expected return (r) in VA's value path. Thus, expected return (r) in Value Averaging using ICC is dynamic, while investment growth (g) is still fixed at the historical dividend per share growth rate.

A further test of ICC is to use ICC-predicted market return as expected return (r) in the value path. A comparative analysis of predicted market returns using ICC versus other forecasting variables is also tested in Section 5 in this study. All of the predicted market returns are alternatives to expected return (r) in VA's value path.

CHAPTER 3

DATA AND SUMMARY STATISTICS

The data sources for this study are the Center for Research in Security Prices (CRSP), S&P Capital IQ Compustat, and public data from previous research. The market data are from CRSP, including stock and money market returns, price and share outstanding, and market Earning-to-Price Ratio (P/E). The historical data for market dividend growth is from S&P Compustat. Other variables are from researchers' websites of Kenneth French, Michael Roberts, and Robert Shiller, including historical market return (Rm), Dividend Yield (Ldy), Cyclically Adjusted Price-to-Earning Ratio (CAPE). The Implied Cost of Capital (ICC) is shared by David Ng exclusively for this study, and was used in his recent study (Li, Ng, and Swaminathan, 2013). All of the variables used in this paper are monthly, reported at the end of each month.

3.1 Return Variables

- Stock market return ($Vwretd$) is monthly NYSE/Amex/Nasdaq value-weighted average returns including dividends from CRSP.

- Money market return ($T30ret$) is 30-day Treasury Bill rate from CRSP.

3.2 Historical Variables

- Historical market return (Rm) is market risk premium (Rp) plus risk-free return (Rf) in the Fama-French Three-Factor Model. Data is available from May 1926 to June 2014, downloaded from Kenneth French's website.

- Historical market dividend per share growth rate ($Dvgr$) is calculated from the S&P 500 Index's monthly dividend per share ($Dvps$) from Compustat.

$$Dvgr = \frac{1}{n} \times \sum_{i=1}^{n} \left(\frac{Dvps_{i+1}}{Dvps_i} - 1 \right)$$

Aggregate dividend per share of S&P 500 ($Dvps$) is available from January 1962. The dividend per share in each month can be calculated using $Dvps$ of the current and previous month. Then, historical market growth, $Dvgr$, is the up-to-date average of $Dvps$ growth since January 1962. The primary usage of variable $Dvgr$ in the Value Averaging method is as an approximation of the expected growth rate of portfolio value.

3.3 Forecasting Variables

- Aggregated Implied Cost of Capital (ICC) is calculated using S&P 500 companies' individual ICC with the value-weighted average method. The individual ICC of S&P firms is from Li, Ng, and Swaminathan (2013)'s paper, "Predicting market returns using aggregate implied cost of capital." The data is available from January 1976 to December 2012. Then, individual ICC data for S&P 500 companies are aggregated by value-weighted average using market capitalization. Price and Shares Outstanding used in market capitalization calculations are from CRSP. The S&P 500 company list is from Compustat. The variable of aggregated implied cost of capital (ICC) is also available from January 1976 to December 2012.

- Dividend payout (Ldy) is calculated following the method used in Boudoukh, Michaely, Richardson, and Roberts' (2007) paper, where Ldy is the natural log of the sum of dividend and repurchases:

$$Ldy = ln\left(\frac{1 + Vwretd}{1 + Vwretx} - 1\right)$$

$Vwretd$ is the S&P 500 portfolio's value-weighted average returns including dividends; $Vwretx$ is the S&P 500 portfolio's value-weighted average returns excluding dividends. Both variables are from CRSP. Ldy from 1926 to 2010 is available on Michael Roberts' website. The variable Ldy in this paper is monthly from January 1976 to December 2012.

- Earnings-to-price ratio (E/P) is the value-weighted average of firm-level earnings-to-price of S&P 500 companies. Earnings per share and price data are obtained from CRSP.

- The Cyclically Adjusted Price-to-earnings ratio (CAPE), also known as Shiller's 10-year P/E ratio, is the current price of S&P 500 firms divided by the average earning per share in the past 120 months. Data is obtained from Robert Shiller's website from 1881 to the current month.

$$CAPE_t = {Price_t}\Big/{\sum_{i=1}^{120} Earning_i}$$

3.4 Summary Statistics

[Insert Table 1 Here]

Table 1 presents descriptive statistics for all variables used in this paper. During the in-sample period for this paper, from January 1976 to December 2012, the average stock market and money market returns are 1.00% and 0.42%, respectively. The standard deviations are 4.54% of stock market returns, and 0.28% of the money market. Generally, the stock market is more profitable and volatile than the money market. Historical market return and growth of the stock market from January 1962 to December 1975 are 0.48% and 0.53%, respectively, which are primarily used in the Value Averaging Strategy as expected return and growth of the portfolio's value path. Historically, the stock market is less profitable and slightly less volatile than after 1976. Dvgr varies with a standard deviation of 6.11% because of differences in firms' dividend payout policies.

In the forecasting variables panel, ICC is reported as a monthly percentage of 0.96%, which is roughly at the same scale of aggregate market return. ICC's standard deviation is only 0.22%. Dividend Payout in logarithm (Ldy) is monthly at an average of -3.62. P/E and Cyclically Adjusted P/E are reported at absolute value. Shiller's 10-year P/E ratio (CAPE) is slightly higher at 19.96 than the average of current P/E at 19.86. CAPE is smoother than P/E with a standard deviation at 9.09, compared to 14.46 of P/E. CAPE remains relatively stable among market ups-and-downs since it incorporates firm earnings information for the past 10 years.

CHAPTER 4

COMPARATIVE ANALYSIS OF DIFFERENT PORTFOLIO ALLOCATION STRATEGIES

In this section, the different portfolio allocation strategies explained in Section 2 are compared under different measurements, including Internal Rate of Return (IRR), portfolio value paths of stock and money market accounts, sensitivity tests over various asset class weights, market timing, and portfolio horizons, and risk analysis using the Sharpe Ratio and Maximum Drawdown. The results are shown in the appendices and described in the following sections.

4.1 Full Sample Portfolios Comparison

4.1.1 IRR Comparison

Internal Rate of Return (IRR) is the primary measure of comparison among the four investment strategies in Model (1), (2), (3), and (4), which are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The investment horizon is within the entire 37-year sample from 1976 to 2012. Investment frequency is monthly, with an additional investment cost of $100 at the beginning of each month. All four strategies follow the "60-40" rule of putting 60% of initial investment in the stock market account and 40% in the money market account.

In Model (1), of DCA, $60 is invested in the stock market and $40 is put in the money market at the beginning of every month. In Model (2), of SAA, $60 and $40 are invested in the portfolio each month. At the end of each month, the portfolio is rebalanced internally between the stock and money markets for a 60-40 allocation target. In Model (3), of VA, the value path will increase following the method explained in Section 2.3. In the value path formula, the expected return and growth of portfolio value are determined by historical variables described in Section 3.2. The portfolio's expected return in January 1976 is set to be historical market return using variable (Rm) from January 1962 to December 1975. In the following months, the historical Rm uses the moving averaging of up-to-date value since January 1962. The portfolio's expected growth in January 1976 is set to be that of the historical S&P 500 companies value-weighted dividend per share growth rate from January 1962 to December 1975. The value in January 1976 is fixed throughout the portfolio horizon to December 2012. In Model (4), of VA-ICC, the expected portfolio return is replaced by aggregate ICC in each month, while portfolio growth uses the same value of variable Dvgr in January 1976 as the basic VA strategy in Model (3).

[Insert Table 2 Here]

Table 2 presents the IRR of the in-sample models of the four portfolio allocation strategies tested in this paper. VA-ICC has the highest IRR within the 37-year investment horizon, at 0.867% per month on average. The pure VA method using historical market return as expected return of value path is the second best strategy among its peers at 0.716% per month on average, which is also slightly better than DCA at 0.714% per month. This result is consistent with Edleson's analysis (Edleson, 2007). A Strategic Asset Allocation strategy with the "60-40" internal rebalancing rule at the end of each month has an IRR at only 0.659%.

4.1.2 Value Path Comparison

The value paths of stock, money market, and total portfolio under the four strategies are plotted in Figure 1. In Panel (A), the value path curves of the four strategies are reported from January 1976 on. The NBER recession periods within the portfolio horizon are shaded in the figure. The value path of VA-ICC (in solid line) wins over its peers most of the time. The ending value of the portfolio with a monthly $100 investment is at $525,526 after 444 months. The second and third, are VA, presented by the dotted line, and DCA, presented by the dashed line. The ending values are similar: DCA at $318,343 and VA at $319,706. The ending value of SAA's value path, presented by the dashed/dotted line, is the lowest at $266,846.

[Insert Figure 1 Here]

Panel (B) provides a clearer view of the value paths in the most recent two NBER recession periods. When the market plummets in late 2008, the value path of VA-ICC (solid line) drops to the lowest point, compared to its peers. It has the strongest rebound after the recession and ends almost twice as high as the others. Comparing VA (dotted line) with DCA (dashed line), DCA is consistently better than VA before both drop in the most recent recession. VA then outperforms DCA with a slightly better recovery. These lines show that Value Averaging reduces risks in market down times. VA incorporated with ICC has a stronger feature of risk reduction.

[Insert Figure 2 Here]

Figure 2 presents the breakdown value paths of the stock market account in dotted lines and the money market account in dashed lines. The total value of the strategy is plotted in the solid lines. In Panel (A), for the DCA strategy, the total value (solid line) of the portfolio is determined by the stock market account (dotted line). This is because of the constant 60-40 investment distribution in stock and money market accounts without rebalancing. It is an indicator of returns and market trends of stock and money markets. In Panel (B), for the SAA strategy, portfolio value is divided into 60% in the stock market (dotted line) and 40% in the money market (dashed line) at all times. Given the fact that the stock market outperforms the money market in the investment horizon, SAA must have a lower investment return than DCA, since SAA's stock weight is significantly lower than that of the DCA portfolio.

For both VA strategies, in Panel (C) and (D), investors borrow from the money market to ensure the stock market value path (dotted line) during the recession periods (shaded in the figures). During the most recent recession, in late 2008, both VA investors borrow significantly from the money market. This movement explains why VA and VA-ICC outperform DCA. The rationale behind the borrowing is an expected market rebound. A VA-ICC investor borrows more than a pure VA investor. The reason for this is that using aggregate ICC in VA gives a higher expected return than using historical market return. In the recession period, ICC, as an effective forecasting variable, provides an optimistic prediction of future market. So the value path of the stock market account using VA-ICC is steeper than the pure VA strategy.

