A Strategy of Dollar-Cost-Averaging, Indexing and Dynamic Asset Allocation: How Well Does It Serve the Average US Family?

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Abstract: Modern Portfolio Theory (MPT) and the Efficient Markets Hypothesis (EMH) have dominated discussions of investment management strategy for decades, but little mention has been made as to how they have served the average US family in its financial planning for retirement. Previous studies using Canadian data have shown that a strategy based on passive investing, dollar-cost-averaging, and dynamic asset allocation over a forty-year period could allow an average family to build a portfolio that would serve to meet their retirement needs at age 65. This study attempts to answer the same question for the average US family. Does a strategy based on MPT, EMH, and generally accepted rules of financial planning lead to the family having sufficient resources to retire comfortably? To determine this, a model was devised to follow the median US family from 1991 to 2020. In this 30-year period the family is deemed to have invested 10% of their pre-tax income into broad based equity and fixed income indexes. Contributions were made through monthly dollar-cost-averaging, and dynamic asset allocation was practiced when one asset became overweight. The model was also run for investments of 15% and 20% of pre-tax income. From 2020 on, the model was extended to 2030 using the average annual return of the equity and fixed income indexes over the previous 30 years. Annual income changed in this extended 10-year period consistent with the average increases experienced by the family in the 30-year period. The success of the strategy was measured by its ability to provide enough resources at age 65 to provide 70% of the family's pre-retirement income after retirement, when invested at 5%. Considerations were given for both drawing on principal and not drawing on principal to meet the required income. The strategy was deemed to be successful in varying degrees for each of the 10%, 15% and 20% contribution scenarios, when Social Security benefits available to the family at age 65 were considered.

1. Introduction

In 2019 this author examined the outcome of an average Canadian family which had invested from 1977 to 2016 with a strategy based on Modern Portfolio Theory and the Efficient Markets Hypothesis (Fischer, 2019). Impetus for the study considered that by 2016 MPT and EMH had influenced portfolio managers for a generation and that it was time to determine whether investors who had been subject to the strategies that evolved from these theories had been well served. It was particularly pertinent to examine this question given the scrutiny EMH had come under following the Global Financial Crisis that began in 2007. The study developed a model involving dollar-cost-averaging into broad-based Canadian stock and bond indexes. The paper concluded that the average Canadian family following the strategy was well served. The evidence for this was their ability to amass sufficient wealth in the forty-year time frame to provide for a comfortable retirement. A comfortable retirement was deemed as being able to receive an amount equal to 70% of their pre-retirement income after retiring, based on the ability to earn 5% on the portfolio after-retirement.

This paper attempts to replicate much of the earlier study using data for an average US family. It asks the question, was the average US family well-served if it followed an investment strategy based on the principles of MPT and EMH and generally accepted rules-of-thumb in financial planning? The criterion for having been well-served was the ability of the strategy to grow a portfolio with a net value that allows for a comfortable retirement by age 65.

2. Materials and Methods

Markowitz challenged traditional investment strategy with his seminal paper in 1952 (Boyle, Garlappi, Uppal, & Wang, 2012). Seeing the need for diversity among and within asset classes, Markowitz's MPT advocated spreading investment risk among a diverse array of choices whose market performance would not be correlated (Markowitz, 1952). By building a portfolio of assets that were not perfectly positively correlated, investors could mitigate the risk of having the entire portfolio be subject to significant losses at one time. Risk and volatility, as measured by standard deviation, could be smoothed out for a diverse basket of holdings in the long-term, although the individual holdings in the portfolio might be more individually volatile.

While MPT established the rationale for diversity, EMH argued that markets were efficient in that security prices adjusted quickly as players in the market acted in response to new information (Fama, 1970). Strong believers in the EMH suggested that all investors have access to all information that is disseminated. That being the case, no individual has an advantage over any other in selecting severities that may obtain abnormal returns, including professionals. Based on this conclusion, belief in the EMH leads one to abandon the inherent stock picking of active investment management and invest in the diverse market itself through a broad-based index, where most investors will be better served over time (Buffett, 1991).

This study follows an average US family over a 30-year time frame from January 1990 to January 2020. Their investment strategy was informed by MPT and EMH and followed generally accepted rules-of-thumb in financial planning. In specific:

a. The family practiced dollar-cost-averaging (DCA), investing a specific amount (10%) of their pre-tax income into their investments on the first trading day of the month. This was done without fail, regardless of market conditions at any one point in time.

b. A passive rather than active investment strategy is followed. Broad-based equity and fixed-income indexes serve as the vehicles of choice.
c. The assets were divided between equity and fixed income based on the age of the oldest member of the household. The equity percentage was based on the formula 100 – AGE. For example, at the age of 25 when the portfolio was started, 75% of the portfolio would be invested in the equity index, and the other 25% in the fixed-income index. This would be adjusted each year. At age 26, 74% would be allocated to equity, and 26% to fixed income.
d. Dynamic asset allocation was also practiced, if one of the assets grew to a portion greater than its recommended weighting by 5% at any one time. In this event, the amount above was sold from the overweight asset and added to the underweight asset to restore the portfolio to its weightings based on age.

