
SHORT PAPER: ROBO-ADVISOR METHODOLOGIES

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ABSTRACT

The takeover of robo advisors in the classic field of investment management is an emerging trend across the industry. Today, most robo-advisors are built on the fundamental principles of the modern portfolio theory, with the objective in obtaining the optimal portfolio that provides the highest expected returns given the risk. Although robo-advisors are already widely known, the inner workings of each robo-advisor remains obscured. This paper will provide a deep insight in the methodologies behind the three major robo-advisors in the market, namely, Betterment, Schwab Intelligent Portfolio and Wealthfront, and will compare and contrast the robo-advisors through three factors, that is, asset allocation, portfolio rebalancing and monitoring.

1 Introduction

Robo-advisors have intertwined the theories of investment with modern technology. The origins can be traced back to the works of Markowitz which forms the fundamental design of most robo-advisors. In the late 2000s, companies such as Betterment and Wealthfront, which pioneered the robo-advisors, became one of the strongest advocates of the modern portfolio theory. The theory was used to construct an optimal portfolio based on the investor's risk preference, combined with the passive investing strategies influenced by the efficient market hypothesis philosophy. By the end of year 2020, there are over 200 robo-advisors in the global market, each distinct by different features, optimization models and management tools. In the later sections of this paper, the author will unravel the methodologies behind three major robo-advisors in the market, namely, Betterment, Schwab Intelligent Portfolio and Wealthfront, providing a unique insight of the characteristics, the similarities and differences between them.

2 Methodologies

2.1 Asset allocation: Alignment of Investor's Profile and Portfolio

Before asset allocation can be executed, Robo-Advisors typically carries out an evaluation of their investor's profile in order to align them with their investment goals, and to determine the most optimal portfolio. The approach to acquire information about their clients are similar across Betterment, Charles Schwab and Wealthfront. For example, a list of questions are provided to the client and based on the client's responses, they will verify the consistency in his/her responses and also assess the individual's risk tolerance. After the assessment is completed, a risk profile will then be matched to each investor through an algorithm. Each profile has a different set of asset allocation. For example, in Schwab Intelligent Portfolios, the 'conservative' risk profile has approximately 20% equities allocated to it, with the remaining in cash investments and fixed income assets. In comparison, the 'aggressive' risk profile comprises of 95% equities and 5% in cash investments.[1] Although the concept to match each client to a profile is similar, the categorization of profiles is unique to each Robo-Advisor.

Betterment provides 5 types of investing goals to their clients, namely, retirement, retirement income, safety net, general investing, and major purchase. Once the client has selected a goal, Betterment will recommend a portfolio, a level of risk, and the savings strategy in order to achieve that goal. For each type of goal, Betterment provides a customized stock-to-bond allocation recommendation, which is designed to automatically adjust to help clients reach their targeted goals without taking on unnecessary risk. For example, a maximum and minimum stock allocation would

be recommended, based on the investor's term, while making certain cash-out assumptions. [2]

Schwab Intelligent Portfolio evaluates their clients' capacity to bear risk and also the willingness to take risk before automatically assigning them into one of the 6 different risk profiles such as 'conservative', 'moderate' and others. Based on the risk profile, a portfolio comprising of a potential combination of stocks, fixed income, commodities and cash would then be recommended to the investor. These portfolios will have different risk and return characteristics depending on the composition of assets within it. [1]

Wealthfront provides a total of 20 different risk profiles, with each risk score having a different target asset allocation comprised of U.S. stocks, foreign developed market stocks, emerging market stocks, dividend growth stocks, corporate bonds, treasury inflation-protected securities, U.S. government bonds, municipal bonds, and other asset classes. The risk score constitutes the subjective and objective risk tolerance with a heavier weighting to whichever component is more risk averse. After computing the risk score, an optimal portfolio will then be recommended to the user. While Wealthfront and Charles Schwab share similar approaches to risks and asset allocation, the prior takes into consideration of the individual's lack of self-awareness when stating his/her true risk tolerance.[3]

2.2 Asset Allocation: Models

Betterment, Schwab Intelligent Portfolio and Wealthfront shares some similarities and differences in their approach (models) to optimize their investors' portfolio assets. One approach that is common to all is the use of the mean-variance optimization model to solve the efficient frontier of portfolios with maximum expected return for each risk level. However, the mean-variance optimization model is limited due to its inability to capture additional information such as the investors' loss aversion. Consequently, this led to Betterment and Charles Schwab to incorporate other models to complement the existing mean-variance optimization model such as the downside risk optimization model (Betterment) and the full-scale optimization model (Charles Schwab). On the other hand, Wealthfront uses the mean-variance optimization model singularly without the complementary of other models.[3]

The downside risk optimization model deployed by Betterment is used to compute the efficient frontier's expected outcomes in the worst cast scenarios.[4] This is achieved through the downside risk optimization model which generates several scenarios and evaluates the portfolios' returns in each scenario accordingly. In addition, the model is also used to analyze the severity and the duration of the drawdown for each portfolio during a bearish market condition. In contrast, Schwab Intelligent Portfolios utilizes the full-scale optimization model which determines the optimal weights for the allocated assets by first, computing the portfolio's utility at each iteration and second, summing the utility score across all periods to yield the total expected utility.[5] One advantage of the full-scale optimization model is the integration of a complex utility function that is formulated to capture the investor's preference, usually represented in higher moments (i.e. skewness and kurtosis).