4.1.3 Asset Allocation Comparison

The "60-40" rule of stock vs. money market asset value is applied at the beginning of each portfolio investment. As ongoing rebalance rules are applied to the portfolios, the stock-money ratio will change dramatically or fluctuate around a certain number. The figure below indicates the stock-money ratio curve against the maximum borrowing amount. The Y-axis stands for the stock-money ratio, while the X-axis stands for the percentage of stock market value in the portfolios. For example, if stock value accounts for 80% in the portfolio, the stock-money ratio is 80%/20% = 4. However, if stock value accounts for 150% of portfolio value, that means that the money market is -50% of the portfolio's value. In this case, 50% of the portfolio is borrowed from the money market, and the stock-money ratio is 150%/(-50%) = -3. The following figures illustrates that the stock-money ratio will rocket to 100 (but less than 100) when stock market value approaches 100% (but less than 100%) of the portfolio's value. When stock market value passes 100% of portfolio value, which means that it starts risk-free borrowing to hold investment positions, the stock-money ratio suddenly reverses to -100 (but more than -100) and starts converging to 0 (but always lower than 0), again.

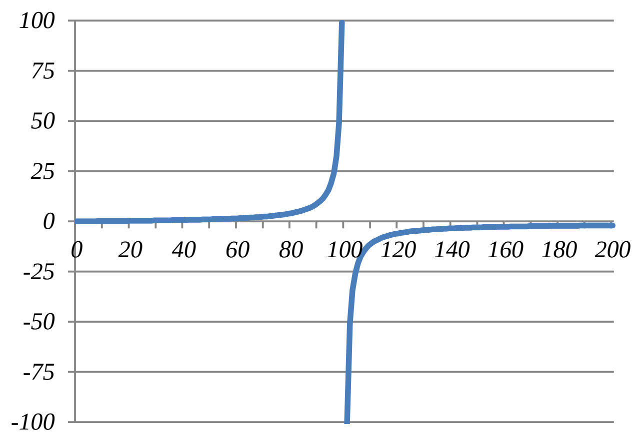


Figure 3 illustrates the ongoing stock-money ratio across the 37-year investment horizon.

[Insert Figure 3 Here]

Panel (A) shows the curve of the stock-money ratio of the Dollar Cost Averaging (DCA) portfolio. Since DCA invests $60 and $40 each month in stock and money markets, respectively, the values of stock market assets and money market assets are determined by the 1.5 stock-money ratio and different returns in stock and money markets. Overall, the stock market returns much more than money market, as shown in the value paths in Panel (A) of Figure 2. Thereby, the stock-money ratio increases and decreases following the stock market assets value path. Panel (B) presents the curve of the stock-money ratio of the Strategic Asset Allocation (SAA) portfolio. SAA requires rebalancing asset allocation to 60-40 at the end of each month. Thus, SAA's stock-money curve maintains around 1.5.

The Panel (C) curve remains flat before the most recent financial crisis. Starting from the recession period, the Value Averaging (VA) method requires borrowing from the money market to ensure the pre-setup equity value path. A negative stock-money ratio indicates a strong borrowing of risk-free assets when the money market account is negative. Therefore, the VA investor is actually borrowing from the money market to hold the position in the stock market. This approach can be quite risky. An analysis of risk performance is in Section 4.2.

Panel (D) incorporates the S&P 500 Aggregated Implied Cost of Capital (ICC) into the VA method. The underlying intention is to hold the stock market account based on previous market ICC. In order to maintain the stock market value path, the VA-ICC investor, like VA investors, will borrow from the money market in recession periods. Strong borrowing will push the stock-money ratio to an extreme high level, while even stronger borrowing will clear the money market account or turn it negative. Similarly, this indicates potential risks in the strategy, which will be analyzed in Section 4.2.

[Insert Table 3 Here]

Table 3 further presents the stock-money ratios under different scenarios. In the first panel, of Portfolio Average across all 444 full sample months, DCA has the highest average stock-money ratio at 3.74. SAA retains the 60-40 rule with a ratio of 1.51. Although the ratios of VA and VA-ICC are not high, they still require further risk analysis, since the ratios are sometimes negative as shown in Panel (C) and Panel (D) in Figure 3. The stock-money ratios at

Portfolio Ending show the accumulative asset allocations after the 37-year investment horizon. The high VA-ICC IRR in Table 2 is partially determined by the high percentage of stock in portfolio value. At the end of each recession, VA-ICC has higher stock-money ratios than VA portfolios, which indicates stronger borrowing during recession in VA-ICC portfolios than VA. Particularly after the most recent recession, in June 2009, stock-money ratios in VA and VA-ICC are all negative. As shown in the previous stock-money ratio curve, VA-ICC has lower absolute value of negative stock-money ratio and stronger borrowing from the money market. This VA-ICC portfolio approach results in more risks.

4.2 Portfolio Risk Analysis

4.2.1 Sharpe Ratio

The Sharpe Ratio is a risk measurement that divides the mean of portfolio's risk premium by its standard deviation. The risk premium of the value path is the internal rate of return in that month in excess of the current monthly risk-free rate.

$$Sharpe\ Ratio = \frac{E(r_p)}{\sigma(r_p)} \qquad where\ \ r_p = IRR - r_f$$

The IRR in each month is calculated as the return on investment in that month by investing an incremental \$100. For example, the ending value of a portfolio in January 1980, which is also the beginning value in February 1980, is $1,000. An investor put another $100 into the portfolio and the ending value in February 1980 is $1,210. Only one eleventh of the ending value, $110, is contributed by the incremental investment of $100. So the IRR for February 1980 is $(\$110 - \$100)/\ \$100 = 10\%$. In this manner, all current month IRRs are calculated backwards using the value paths of each portfolio.

[Insert Figure 4 Here]

Figure 4 Panel (A) shows the monthly risk premium for each portfolio. All four figures are presented in the same scale to compare the fluctuation of IRR curves. The rank of the fluctuation of the IRR curves is VA-ICC (solid line), VA (dotted line), DCA (dashed line), and SAA (dashed/dotted line). The fluctuation happens primarily during NBER recession periods, which are shaded in the figures. Similar to the previous analysis, VA and VA-ICC have stronger recovery in the post-recession period with rocketing monthly IRRs.

4.2.2 Drawdown Analysis

Drawdown analysis is a downside risk metric that analyzes how much portfolio value will go down. A Maximum Drawdown is the maximum amount of loss from an equity high through the drawdown and back to the point the equity high is reached again. For example, the stock market starts going down in December 2007, and it reaches the bottom in June 2009. The Maximum Drawdown in that period is the percentage of how much the market value decreases from December 2007 to June 2009. In this manner, the drawdown in each month since the most recent market peak can be calculated.

In order to calculate and compare the drawdowns of different portfolios, an indicator is calculated as the Net Asset Value Index (NAV). The beginning NAV is set at100 on January 1st, 1976. The ending value of NAV in each month is calculated by increasing the NAV in the previous period by the current month's IRR.

[Insert Figure 4 Here]

Panel (B) of Figure 4 shows the NAV Index under different portfolio allocation strategies. Beginning values are all set at 100. The highest ending NAV is VA-ICC (solid line) at 834. VA (dotted line) ranks second at 474, followed by DCA (dashed line) at 472, and SAA (dashed/dotted line) at 391. The trends for each NAV index are the same as the value paths shown in Section 4.1.2.

Panel (C) of Figure 4 shows the drawdowns of all different portfolio allocation strategies. The drawdowns are 0% during market growth or flattening. The major drawdowns happen during NBER recessions (shaded areas in figures), and the biggest drawdown is during the most recent financial crisis from 2007 to 2009. VA (dotted line) and VA-ICC (solid line) present deeper drawdowns over that period, which is consistent with previous analysis. VA-ICC plummets even more sharply, indicating a quite stronger recovery.

4.2.3 Risk Analysis Results

[Insert Table 4 Here]

In Table 4, the Sharpe Ratios of all 4 investment strategies are lower than 1, which is the cutoff for low-risk assets. They could all be considered risky assets. All four asset allocation strategies are roughly at the same risk level. VA-ICC in Model (4) with the highest Sharpe Ratio is the least risky method among its peers. As to the Maximum Drawdown analysis, VA-ICC in Model (4) has the biggest temporary loss at 62.68%. VA in Model (3) ranks second at 48.82%. This result indicates that previous returns using VA and VA-ICC are better partially due to bearing more downside risks.

4.3 Sensitivity Test for Different Asset Class Weights

Table 5 provides a sensitivity analysis of all four strategies, Model (1) – (4), by changing the 60-40 rule. The percentage of stock market value changes from 0% to 100%, with a step of 10%, in the test.

[Insert Table 5 Here]

When stock market account weights 0% in the portfolio, all four strategies end with the same IRR by investing only in the money market. DCA in Model (1) and SAA in Model (2) are essentially the same when investing 100% in the stock market, because the rebalance in SAA is no longer needed in this circumstance. All four models increase IRR by investing more in the stock market account. In summary, the trend found in Section 4.1.1 holds across all asset class weights. When stock market value is 0%, all four models result in the same return since it comes only from the money market. When stock account value is greater than zero, VA portfolio Model (3) has slightly higher returns than DCA portfolio in Model (1). When Aggregated ICC is incorporated into the VA portfolio in Model (4), monthly IRR is much higher.

4.4 Sensitivity Test for Risk-Free Borrowing Limitation

4.4.1 IRR Comparison under Different Borrowing Caps

As per the discussion in Section 4.1.3 of stock-money ratio and that in Section 4.2 of portfolio risk performance, the high IRRs for the VA and VA-ICC methods are partially from more risk bearing through stronger borrowing from the money market during recession periods. On the other hand, DCA and SAA do not borrow from the money market throughout the entire sample horizon. This section applies borrowing caps from 0% to 1000%, with a step of 50%. For example, a 200% maximum borrowing cap means investors can borrow $200 at most from the money market in certain months. The total investment per month remains at $100 to ensure that all portfolios are comparable. In this way, an investor borrows $200 from the money market and puts $100 into the stock market account.

[Insert Table 6 Here]

Table 6 shows the IRRs of 4 models under different maximum borrowing caps. Since DCA and SAA portfolios have no borrowing from the money market, the IRRs remain the same as shown in Table 2 in Section 4.1.1. For the VA and VA-ICC models, the IRRs increase with higher caps on risk-free borrowing. This trend further proves that the higher returns are from higher risk tolerance, particularly during recession periods. Under all borrowing caps, VA-ICC results in higher IRR than SAA and VA. When the risk-free borrowing cap is lower than 550%, DCA in Model (1) provides better return in Model (4) of the VA-ICC portfolio. When maximum borrowing exceeds 550%, VA-ICC starts winning over DCA in IRR comparisons. However, the DCA portfolio earns more than the VA method even when the borrowing cap hits 100%. This comparison indicates that VA methods in Model (3) and (4) win over the Dollar-Cost Averaging method due to their risk-free borrowing from the money market. VA-ICC has lower risk exposure than the VA method since it results in higher IRR than DCA after meeting the 550% risk-free borrowing cap.