Wage data for households was taken from the United States Census Bureau (United States Census Bureau, 2020). The Bureau reported annual wages, broken down by race. Data for "all races" was used. The average household in this study was deemed to have received 1/12 of the annual amount in each month of a given year. This figure was rounded to the nearest dollar. Median as opposed to mean income was used, since average income is skewed higher due to the significantly higher annual incomes of a small portion of the population (Kopestinsky, 2021). The median income is the income in the middle, or the one where half of the families in the sample earned below that level (Social Security Administration, 2021). The Bureau grouped its data by the following age brackets: 15 years and older, 15-24 years, 25-34 years, 35-44 years, 45-54 years, and 55-64 years. The oldest member of the household is used by the Bureau in determining these groupings. The oldest member of the subject household in this study was deemed to turn 25 on January 1, 1990. Data from the relevant groupings was used and followed the household through to 2019. The oldest member would have turned 55 on January 1, 2020. At the time of writing, median income data was not available for 2020, so the income for 2019 was used again for that year.

For the equity portion of the portfolio, money was deemed to be invested in the S&P 500 index. The index is calculated by S&P Dow Jones Indices and has been in existence since 1957. It is calculated in the following three versions (S&P Dow Jones Indices, 2021):

- the Price Return (PR) version does not adjust for cash dividends;
- the Gross Total Return (GTR) version reinvests cash dividends without consideration for withholding taxes;
- the Net Total Return (NTR) version reinvests dividends after deducting applicable withholding taxes.

In this study the Gross Total Return version is used. This reflects assumptions that the investor would reinvest any distributions received back into the fund, and that the fund would be held in a 401(K) or an IRA account and therefore not subject to tax on an annual basis.

The investor was deemed to have bought the index at the opening price on the first trading day of the month. The opening price was determined with data from Bloomberg for the S&P 500 Total Return (TR) Index ((Bloomberg L.P., 2021)

For the fixed-income portion of the portfolio, the family is deemed to have invested in the Bloomberg Barclays US Aggregate (AGG) Total Return Unhedged USD Bond Index. This is a broad-based flagship

benchmark that measures the investment grade, US dollar-denominated, fixed-rate taxable bond market. The index includes Treasuries, government-related and corporate securities, mortgage-backed securities, asset-backed securities, and commercial mortgage-backed securities. Its inception was January 1, 1976 (Bloomberg L.P., 2021). Investments were made on the first trading day of the month, and the fund was deemed to have been obtained at the closing price for the day, as recorded by Bloomberg for the index. This index is reported on a total return basis, hence all distributions such as coupon payments are deemed to be reinvested in the fund. Like the equity portion, it is assumed the investment was held in an IRA or 401(K) account and therefore not subject to annual taxation.

These two indexes were chosen for their broad representation of their respective asset classes. While index funds have existed since 1976, total return funds, those that consider the reinvestment of distributions, were not in existence in 1990. For this reason, to consider the management expense ratio (MER) that would normally be taken from an index fund, the study subtracts from the portfolio an MER of .50% annually, taken quarterly.

This model portfolio was compared to six other variations of this strategy.

Portfolio 1 (the model portfolio) invested 10% of pre-tax income, practicing DCA monthly into both the S&P 500 TR index and the US AGG Bond Index, practicing dynamic asset allocation when one asset was overweight by 5%.

Portfolio 1B invested 15% of pre-tax income, practicing DCA monthly into both the S&P 500 TR index and the US AGG Bond Index, practicing dynamic asset allocation when one asset was overweight by 5%.

Portfolio 1C invested 20% of pre-tax income, practicing DCA monthly into both the S&P 500 TR index and the US AGG Bond Index, practicing dynamic asset allocation when one asset was overweight by 5%.

Portfolio 2 invested 10% of pre-tax income, practicing DCA monthly into both the S&P 500 TR and the US AGG Bond Index, practicing dynamic asset allocation annually if one asset was overweight by 5%.

Portfolio 3 invested 10% of pre-tax income, practicing DCA monthly into both the S&P 500 TR and the US AGG Bond Index, but practiced no dynamic asset allocation.

Portfolio 4 invested 10% of pre-tax income, practicing DCA monthly into the S&P 500 TR only.

Portfolio 5 invested 10% of pre-tax income, practicing DCA monthly into US AGG Bond Index only.