Apart from optimizing the portfolio, some robo-advisory companies also provides the forward-looking estimates of the expected asset class returns. The exception is Schwab Intelligent Portfolio which does not disclose the model used for the forward-looking estimates. The only information available was that Schwab Intelligent Portfolio focuses on historical performance because forecasting financial markets is perceived to be impossible. In contrast, Betterment and Wealthfront uses the Black-Litterman model to generate these estimates, while factoring in information gathered from investors around globe. From a Bayesian perspective, the Black-Litterman model assumes the implied returns as the prior distribution and uses the personal views of investors to alter it. The output of the Black-Litterman model is a diversified portfolio that is optimized and simultaneously mitigates the effects of 'home-bias' investing. In conjunction to the Black-Littleman model, other models such as the Fama-French three-factor model (Betterman), the Gordon growth model (Weathfront) and the Capital Asset Pricing Model (Wealthfront) were also utilized.

The Fama-French three-factor model is used to measure the premium value a fund is capturing, the market sensitivity and the size. For example, a value exposure of 100% indicates that the full return premium captured by the fund is associated with that factor, while a value exposure of 0% means that the fund's performance is independent to that factor and is not exposed to the returns or risks associated with it. The capital asset pricing model is used to calculate an asset's expected return versus its systematic risk. The model is based on the principle that investing in high risk investments should yield higher returns. The Gordon growth model compares the market price of an asset against its predicted value, with the condition that the dividend's growth rate is constant. The difference between the market price and the predicted value gives an indication of whether the stock is over or under valued. Wealthfront's approach is to first use the capital asset pricing model to compute the base estimates, which is then adjusted accordingly using the Black-Litterman model and the Gordon Growth model.

2.3 Portfolio Rebalancing & Monitoring

Robo-advisors have an edge over traditional advisors because of two factors, namely, continuous monitoring and efficient rebalancing, all done through an automated system. The need for rebalancing is directed towards the passive management of assets, where from time to time, some assets which are higher or lower in proportions in the portfolio have to be readjusted. The process of rebalancing helps the investor to benefit from short term capital gains and also in search for opportunities to reinvest in assets that are undervalued. In order to ensure that rebalancing occurs in a timely and effective manner, all three robo-advisors monitors the portfolio on a daily basis. There are some conditions that trigger a rebalance, 1) Sell/Buy rebalancing when the price of one or more asset deviates beyond the threshold price, 2) Cash flow rebalancing when deposited cash or dividends is used to invest in undervalued or under-represented assets, and 3) Investor's amendment to the his/her preferences such as goals and risk resulting in the reallocation of the assets in the portfolio.[6]

While the concept of portfolio rebalancing is common to Betterment, Wealthfront and Schwab Intelligent portfolio, the difference lies in the drift threshold and the time delay before the rebalancing occurs. In the case of drift threshold, Betterment, for example, will suggest a rebalancing action when cash flow drift reaches 2%. When the sell/buy drift reaches 3%, the rebalancing action is automatically triggered, and when a change in asset allocation occurs, the drift is recalibrated to match the target allocation.[6] In comparison, Wealthfront has a higher drift threshold, for example, between 4% to 6% for tax-deferred accounts and between 6% to 10% for taxable accounts. The rebalancing act is often conducted within one business day, except when the asset allocation is adjusted by the user (immediate recalibration of the drift tolerance).[7] Among the three robo-advisors, Schwab Intelligent portfolio is the most conservative. The drift threshold as a default is set at 2% for all assets except cash and 1% for cash. [8]

The act to rebalance the assets in the portfolio is mirrored with the strategy to mitigate tax and transaction costs. For example, dividends are used to purchase undervalued or under-represented assets, in place of cashing out the appreciated assets to make these purchases. Consequently, this helps the investor avoid tax incurred through capital gains. Moreover, all three robo-advisors also deploys the 'tax-loss harvesting' program that aims to avoid short-term capital gains during a rebalancing event. Due to the different tax treatment where short-term capital gains are taxed at a higher rate compared to long-term capital gains, the rebalancing action does not occur until the time when these assets are converted into long-term assets. [9] [10] [11]

3 Conclusion

Robo-advisors are build on the fundamental principle of modern portfolio theory (MPT), in the effort to obtain the efficient frontier that provides the highest expected returns at a given level of risk. Although this association of MPT to robo-advisors is widely known, the inner workings of each robo-advisor and their differences remains obscured unless analyzed deeply. In due to that, this paper provides a thorough comparison and contrast between the robo-advisors through three factors, namely asset allocation, portfolio rebalancing and monitoring. From the analysis, one thing that remains noticeable among Betterment, Schwab Intelligent Portfolio and Wealthfront is the overlapping similarities in features and optimization models used. However, the differences are also not limiting, and will therefore require potential users to first identify their preferences before getting onboard with a particular robo-advisory service.

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