4.4.2 Stock-Money Ratio Comparison

[Insert Table 7 Here]

A stock-money ratio analysis of the portfolio ending balances is presented in this section. As in Section 4.4.1, maximum risk-free borrowing is set from 0% to 100% with a step of 50%. DCA and SAA have the same stock-money ratio since they don't require any borrowing to ensure value paths. Similarly, as IRR trends, VA and VA-ICC both have higher stock-money ratios when borrowing caps increase. Before maximum borrowing hits 600%, VA-ICC has lower ending stock-money ratios than the VA model. The VA-ICC model's ending stock-money ratio is lower than that of the DCA when maximum borrowing is lower than 600%. After reaching the 800% maximum borrowing caps, stock-money ratios fluctuate around 20, which means that the stock market account value in the portfolio is over 95%. This indicates a high risk profile, since the number is the average level of 444 full sample months.

4.4.3 Risk Analytic Comparison

This section compares the key risk factors in this paper, the Sharpe Ratio and Maximum Drawdown, which are explained in Sections 4.2.1 and 4.2.2. A risk-free borrowing cap is applied to all portfolios to test risk performance. Consistent with previous sections, maximum money market borrowing is set from 0% to 1000% with a step of 50%. Sharpe Ratio and Maximum Drawdown results are listed separately in Panel (A) and Panel (B) in Table 8.

[Insert Table 8 Here]

Panel (A) in Table 8 shows slight improvement of Sharpe Ratios in VA and VA-ICC models, resulting in higher Sharpe Ratio values. Interestingly, the Sharpe Ratio decreases and then increases when the maximum borrowing amount is increased in the VA model. The VA-ICC model's Sharpe Ratio decreases with increasing risk-free borrowing caps. Portfolio risks are partially reduced by setting up maximum money market borrowing.

Panel (B) in Table 8 shows significant reduction in Maximum Drawdown values in the VA and VA-ICC models. Generally, the absolute values of Maximum Drawdown decrease as higher borrowing caps are applied to portfolios. Downside risks are controlled by the borrowing caps. Although maximum borrowing is set at 1000%, VA-ICC has a Maximum Drawdown value of -41.94%, which is still lower than the DCA model's -45.87%. The caps on risk-free borrowing generate a significant downside risk reduction for VA-ICC portfolios.

4.5 Sensitivity Test of Different Market Timing and Portfolio Horizons

4.5.1 IRR Comparison for Different Portfolio Horizons

In this section, all four strategies are tested under different market entry timings and the portfolios are held by different time horizons. In the previous analysis, the timing for market entry is January 1976, and the portfolio is held for 37 years to the end of 2012. By changing the horizon to one year, an investor's starting date could be January 1976, February 1976, …, to January 2012. All of the IRRs of the 433 portfolios are then averaged and reported under all four strategies. This test will rule out the market timing effect and compare across different time horizons. For all of the one-year portfolios, the earliest and latest are January 1976 to December 1976 and January 2012 to December 2012, respectively. For all of the ten-year portfolios, the earliest is January 1976 to December 1985 and the latest is January 2003 to December 2012.

[Insert Table 9 Here]

Table 9 presents the average IRRs for Model (1) - (4) under different portfolio horizons. If holding the portfolios for one year, DCA in Model 1 has the best IRR at 0.731%. The two VA methods in Model 3 and 4 have lower average returns on investment. This trend holds when comparing them in a 2-year portfolio. VA and VA-ICC start winning over DCA when the length of the horizon is extended to 5 years. The 10-year result is even better. No matter how long the horizon is, DCA outperforms SAA on average and VA-ICC outperforms VA on average. The best length of time to hold a DCA portfolio or an SAA portfolio is 2 years; while the most profitable length of time to hold a VA or a VA-ICC portfolio is 10 years.

The full sample of IRRs in the 37-year investment horizon is included in Table 9 as the benchmark. The numbers are the same as in Table 2 in Section 4.1.1. For portfolio horizons of 1 year and 2 years, DCA has the higher IRRs. In the 5-year and 10-year portfolios, both VA and VA-ICC yield to higher returns than the DCA model, while VA-ICC contributes the highest returns.

[Insert Figure 5 Here]

Figure 5 presents the IRR curves of different market timing portfolios under different portfolio horizons and portfolio allocation strategies. All 16 figures in the 4 panels are of the same scale to compare the fluctuations of IRR curves. From Panel (A) to Panel (D), with an increase in portfolio horizon, the IRR curves become more flattened across all of the strategies. Comparing the third and the fourth columns of VA (dotted lines) and VA-ICC (solid lines) with the first and second columns of DCA (dashed lines) and SAA (dashed/dotted lines), VA and VA-ICC have sharper peaks during NBER recession periods. Both VA methods perform worse than DCA if an investor enters the market just before the market plummets. The negative peak of VA-ICC is slightly higher than that of VA, indicating that ICC could reduce the downside risks of the VA method.

4.5.2 Average Portfolio Ending Stock-Money Ratio

The average stock-money ratios of ending portfolio balances in different models under time horizons are analyzed in this section. All results are listed in Table 10. For example, when holding a portfolio for only 1 year, there are 433 different starting months since January 1976. Averages of all stock-money ratios at the end of each of the 433 portfolios are taken and presented in the table.

[Insert Table 10 Here]

In Table 10, VA and VA-ICC have similar average stock-money ratios under the 1-year portfolio horizon. As the portfolio time horizon increases, VA and VA-ICC rely more on the weights of stock market values for better returns, as shown in Table 9. This further suggests that underlying risk factors will contribute to returns for VA and VA-ICC models.

CHAPTER 5

RETURN AND RISK COMPARISONS IN OUT-OF-SAMPLE PREDICTIONS

5.1 Econometric Specification

The out-of-sample predictive model is

$$r_{t+1} = \alpha_i + \beta_i x_{i,t} + \varepsilon_{i,t+1}$$

where r_{t+1} is the monthly market premium defined as the difference between the monthly continuously compounded return on the value-weighted market index from CRSP, Vwretd, and the monthly continuously compounded one-month T-bill rate, T30ret. $x_{i,t}$ stands for forecasting variable i, i.e., ICC_t, Ldy_t, E/P_t, and $CAPE_t$. $\varepsilon_{i,t+1}$ is the error term.

The entire sample T is divided into two periods: m and $q = T - m$. The first m variables in sample T are used to estimate parameters $\hat{\alpha}_{i,m}$ and $\hat{\beta}_{i,m}$ from an OLS regression. Then, the first predicted return in the next period $\hat{r}_{i,m+1}$ can be predicted as follows:

$$\hat{r}_{i,m+1} = \hat{\alpha}_{i,m} + \hat{\beta}_{i,m} x_{i,m}$$

The second out-of-sample predicted variable is calculated after an OLS regression on the first $m + 1$ variables. Proceeding in this manner through the end of the forecast period, all q variables will be predicted.

$$\hat{r}_{i,m+2} = \hat{\alpha}_{i,m+1} + \hat{\beta}_{i,m+1} x_{i,m+1}$$

5.2 Forecast Evaluation

Out-of-sample R-Square is used to compare predictability across all forecasting variables. R_{os}^2 measures the reduction in mean squared prediction error (MSPE) for the predictive regression. If the predicted return outperforms the historical return in forecasting, R_{os}^2 will be greater than zero. For forecasting variables, higher R_{os}^2 means more predictability of future market return over the others.

$$R_{os}^2 = 1 - \frac{\sum_{k=1}^{q} \left(r_{m+k} - \hat{r}_{i,m+k} \right)^2}{\sum_{k=1}^{q} \left(r_{m+k} - \bar{r}_{i,m+k} \right)^2}$$

A mean-variance investor with a relative risk aversion of γ optimizes portfolio return by allocating assets between stock and money markets. The percentage of assets in the stock market, $\omega_{1,t}$, is predicted by historical market returns with the equation:

$$\omega_{1,t} = \left(\frac{1}{\gamma} \right) \left(\frac{\bar{r}_{t+1}}{\hat{\sigma}_{t+1}^2} \right)$$

Stock allocation can also be determined by the predictive market returns from forecasting variables. In both methods, $\hat{\sigma}_{t+1}^2$ is the volatility of stock market returns in the past 10 years.

$$\omega_{2,t} = \left(\frac{1}{\gamma}\right)\left(\frac{\hat{r}_{i,t+1}}{\hat{\sigma}^2_{t+1}}\right)$$

Thus, a mean-variance investor's expected portfolio return is

$$r_t = \omega_t \times r_m + (1 - \omega_t) \times r_f$$

where r_m is the stock market return and r_f is the money market return. For both $\omega_{1,t}$ and $\omega_{2,t}$, the maximum amount of stock weight is limited to 150%. The average utility of the investor based on historical market return is

$$U_1 = \mu_1 + \frac{1}{2}\gamma\hat{\sigma}_1^2$$

where μ_1 is the mean of the portfolio's return, and $\hat{\sigma}_1^2$ is the variance. The utility based on forecasting variables' predictions can be calculated in the same manner:

$$U_2 = \mu_2 + \frac{1}{2}\gamma\hat{\sigma}_2^2$$

The utility gain of using a particular forecasting variable can be measured as the excess utility from using historical market return. This result is reported using $\gamma = 3$.

$$U_{Gain} = U_2 - U_1$$

5.3. Forecasting Results

5.3.1 IRR Comparison of Different Strategies

[Insert Table 11 Here]

In Table 11, the out-of-sample prediction period is 180 months from January 1998 to December 2012. The result for the entire sample period from January 1976 to December 2012 is shown again for comparison. VA and VA-ICC in Model (3) and (4)4 are both still better than DCA and SAA in Model (1) and (2) in the out-of-sample period. VA and VA-ICC outperform even more in the out-of-sample period given the strong rebounds in post-recession periods. In the out-of-sample periods with the most three recent market recessions, VA and VA-ICC provide higher return by bearing more risks.

5.3.2 Out-of-Sample Test Results

[Insert Table 12 Here]

Table 12 summarizes the out-of-sample analysis of forecasting models using different forecasting variables for the predicting period from January 1998 to December 2012. In Models (6), (7), (8), and (9), ICC, Ldy, P/E, and CAPE are used as forecasting variables for predicting market returns, respectively. The out-of-sample R-square is the mean squared prediction error (MSPE). Stock Weight is the percentage of stock market value in the portfolio at the end of the investment horizon, which is $\omega_{2,t}$ explained in Section 5.2.

From this section forward in this paper, average ICC for the past 2 years is used as the forecasting variable to predict market return and calculate utility gain of a mean-variance investor. 2-year average ICC is the best forecasting variable with the lowest R_{os}^2 and highest relative utility gain. The negative R_{os}^2 in all four models indicate that none of the predictors beat the historical market return. The Utility Gains of ICC in Model (6) and Dividend Yield (Ldy) in Model (7) are positive, showing better performance of ICC and Ldy over the historical average forecast. The ending stock weight indicates slightly risk-free borrowing in Model (6), (8), and (9). Model (7) also has 99.66% of its value from the stock market account.