3. Results

Table 1 summarizes the results of following the investment strategy in the model portfolio from 1990-2019 and compares it to the other variations.

The model portfolio, as well as 1B and 1C, had an average annualized return of 9.79%. This performance was beaten marginally by Portfolio 2, which returned 9.94%, and practiced dynamic asset allocation annually on the first trading day of the year.

It was also beaten by Portfolio 3, which returned 10.44%, and did not practice dynamic asset allocation.

Portfolio 4, the all-equity portfolio, outperformed all others with a return of 11.37%.

During the 30-year period Portfolio 1 (and 1B and 1C) practiced dynamic asset allocation a total of 17 times. Table 2 lists these dates and the asset which was overweight in each instance.

The incidents of rebalancing portray the bull and bear markets of the 30-year period of the study. Over weightings of equity were rebalanced five times from April 1995 to January 2000, shortly before the bursting of the dot.com market bubble. This was followed by two instances of overweighting in fixed income in 2001 and 2002 as the equity markets continued to correct. Fixed income overweighting in October and December of 2008 account for the Global Financial Crisis and the bear market in equities which ensured. Overweighting in equities was rebalanced seven times from December 2009 to December 2019, marking the long-running bull market of that period.

Portfolio 3, which rebalanced the portfolio only if an asset was overweight at the end of the year, did so 13 times.

Rebalancing the portfolio through dynamic asset allocation did not appear to make a significant effect on the portfolio's overall growth, whether practiced immediately or annually.

4. Discussion

To determine if the model portfolio adequately served the average family, the benchmark to be met would be for the portfolio to provide for the family in retirement. Generally accepted rules of thumb in financial planning call for retirement income to be 70% to 80% of pre-retirement income to maintain a similar lifestyle. If the family had no employer pension and were dependent entirely on the proceeds of this portfolio for retirement income, they would not be able to retire at age 55. Assuming the portfolio could be invested at 5% with no further contributions, this would yield $23,580 annually, far short of the $64,554 desired (70% of $92,221). This assumes the principal is not drawn down. If a combination of returns and principal were used to pay the family the desired $64,554 annually, the principal would be depleted in 9.32 years when the family was 65. Had the family saved 15% of their pre-tax income, as in Portfolio 1B, their $707,403 would yield $35,370 if invested at 5%, still far short of the desired amount if not drawing from the principal. If both principal and return were used to pay the annual desired amount in retirement, the portfolio would be depleted in 16.27 years, when the family was 71. If the family invested 20% of their pre-tax income, as in Portfolio 1C, their $943,204 would yield $47,160, still short of the desired 70% of pre-retirement income, without touching the principal. If both principal and return were used to pay the annual desired amount, the portfolio would last 26.88 years, when the family was almost 83. While this last scenario is a more desirable one, it still leaves open the possibility of outliving one's savings if the couple live beyond 83. Again, all these scenarios assume that the family, at age 55, would not receive any company pension or social security at this time.

Over the 30-year period the family average annual income increased by an average of 3.88%. This reflects both cost-of-living increases as well as the possibility of promotion and seniority gained in the workplace. If the income continued to increase at this level, and the portfolio strategy is extended another 10 years until January 2030, when the family will turn 65, the model portfolio would have a value of $1,144,820 if 10% of pre-tax income continued to be invested each year. This also assumes the S&P 500 TR

equity index has an expected return of 11.31% consistent with its previous 30-year average, and the Bloomberg Barclays AGG Bond TR index has an expected return of 6.02%, consistent with its previous 30-year average up to January 2020. Invested at 5% in 2030, the portfolio would provide an annual retirement income of $57,241, without touching the principal. This only represents 44% of the $129,955 the family would be earning in 2029, their last year of employment. Drawing on principal to meet the desired income of $90,969, or 70% of pre-retirement income, the portfolio would last 20.33 years, with zero remaining when the family would then be 85.

If the family saved 15% of pre-tax income for 40 years in this extended scenario, the portfolio would be valued at $1,717,230 at retirement. Invested at 5%, this provides an income of $85,861 annually, or 66% of pre-retirement income. Again, this considers no other income from social security or other sources. With regular social security benefits that accrue at the age of 65, the average family would meet its threshold of 70% of pre-retirement income at this point, without touching the principal. If they opted to meet their 70% goal, receiving $90,968 annually in retirement, without other benefits and by drawing on the principal, their portfolio would be depleted in 59 years.

A family saving 20% of pre-tax income in the extended scenario would have a portfolio of $2,289,639 at retirement. Invested at 5%, this would provide an annual income of $114,482 or 88% of pre-retirement income, without touching the principal. Earning 5%, the family could afford to pay themselves an annual salary of $129,995, equal to what they earned pre-retirement, and deplete their retirement savings in 43.57 years.

The retirement scenarios are depicted in Table 3.