5.3.3 Portfolio Comparison under Different Asset Weights

[Insert Table 13 Here]

Table 13 provides IRR comparisons over different asset class weights in Strategic Asset Allocation strategies (SAA). Model (2) is the SAA under the "60-40" rule as the same from Section 5.3.1. In Model (5) of Historical Average Forecasting, stock class weight is determined by $\omega_{1,t}$ in Section 5.2. In Model (6a) to Model (9a), stock class weight is determined by $\omega_{2,t}$ in Section 5.2, by using forecasting variables of ICC, Ldy, P/E, and CAPE, respectively.

The IRR results show that none of the forecasting variables could provide better asset class allocation returns than using historical average for forecasting. The historical average forecasting method provides a better IRR portfolio than the Strategic Asset Allocation (SAA) strategy under the 60-40 rule. As to risk factors, Model (5), using the historical average forecasting method, has the highest Maximum Drawdown and second highest Sharpe Ratio. Compared to Model (5), Models from (6a) to (9a) have lower IRRs, lower Sharpe Ratios, and relatively same Maximum Drawdown values. Thereby, their portfolios did not perform better than if the historical average forecasting method had been used. Compared to Model (2), Model (5) has higher return and higher risk, which is the traditional trade-off of risk and return.

5.3.4 Comparison of VA Portfolios Incorporating Different Market Predictors

[Insert Table 14 Here]

Table 14 provides IRR comparisons over different expected returns of value paths in Value Averaging strategies (VA). Model (3) is the pure VA strategy as in Section 5.3.1. In Model (4), of VA-ICC, expected returns are replaced by aggregate ICC for each month, which is also what is done in Model (4) in Section 5.3.1. For Model (6b) to (9b), expected return of value paths are determined by $\hat{r}_{i,m+t}$ in Section 5.1, by using forecasting variables of ICC, Ldy, P/E, and CAPE, respectively.

The IRR results show that none of the forecasting variables provide better returns than using historical average or aggregate ICC as expected portfolio return in VA's value paths. Among the four models from (6b) to (9b), CAPE provides the best predicted market return used in the VA strategy, followed by the 2-year average aggregate ICC. All VA methods borrow from the money market somehow at the end of investment horizon. The higher the absolute value of the negative stock-money ratios, the lower percentage of risk-free borrowing is indicated. Both Sharpe Ratio and Maximum Drawdown values decrease by applying different market predictors' forecasted returns in VA methods in models from (6b) to (9b), indicating a slightly increasing overall risk level and a slightly decreasing downside risk.

CHAPTER 6

CONCLUSION

This paper examines four portfolio allocation strategies, Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC). Portfolios' performances are evaluated based on their returns and risks across different asset allocations, maximum risk-free borrowing limitations, and market timing and investment horizons. An out-of-sample analysis is conducted to test the utility gains for different market predictors against Aggregated Implied Cost of Capital (ICC). In addition, mean-variance investors' stock value percentages, and market return forecasted by different market predictors are applied to VA methods for return and risk comparison.

During the entire portfolio horizon from January 1976 to December 2012, DCA outperforms SAA, as a DCA investor puts much more weight in the market money account without rebalancing to a fixed rate such as the "60-40" rule. Value Averaging methods outperform DCA, since VA methods involve automatically borrowing from the money market during market recessions. Value Averaging methods, including VA and VA-ICC, will rebound very quickly in post-recession periods after borrowing from the money market and investing more shares in the stock market during recessions.

During the value path analysis, VA methods, particularly VA-ICC, present deeper losses in the portfolio value path during market recessions, with sharp rebounds when the market begins recovering. This pattern indicates the potential risk level of VA methods. A further check on the stock-money ratio at different points of time during the investment horizon, particularly the post-recession month, indicates that VA methods rely more on stock market assets in the portfolios to yield higher monthly IRR. VA-ICC's highest return comes from the highest stock account percentages and the strongest risk-free borrowing during financial crisis periods to hold stock market account positions. All results reveal potential risks of VA methods.

Sharpe Ratio analysis indicates the same risk level for all four strategies, and shows VA-ICC to be the least risky, relatively speaking. On the other hand, Maximum Drawdown analysis presents VA-ICC with the biggest Maximum Drawdown during the entire sample period from January 1976 to December 2012. During market recessions, VA methods tend to have greater drawdowns. Generally, VA methods require a longer hold of stock market asset during recessions, expecting a bigger win when markets are recovering. It appears that VA methods are not bearing more risks, but pushing risks forward to the future.

VA methods hold more stock market shares and expect a market recovery. A pure VA method uses historical market return as expected portfolio return in the value path; while VA-ICC uses S&P 500 Aggregate ICC as an alternative. ICC is a predictor of future market return and is higher than historical market return. In this manner, VA-ICC expects a steeper growing value path than the pure VA strategy. During recession periods, VA-ICC investors will borrow more from the money market and hold more shares in the stock market. Eventually, the VA-ICC's movement during recessions will further boost a stronger recovery after recessions.

This paper then tests the robustness of VA-ICC as the most profitable portfolio allocation strategy with the highest IRR. Under various weights of stock asset class from 0% to 100%, VA methods are shown to be better than DCA, and VA-ICC outperforms VA regardless of its portfolio weights.

The sensitivity test of different maximum risk-free borrowing amounts shows how much each strategy relies on borrowing from the money market to hold the value paths. VA-ICC won't be able to generate higher IRR than DCA until borrowing reaches a maximum of $500 from the money market. However, if the maximum borrowing amount is within $1,000, VA methods, including VA and VA-ICC, have higher Sharpe Ratios and lower Maximum Drawdown Ratios. Thereby, VA methods outperform DCA methods in risk performance throughout the sensitivity test. VA-ICC has even lower overall risks and downside risks than the pure VA portfolio.

Another major source of return is market timing. After testing the same portfolio of a fixed horizon with different starting dates, VA methods have higher average IRR of all portfolios when portfolio horizon increases. During 1-year and 2-year horizons, VA methods have lower average IRRs compared to DCA and SAA. During 5- and 10-year horizons, VA methods have higher average IRRs. VA-ICC outperforms VA among all various portfolio horizons. This is consistent with previous analysis given the fact that VA methods generate greater loss and stronger recovery during market recessions. The shorter the horizon, the less likely it is that a VA investor will have a chance to recover.

A similar portfolio IRR and value path construction is done in the out-of-sample testing period from January 1998 to December 2012. There are three major market recessions in this period. VA and VA-ICC strongly outperform DCA and SAA, compared to the entire 37-year portfolio. The primary reason for this is VA methods are better across market recessions with strong recovery.

In the out-of-sample test, ICC provides the highest MSPE, measured by out-of-sample R-square. Even though the out-of-sample R-squares are all negative, using forecasting variables of ICC, Ldy, P/E, and CAPE, ICC indicates that the highest positive utility gain for an investor with mean-variance preferences and a risk aversion coefficient of three, which is greater than that for another mean-variance investor using historical benchmark forecasting model. Total stock market Dividend Payout in logarithm (Ldy) ranks second among all forecasting variables, in terms of both MSPE and utility gain.

Mean-variance investors' portfolio asset weights are estimated by historical market returns and the forecasting variables of ICC, Ldy, P/E, and CAPE. These weights are compared to the 60-40 rule. The results show that historical market return is the best indicator for asset distribution over the 60-40 rule and all forecasting variables. Within forecasting variables, ICC constructs the most profitable portfolio. The historical return model and all

VA methods have higher risks than the SAA model under the 60-40 rule. In summary, mean-variance investors' returns are generated from enduring more risks in stock markets.

When incorporating forecasting in Value Averaging methods, future market returns are predicted by forecasting variables. Then, predicted market returns are used in VA methods, as the expected return of the value paths used as alternatives to ICC and historical market return. None of the VA methods incorporated with forecasting variable predicted market returns provide better IRRs than VA or VA-ICC strategies. Within the forecasting variables, CAPE predicted market return provides the best portfolio IRR. Risk factors among all different VA methods are at the same level.

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APPENDICES

All tables and figures are presented in the Appendices. A brief explanation is under each table and figure. A list of figures is on Page ix. A list of tables is on Page x.

Table 1 – Summary Statistics for Forecasting Variables

This table provides mean, standard deviation, number of observations, and the time horizon for all variables used in this paper. (1) The NYSE/Amex/Nasdaq value-weighted market return (Vwretd), one-month T-bill rate (T30ret), value-weighted aggregate implied cost of capital (ICC) are reported monthly in percentages from January 1976 to December 2012. (2) The historical market return (Rm) and historical market dividend per share growth rate (Dvgr) are reported in percentages from January 1962 to December 1975. (3) Dividend Payout (Ldy) is reported in natural logarithm from January 1976 to December 2012. (4) S&P 500 aggregate Price-to-Earning (P/E) and Robert Shiller's 10-year Cyclically Adjusted Price-to-Earning (CAPE) are reported in exact value from January 1976 and December 2012. All variables are reported at the end of each month. Detailed descriptions for these variables are provided in Section 3.

	Mean	Std. Dev.	No. of Obs.	Bgn. Month	End Month
Return Variables					
Vwretd	1.00	4.54	444	Jan. 1976	Dec. 2012
T30ret	0.42	0.28	444	Jan. 1976	Dec. 2012
Historical Variables					
Rm	0.48	4.45	168	Jan. 1962	Dec. 1975
Dvgr	0.53	6.11	168	Jan. 1962	Dec. 1975
Forecasting Variables					
ICC	0.96	0.22	444	Jan. 1976	Dec. 2012
Ldy	-3.62	0.43	444	Jan. 1976	Dec. 2012
P/E	19.86	14.46	444	Jan. 1976	Dec. 2012
CAPE	19.96	9.09	444	Jan. 1976	Dec. 2012

Table 2 – IRR Comparison of Different Portfolio Allocation Strategies

This table provides the IRR for the in-sample models of the four portfolio allocation strategies tested in this paper. The models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. All models are explained in Section 2 in terms of how to invest monthly among different asset classes. The portfolio horizon is 37 years from January 1976 to December 2012, with a monthly investment cost of $100. Analysis of the table is in Section 4.1.1.

Strategy	(1) **DCA**	(2) **SAA**	(3) **VA**	(4) **VA-ICC**
IRR	0.714%	0.659%	0.716%	0.867%

Figure 1 – Value Path Comparison of Different Asset Allocation Strategies

This figure plots the value path curves of the four portfolio allocation strategies. DCA, SAA, VA, and VA-ICC are plotted on the dashed line, dashed/dotted line, dotted line, and solid line, respectively. Panel (A) shows the entire horizon since January 1976; Panel (B) shows the time period since January 1997. The NBER recession periods are shaded. A detailed explanation of the figures is in Section 4.1.2.

Panel (A) – Value Paths from January 1976 to December 2012

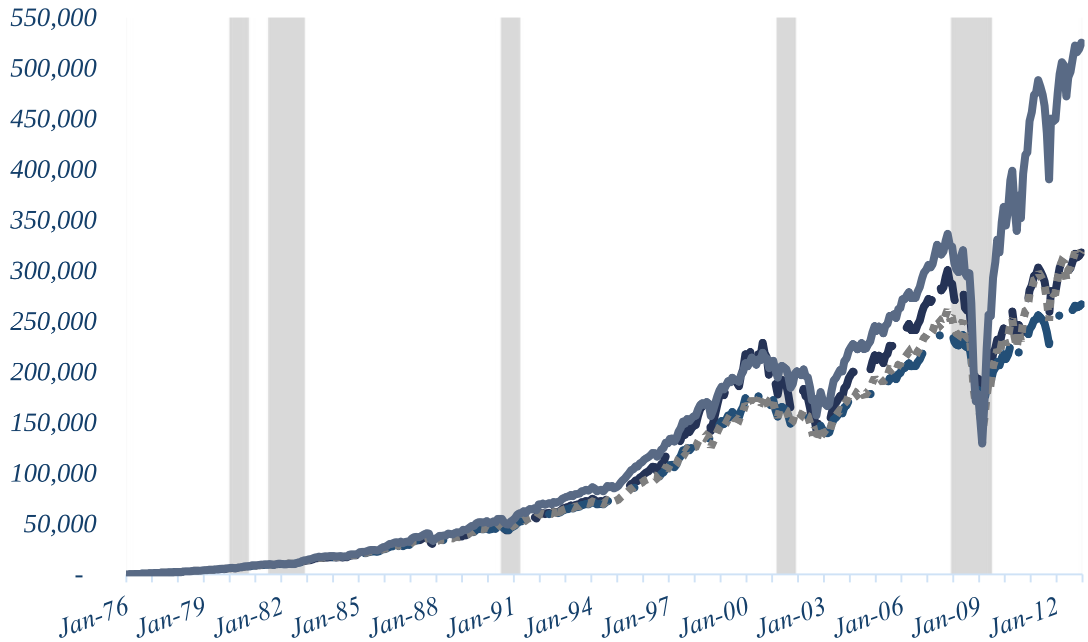


Figure 1 – Value Path Comparison of Different Asset Allocation Strategies (Cont'd)

Panel (B) – Value Paths from January 1997 to December 2012

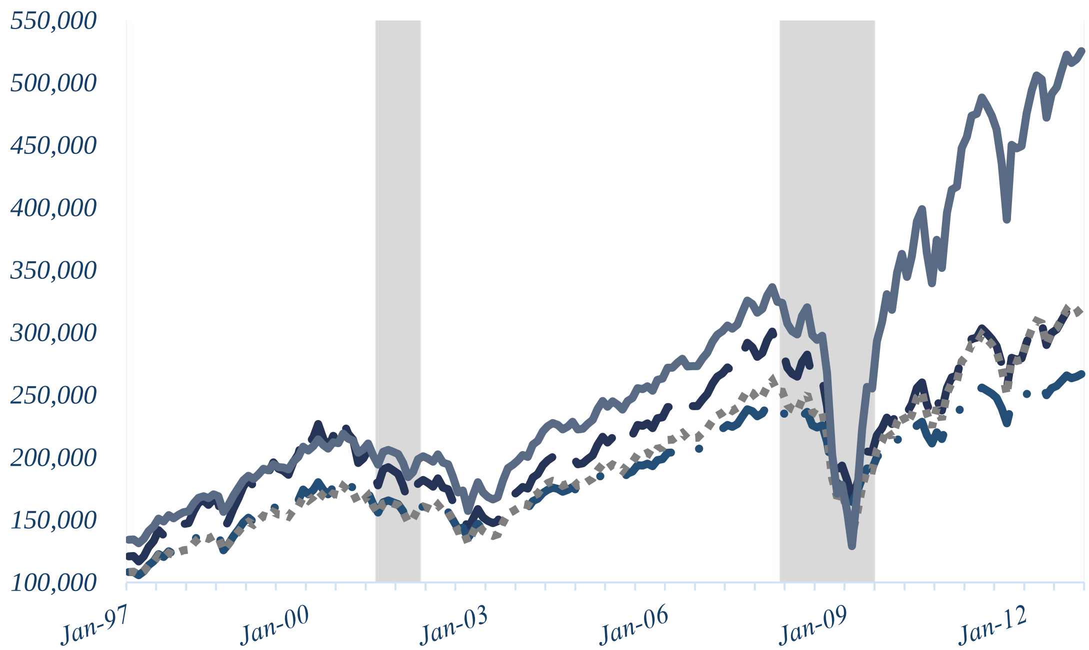
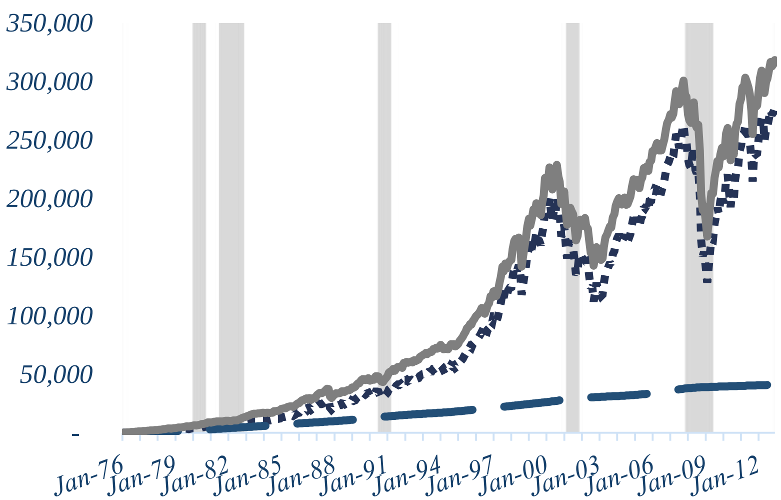


Figure 2 – Value Path Breakdown of Different Portfolio Allocation Strategies

The breakdown value paths are plotted in the following figures. The total value of portfolio, value of stock market account, and value of money market account are represented by the solid line, dotted line, and dashed line, respectively. Strategies of DCA, SAA, VA, and VA-ICC are in Panels (A), (B), (C), and (D), respectively. NBER recession periods are shaded. The analysis of the figures is also in Section 4.1.2.

Panel (A) – Dollar Cost Averaging



Panel (B) – Strategic Asset Allocation

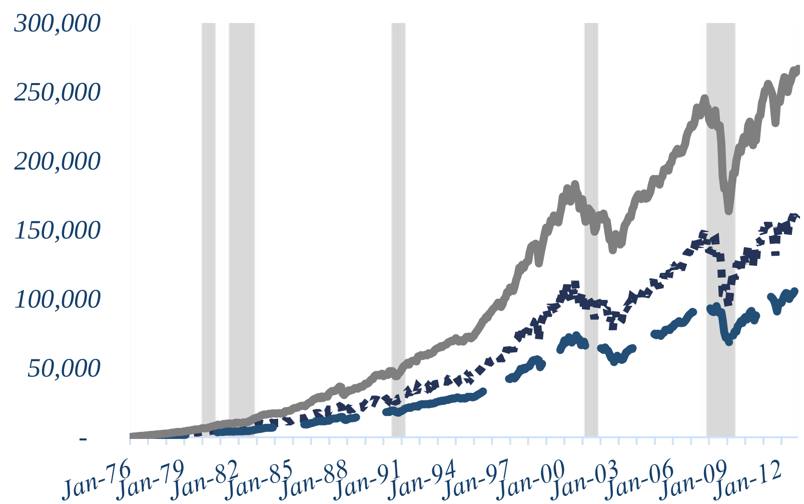
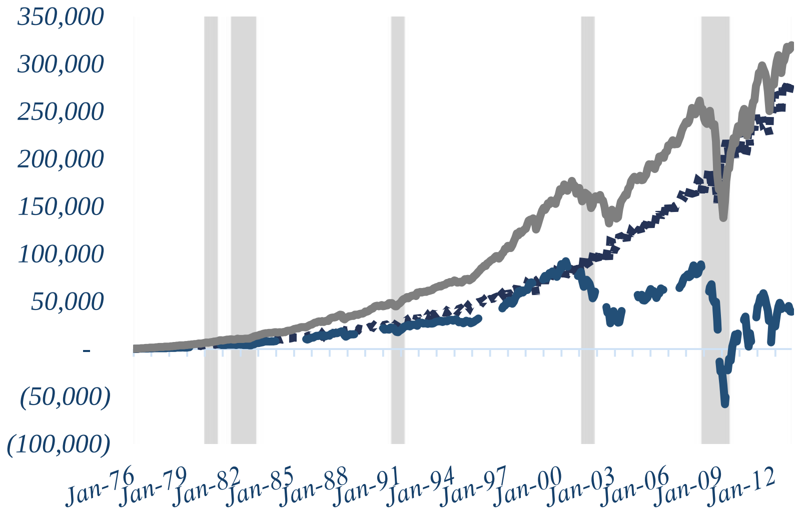


Figure 2 – Value Path Breakdown of Different Portfolio Allocation Strategies (Cont'd)

Panel (C) – Value Averaging



Panel (D) – Value Averaging incorporated with Aggregate ICC

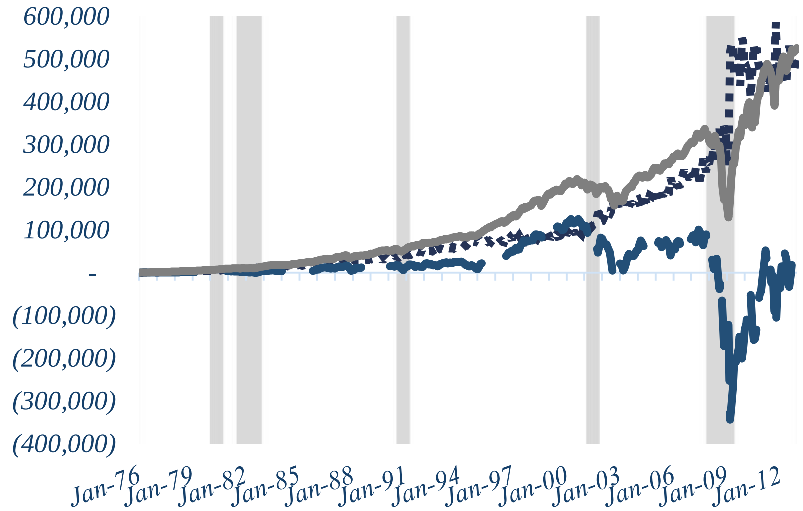
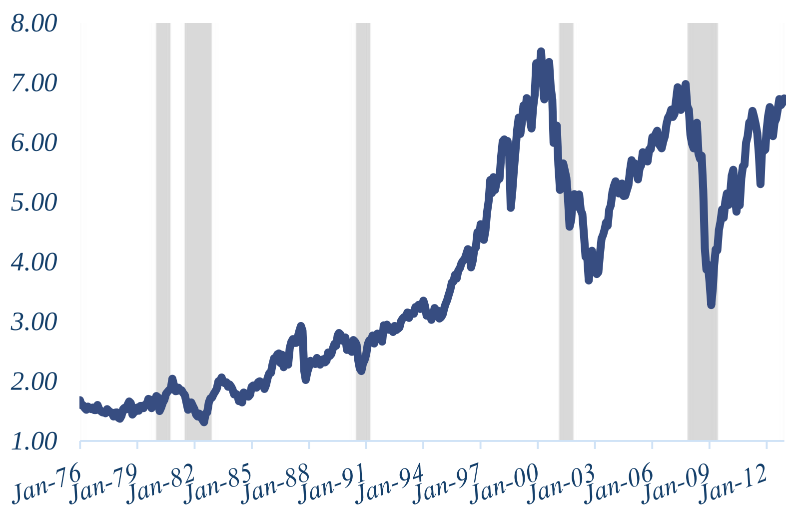


Figure 3 – Stock-Money Ratio in Different Portfolios

The stock-money ratio curves are plotted in the following figures. At the beginning of each portfolio, the initial investment is $60 in the stock market and $40 in the money market. Strategies of DCA, SAA, VA, and VA-ICC are in Panels (A), (B), (C), and (D), respectively. NBER recession periods are shaded. Analysis of the figures is in Section 4.1.2.