The average Social Security retirement benefit in June 2020 was $1,514 monthly, or $18,170 annually (Center on Budget and Policy Priorities, 2021). At age 65, the average family would be able to complement their investment income with Social Security benefits. The family which had saved 15% of their pre-tax income throughout their working careers would easily make up the shortfall of $5,108. If two members of the household are receiving benefits, they may be able to make up the shortfall if they had only invested 10% during their working careers.

5. Conclusions

This study examined the ability of a portfolio that followed specific tenets of MPH, EMH, and generally accepted principles of financial planning to meet the financial goals of a family making the median income for their age throughout the period 1991-2020. These included a passive investment strategy of indexing, annually adjusting the mix of equities and fixed income to reflect increasing age and rebalancing the portfolio through dynamic asset allocation. The goal was defined as building a portfolio that could provide, in retirement, 70% of pre-retirement income if invested after retirement with an expected return of 5%. The family would not have met this goal by age 55, whether they had invested 10%, 15%, or 20% of their pre-tax income through dollar-cost-averaging, without being able to access other income resources at that time. Had the family continued to earn income at the median level for another ten years, to age 65, they would meet the retirement goal if investing 15% or 20% of their pre-tax income for 40 years. They would quite likely meet their goal at the 10% investing as well, given their qualification for Social Security at that time, and the ability to draw down from the principal of their portfolio. These findings are consistent with those of the study which followed a typical Canadian family for a 40-year period (Fischer, 2019), using Canadian data, and inspired this study.

The study followed the median-income family for 30 years, then forecasted for another 10 years. In focusing on an average family, the study gave no consideration for variables that affect most families to some degree. These include the possibilities of career changes, single-parenting, geographic location, and innumerable other demographic variables. The actual experience for a US family can differ from state-to-state based on the wide disparity of income tax rates among jurisdictions, as well as the cyclical nature of local economies, and the adjustments made by technological revolution which affect some industry groups more than others. Also, the study focused only on financial investments in the equity and fixed income markets. It did not consider real estate investments, such as the family home, as part of the family's overall investment strategy. For example, the family may have owned a home during the 40-year period and, selling it to downsize in retirement, used the gains made from their sale over the price paid for their new home to enhance their retirement portfolio. In short, while the study shows the feasibility of reaching one's retirement goals using the strategies described in a general sense, each individual family's own financial planning must reflect its own circumstances.

Table 1. Model portfolio returns 1990-2019 for an average US family

Portfolio	Style	Amount Invested	Portfolio Value January 1 2020	Annualized Return
1	10% of pre-tax income split between equity and fixed income, based on age, dynamic asset allocation when 5% overweight	167,147	471,601	9.79%
1B	15% of pre-tax income split between equity and fixed income, based on age, dynamic asset allocation when 5% overweight	250,720	707,402	9.79%
1C	20% of pre-tax income split between equity and fixed income, based on age, no dynamic asset allocation when 5% overweight	334,294	943,203	9.79%
2	10% of pre-tax income split between equity and fixed income, based on age, annual dynamic asset allocation when 5% overweight	167,147	482,543	9.94%
3	10% of pre-tax income split between equity and fixed income, based on age, no dynamic asset allocation	167,147	527,571	10.44%
4	10% of pre-tax income into equity only	167,147	644,282	11.37%
5	10% of pre-tax income into fixed income only	167,147	300,798	6.02%

Table 2. Model portfolio incidents of rebalancing to correct 5% overweighting

Date	Overweight Asset
April 1995	equity
June 1996	equity
July 1997	equity
January 1991	equity
January 2000	equity
March 2001	fixed income
July 2002	fixed income
February 2007	equity
October 2008	fixed income
December 2008	fixed income
December 2009	equity
February 2011	equity
April 2013	equity
January 2014	equity
December 2016	equity
December2017	equity
December 2019	equity

Table 3. Retirement Scenarios

Percentage of pre-tax income invested from 1991-2020	Portfolio value at end of 30-year period	Return generated from portfolio in retirement when invested at 5%	Shortfall between return and desired income (65,554) if principal not used	Years to depletion if principal used to make up shortfall	Age at depletion
10%	471,602	23,580	41,974	9.32	65
15%	707,403	35,370	30,184	16.27	71
20%	943,204	47,160	18,394	26.88	83
Percentage of pre-tax income invested with extension to 2030	**Portfolio value at end of 40-year period**	**Return generated from portfolio in retirement when invested at 5%**	**Shortfall between return and desired income (90,969) if principal not used**	**Years to depletion if principal used to make up shortfall**	**Age at depletion**
10%	1,144,820	57,241	33,728	20.33	85
15%	1,717,230	85,861	5,108	59	124
20%	2,289,639	114,482	No shortfall	No shortfall	No shortfall

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