Panel (A) – Dollar Cost Averaging



Panel (B) – Strategic Asset Allocation

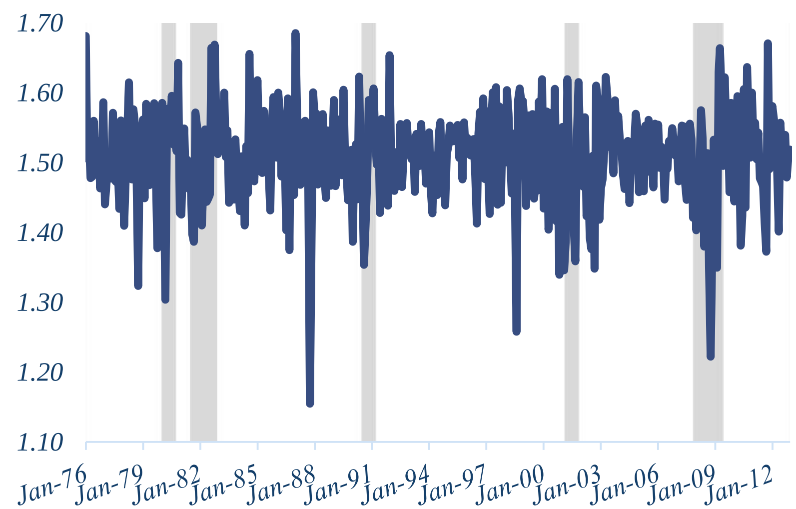
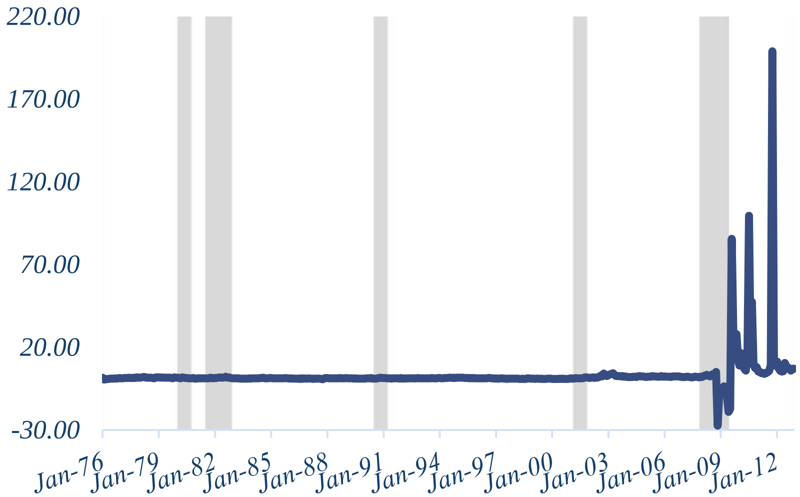


Figure 3 – Stock-Money Ratio in Different Portfolios (Cont'd)

Panel (C) – Value Averaging



Panel (D) – Value Averaging incorporated with Aggregate ICC

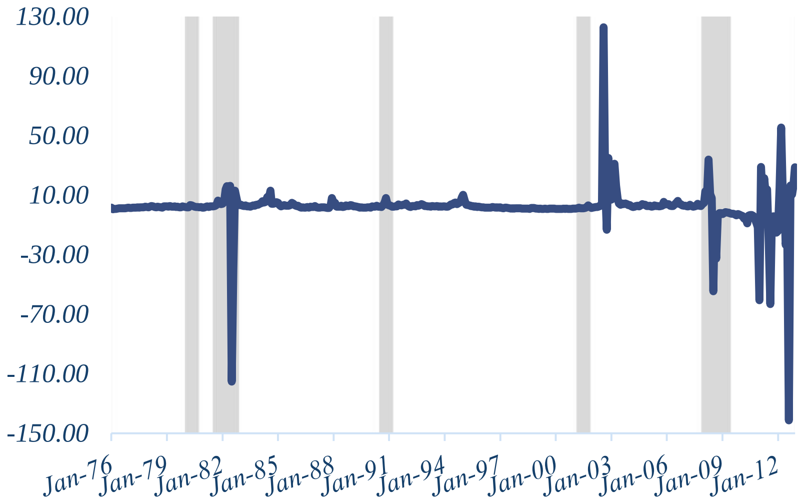


Table 3 – Stock-Money Ratio in Different Portfolios

This table provides the Stock-money Ratio of the in-sample models of the four portfolio allocation strategies tested in this paper. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The stock-money ratios at the full sample average level, at portfolio ending in December 2012, and after each recession period, are presented in the table. Analysis of the table is in Section 4.1.3.

	(1) **DCA**	(2) **SAA**	(3) **VA**	(4) **VA-ICC**
Portfolio Average				
444 Months	3.74	1.51	2.87	1.91
Portfolio Ending				
Dec. 2012	6.74	1.52	7.16	28.74
NBER Recession Ending				
Jul. 1980	1.79	1.60	1.51	2.31
Nov. 1982	1.72	1.57	1.42	4.04
Mar. 1991	2.68	1.54	1.26	2.14
Nov. 2001	5.06	1.62	1.87	2.29
Jun. 2009	4.19	1.50	(19.05)	(2.25)

Figure 4 – Portfolio Risk Premium and Drawdown Analysis

All 4 figures for each Panel are of the same scale to compare the fluctuation of IRR curves. Panels (A), (B), and (C) present monthly risk premium, Net Asset Value (NAV) index, and Maximum Drawdown, respectively. DCA, SAA, VA, and VA-ICC are plotted on the dashed line, dashed/dotted line, dotted line, and solid line, respectively. NBER recession periods are shaded. The horizontal axis represents portfolio beginning months from January 1976. Analyses of the figures and the results are in Section 4.2.1 and Section 4.2.2

Panel (A) – Monthly Risk Premium

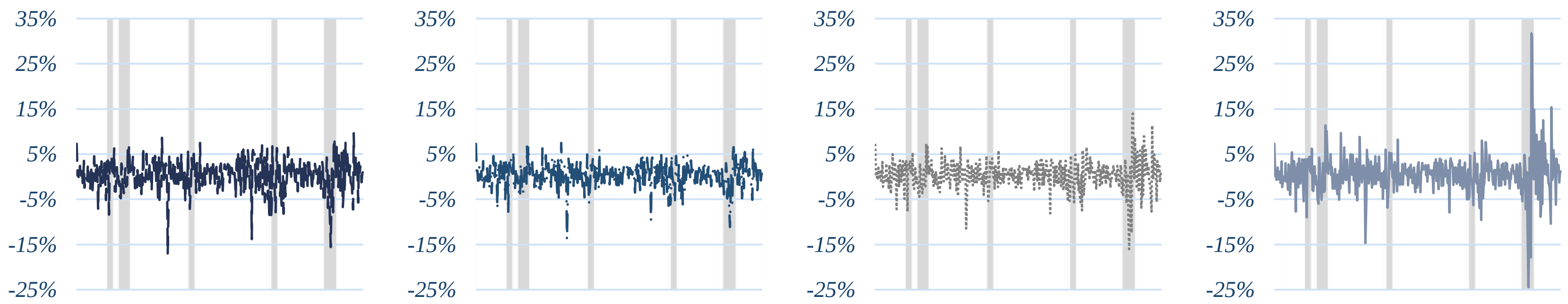
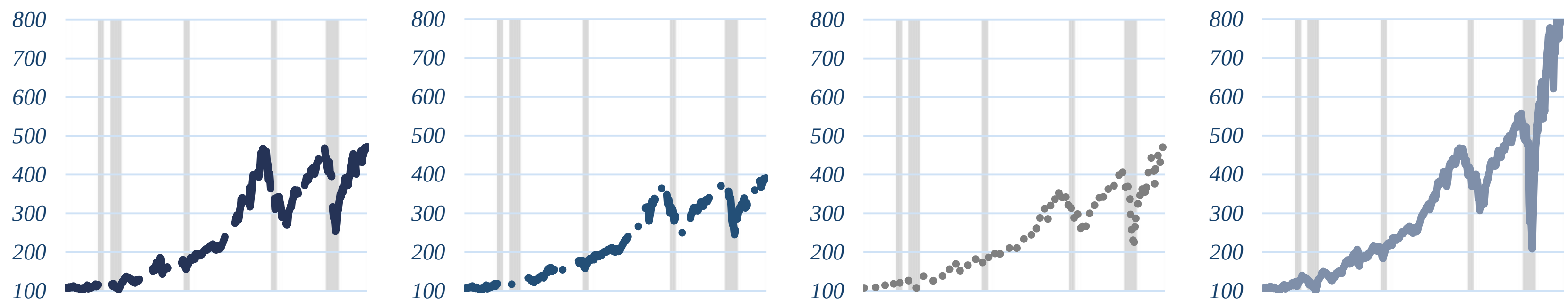


Figure 4 – Portfolio Risk Premium and Drawdown Analysis (cont'd)

Panel (B) – Net Asset Value Index



Panel (C) – Maximum Drawdown

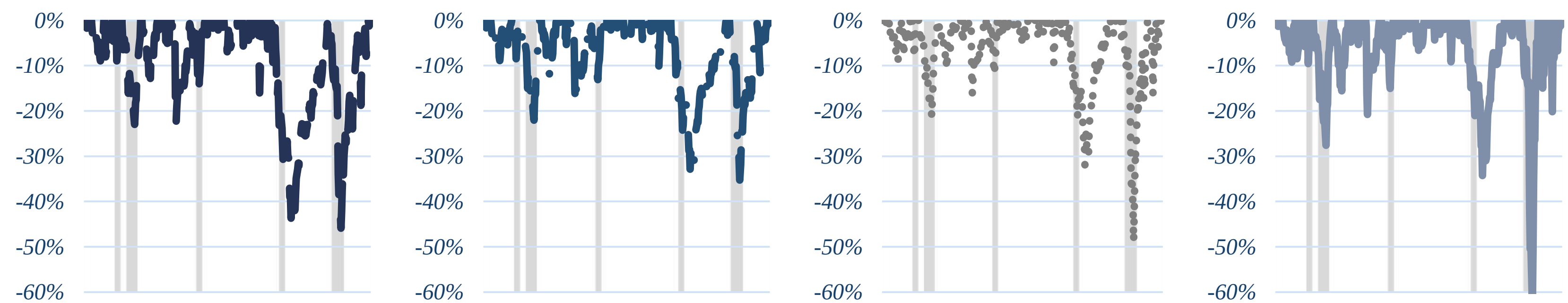


Table 4 – Risk Analysis of Different Portfolio Allocation Strategies

This table provides the Sharpe Ratio and Maximum Drawdown of different portfolio allocation strategies. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. Analysis of the table and results is in Section 4.5.3.

Ratio	(1) **DCA**	(2) **SAA**	(3) **VA**	(4) **VA-ICC**
Sharpe Ratio	0.1186	0.1264	0.1284	0.1296
Maximum Drawdown	-45.87 %	-35.27%	-48.82%	-62.68%

Table 5 – Sensitivity Test for Portfolio Weights

This table provides a sensitivity analysis of all four strategies by changing the percentage of the stock market account. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. Percentages of the stock market account are changed from 0% to 100% with a step of 10%. The 60-40 rule used in previous tables and figures is shaded. A detailed explanation of the table is in Section 4.3.

	(1)	(2)	(3)	(4)
Stock (%)	**DCA**	**SAA**	**VA**	**VA-ICC**
0	0.337%	0.337%	0.337%	0.337%
10	0.443%	0.396%	0.444%	0.519%
20	0.521%	0.453%	0.522%	0.630%
30	0.583%	0.508%	0.584%	0.710%
40	0.634%	0.560%	0.635%	0.773%
50	0.677%	0.611%	0.678%	0.824%
60	0.714%	0.659%	0.716%	0.867%
70	0.747%	0.705%	0.749%	0.904%
80	0.777%	0.748%	0.778%	0.937%
90	0.804%	0.789%	0.805%	0.966%
100	0.828%	0.828%	0.830%	0.993%

Table 6 – IRR Comparison under Maximum Borrowing Limitation

This table provides a detailed IRR comparison of all four strategies by applying the maximum risk-free borrowing percentages from the money market. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The borrowing caps are changed from 0% to 1000% with a step of 50%. A detailed explanation of the table is in Section 4.4.1.

Maximum Borrowing	(1) **DCA**	(2) **SAA**	(3) **VA**	(4) **VA-ICC**
0%	0.714%	0.659%	0.621%	0.665%
50%	0.714%	0.659%	0.627%	0.675%
100%	0.714%	0.659%	0.632%	0.681%
150%	0.714%	0.659%	0.637%	0.686%
200%	0.714%	0.659%	0.642%	0.690%
250%	0.714%	0.659%	0.646%	0.694%
300%	0.714%	0.659%	0.650%	0.698%
350%	0.714%	0.659%	0.654%	0.702%
400%	0.714%	0.659%	0.658%	0.706%
450%	0.714%	0.659%	0.661%	0.709%
500%	0.714%	0.659%	0.665%	0.713%
550%	0.714%	0.659%	0.667%	0.716%
600%	0.714%	0.659%	0.670%	0.719%
650%	0.714%	0.659%	0.672%	0.722%
700%	0.714%	0.659%	0.675%	0.725%
750%	0.714%	0.659%	0.677%	0.728%
800%	0.714%	0.659%	0.679%	0.731%
850%	0.714%	0.659%	0.684%	0.739%
900%	0.714%	0.659%	0.682%	0.737%
950%	0.714%	0.659%	0.684%	0.739%
1000%	0.714%	0.659%	0.685%	0.741%
No Cap	0.714%	0.659%	0.716%	0.867%

Table 7 – Ending Stock-Money Ratio under Maximum Borrowing Limitation

This table provides an ending balance stock-money ratio comparison of all four strategies by applying maximum risk-free borrowing percentages from the money market. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The borrowing caps are changed from 0% to 1000% with a step of 50%. A detailed explanation of the table is in Section 4.4.2.

Table 7 – Ending Stock-Money Ratio under Maximum Borrowing Limitation (Cont'd)

Maximum Borrowing	(1) DCA	(2) SAA	(3) VA	(4) VA-ICC
0%	6.74	1.52	1.06	1.06
50%	6.74	1.52	1.17	1.17
100%	6.74	1.52	1.62	1.31
150%	6.74	1.52	1.89	1.48
200%	6.74	1.52	2.21	1.68
250%	6.74	1.52	2.61	1.90
300%	6.74	1.52	3.11	2.17
350%	6.74	1.52	3.76	2.48
400%	6.74	1.52	4.60	2.85
450%	6.74	1.52	4.77	3.29
500%	6.74	1.52	4.99	3.85
550%	6.74	1.52	5.25	4.56
600%	6.74	1.52	5.55	5.51
650%	6.74	1.52	5.90	6.80
700%	6.74	1.52	6.30	8.70
750%	6.74	1.52	6.77	11.61
800%	6.74	1.52	7.32	15.89
850%	6.74	1.52	9.64	20.93
900%	6.74	1.52	8.73	18.68
950%	6.74	1.52	9.64	20.93
1000%	6.74	1.52	10.80	23.72
No Cap	6.74	1.52	7.16	28.74

Table 8 – Risk Analytic Results under Maximum Borrowing Limitation

This table provides a risk factors comparison of all four strategies by applying maximum risk-free borrowing percentages from the money market. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The borrowing caps are changed from 0% to 1000% with a step of 50%. Panel (A) presents Sharpe Ratio results; Panel (B) presents Maximum Drawdown results. A detailed explanation of the table is in Section 4.4.3.

Table 8 – Risk Analytic Results under Maximum Borrowing Limitation (Cont'd)

Panel (A) Sharpe Ratio

Maximum Borrowing	(1) DCA	(2) SAA	(3) VA	(4) VA-ICC
0%	0.1186	0.1264	0.1325	0.1390
50%	0.1186	0.1264	0.1326	0.1411
100%	0.1186	0.1264	0.1328	0.1410
150%	0.1186	0.1264	0.1328	0.1399
200%	0.1186	0.1264	0.1326	0.1395
250%	0.1186	0.1264	0.1324	0.1394
300%	0.1186	0.1264	0.1319	0.1394
350%	0.1186	0.1264	0.1314	0.1392
400%	0.1186	0.1264	0.1309	0.1390
450%	0.1186	0.1264	0.1318	0.1389
500%	0.1186	0.1264	0.1325	0.1387
550%	0.1186	0.1264	0.1332	0.1384
600%	0.1186	0.1264	0.1337	0.1382
650%	0.1186	0.1264	0.1342	0.1379
700%	0.1186	0.1264	0.1346	0.1376
750%	0.1186	0.1264	0.1350	0.1373
800%	0.1186	0.1264	0.1353	0.1371
850%	0.1186	0.1264	0.1356	0.1377
900%	0.1186	0.1264	0.1358	0.1383
950%	0.1186	0.1264	0.1360	0.1387
1000%	0.1186	0.1264	0.1361	0.1391
No Cap	0.1186	0.1264	0.1284	0.1296

Table 8 – Risk Analytic Results under Maximum Borrowing Limitation (Cont'd)

Panel (B) Maximum Drawdown

Maximum Borrowing	(1) DCA	(2) SAA	(3) VA	(4) VA-ICC
0%	-45.87%	-35.27%	-27.89%	-26.23%
50%	-45.87%	-35.27%	-29.18%	-27.01%
100%	-45.87%	-35.27%	-30.51%	-28.02%
150%	-45.87%	-35.27%	-31.84%	-29.12%
200%	-45.87%	-35.27%	-33.16%	-30.22%
250%	-45.87%	-35.27%	-34.47%	-31.30%
300%	-45.87%	-35.27%	-35.79%	-32.39%
350%	-45.87%	-35.27%	-37.08%	-33.47%
400%	-45.87%	-35.27%	-38.32%	-34.53%
450%	-45.87%	-35.27%	-38.10%	-35.58%
500%	-45.87%	-35.27%	-37.94%	-36.62%
550%	-45.87%	-35.27%	-37.82%	-37.66%
600%	-45.87%	-35.27%	-37.73%	-38.69%
650%	-45.87%	-35.27%	-37.66%	-39.71%
700%	-45.87%	-35.27%	-37.60%	-40.71%
750%	-45.87%	-35.27%	-37.57%	-41.66%
800%	-45.87%	-35.27%	-37.55%	-42.40%
850%	-45.87%	-35.27%	-37.54%	-42.25%
900%	-45.87%	-35.27%	-37.55%	-42.12%
950%	-45.87%	-35.27%	-37.56%	-42.03%
1000%	-45.87%	-35.27%	-37.60%	-41.94%
No Cap	-45.87%	-35.27%	-48.82%	-62.68%

Table 9 – Sensitivity Test for Portfolio Horizons

This table provides the average IRRs of different time horizons under different strategies. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The best average IRR for holding a portfolio under a certain model is shaded. Analysis of the table and results is in Section 4.5.1.

Horizon (Portfolio #)	(1) **DCA**	(2) **SAA**	(3) **VA**	(4) **VA-ICC**
1 Year (n=433)	0.731%	0.727%	0.693%	0.696%
2 Years (n=421)	0.739%	0.735%	0.729%	0.735%
5 Years (n=385)	0.736%	0.731%	0.778%	0.794%
10 Years (n=324)	0.732%	0.721%	0.802%	0.839%
Full Sample (n=1)	0.714%	0.659%	0.716%	0.867%

Figure 5 – IRR Curves of Different Market Timings and Portfolio Horizons

All 16 figures in the 4 panels are of the same scale to compare the fluctuation of IRR curves. Panels (A), (B), (C), and (D) present portfolio horizons of 1, 2, 5, and 10 years, respectively. DCA, SAA, VA, and VA-ICC are plotted on the dashed line, dashed/dotted line, dotted line, and solid line, respectively. NBER recession periods are shaded. Analysis of the table and results is in Section 4.5.1.

Panel (A) – 1 Year Portfolio Horizon

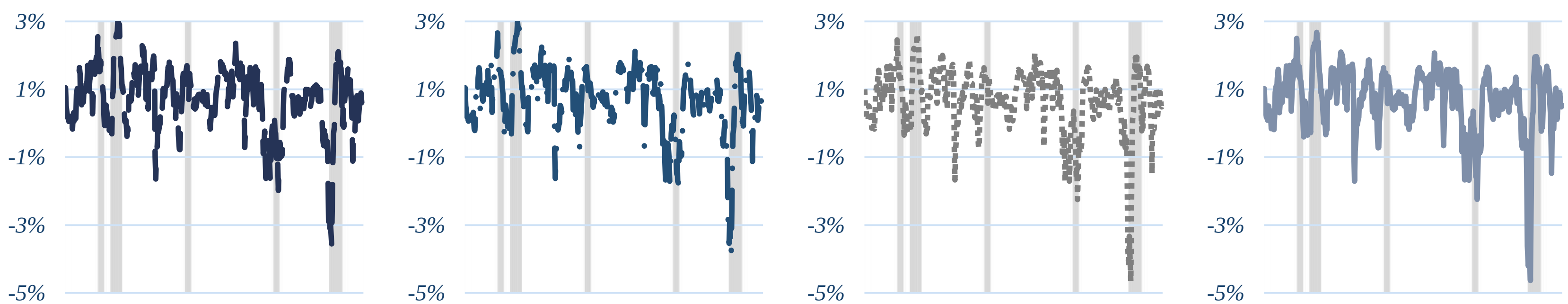


Figure 5 – IRR Curves of Different Market Timings and Portfolio Horizons (Cont'd)

Panel (B) – 2 Year Portfolio Horizon

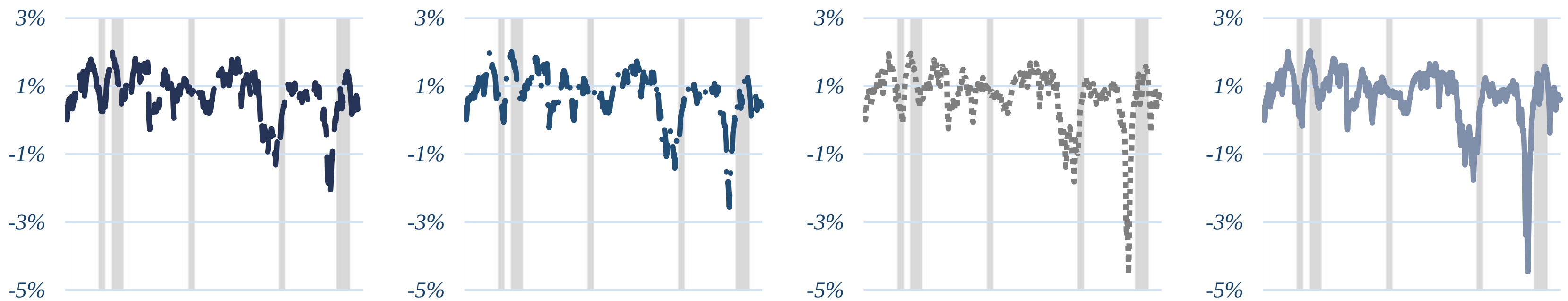


Figure 5 – IRR Curves of Different Market Timings and Portfolio Horizons (Cont'd)

Panel (C) – 5 Year Portfolio Horizon

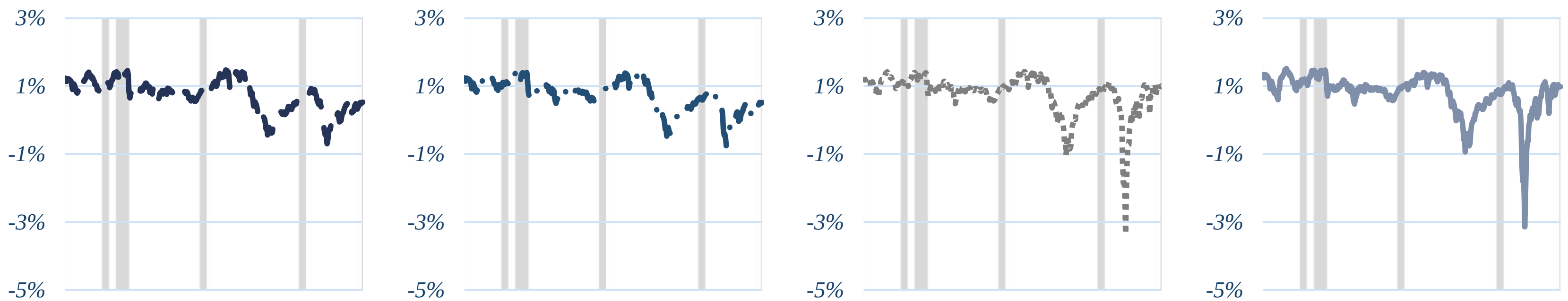


Figure 5 – IRR Curves of Different Market Timings and Portfolio Horizons (Cont'd)

Panel (D) – 10 Year Portfolio Horizon

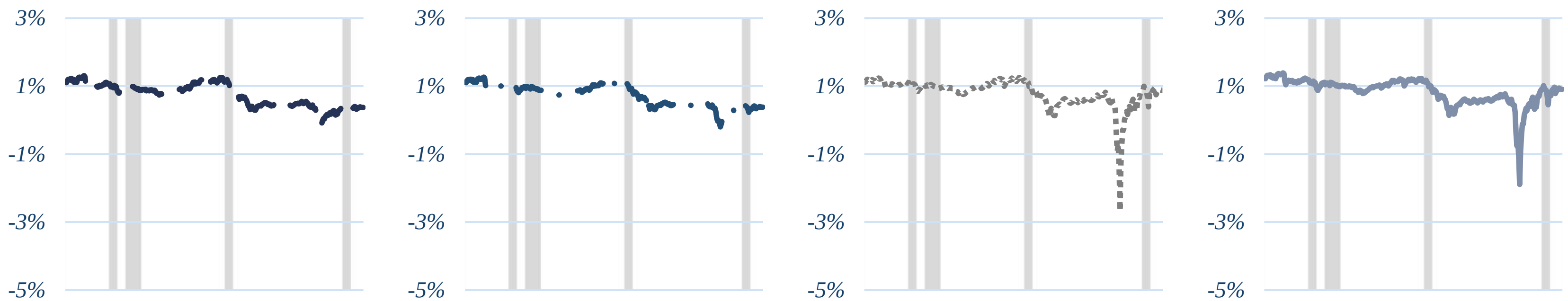


Table 10 – Average Ending Stock-Money Ratio

This table provides the average stock-money ratios of ending balances for different time horizons under different strategies. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. Analysis of the table and results is in Section 4.5.2.

	(1)	(2)	(3)	(4)
Horizon (Portfolio #)	**DCA**	**SAA**	**VA**	**VA-ICC**
1 Year (n=433)	1.56	1.51	1.55	1.57
2 Years (n=421)	1.61	1.51	3.09	3.22
5 Years (n=385)	1.78	1.51	34.27	11.23
10 Years (n=324)	2.17	1.51	(6.01)	5.47
Full Sample (n=1)	6.74	1.52	7.16	28.74

Table 11 – Out-of-Sample IRR Comparison of Different Asset Allocation Strategies

This table provides the IRR of the in- and out-of-sample models of the four portfolio allocation strategies tested in this paper. Models (1), (2), (3), and (4) are Dollar Cost Averaging (DCA), Strategic Asset Allocation (SAA), Value Averaging (VA), and Value Averaging incorporated with Aggregate Implied Cost of Capital (VA-ICC), respectively. The portfolio horizon of in-sample results is 37 years from January 1976 to December 2012. The portfolio horizon of out-of-sample results is 15 years from January 1998 to December 2012. Analysis of the table is in Section 5.3.1.

	(1)	(2)	(3)	(4)
Horizon	**DCA**	**SAA**	**VA**	**VA-ICC**
Jan. 1998 - Dec. 2012	0.323%	0.339%	0.692%	0.692%
Jan. 1976 - Dec. 2012	0.714%	0.659%	0.716%	0.867%

Table 12 – Out-of-Sample Test

This table summarizes the out-of-sample analysis of forecasting models using different forecasting variables for the predicting period from January 1998 to December 2012. In Models (6), (7), (8), and (9), ICC, Ldy, P/E, and CAPE are used as forecasting variables for predicting market returns, respectively. The out-of-sample R-square is the mean squared prediction error (MSPE). Utility Gain is the portfolio management fee that an investor with mean-variance preferences and a risk aversion coefficient of three would be willing to pay to have access to a forecasting model using a particular forecasting variable relative to the historical average benchmark forecasting model. Stock Weight is the percentage of stock market value in the portfolio at the end of the investment horizon. An explanation of this analysis is in Section 5.3.2.

	Forecasting Variables	**Out-of-Sample R-Square** (R_{OS}^2)	**Utility Gain** (U_{Gain})	**Stock Weight** $(\omega_{2,t})$
(6)	**ICC**	-0.04	0.98	101.12%
(7)	**Ldy**	-0.23	0.97	99.66%
(8)	**P/E**	-0.76	-0.36	120.05%
(9)	**CAPE**	-1.16	-0.16	119.89%

Table 13 – Out-of-Sample Comparison under Different Asset Weights

Table 13 provides IRR comparisons of different asset class weights in Strategic Asset Allocation strategies (SAA). Model (2) is the SAA under the "60-40" rule, as in Section 5.3.1. In Model (5) of Historical Average Forecasting, stock class weight is determined by $\omega_{1,t}$ in Section 5.2. In Model (6a) to Model (9a), stock class weight is determined by $\omega_{2,t}$ in Section 5.2, by using forecasting variables of ICC, Ldy, P/E, and CAPE, respectively.

Strategy	(2) SAA	(5) Hist. Avg	(6a) ICC	(7a) Ldy	(8a) P/E	(9a) CAPE
IRR	0.339%	0.445%	0.215%	0.202%	0.173%	0.200%
Stock/Money	1.52	(3.04)	(24.76)	7.43	18.97	17.71
Sharpe Ratio	0.068	0.064	0.038	0.032	0.029	0.033
Maximum Drawdown	-35.27%	-69.60%	-65.32%	-61.93%	-64.33%	-64.67%

Table 14 – Out-of-Sample Comparison of VA Portfolio Incorporating Different Market Predictors

Table 14 provides IRR comparisons of different expected returns of value path in Value Averaging strategies (VA). Model (3) is the pure VA strategy, as in Section 5.3.1. In Model (4), of VA-ICC, expected returns are replaced by aggregate ICC for each month, as in Model (4) in Section 5.3.1. In Models (6b) to (9b), expected returns of value paths are determined by $\hat{r}_{i,m+t}$ in Section 5.1, by using forecasting variables of ICC, Ldy, P/E, and CAPE, respectively.

Strategy	(3) **VA**	(4) **VA-ICC**	(6b) **ICC**	(7b) **Ldy**	(8b) **P/E**	(9b) **CAPE**
IRR	0.692%	0.692%	0.527%	0.532%	0.525%	0.546%
Stock/Money	(3.43)	(5.59)	(5.58)	(11.16)	(6.57)	(7.56)
Sharpe Ratio	0.085	0.089	0.073	0.076	0.073	0.075
Maximum Drawdown	-75.43%	-69.47%	-66.30%	-60.62%	-62.83%	-63.86%