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Making “Robo-Investing” Work: Key Requirements

Northfield Information Services Commentary

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"There is always a well-known solution for every human problem – neat, plausible and wrong” - H.L. Mencken

As the catch phrase “robo-investing” has gained popularity in the retail end of the financial services industry, the Northfield view has been an uneasy combination of satisfaction, and concern. We started using the terminology “portfolio manufacturing” twelve years ago in 2003. Just three years later in 2006 our website featured animated videos depicting *an assembly line of industrial robots* as an illustration of our MARS wealth management platform. Also in the 2006, the CFA Research Foundation published the book *Investment Management for Private, Taxable Wealth* (authors: diBartolomeo, Horwitz, and Wilcox) that included a chapter devoted to automating the customization of asset allocation, security portfolio composition and trading to the needs of specific individual households.

We feel satisfied because we believe that our conceptual innovations have contributed to the development of “robo-investing” as a legitimate step in evolving improved investment services for retail households. However, we are also concerned that in an effort to make this sort of financial service appealing to consumers, the investment processes that are being marketed under this banner have been oversimplified to the point where the degree of benefit to investors is far, far less than is readily achievable.

More than simply an academic interest, Northfield has more than two decades of commercial experience in the analytical and technological needs of wealth management. In 1995, we created the first portfolio optimizer that was capital gain tax sensitive, which led to materially broader use of quantitative methods in wealth management. Since then our MARS and WealthBalancer systems have been used by dozens of firms to manage the investments of hundreds of thousands of households. Additionally, some specific components (e.g. our AHP computation engine) have formed the analytical core of online systems for asset allocation, and mutual fund selection available to retail investors.

Given the experience of two decades and hundreds of thousands of portfolios, we’ve formulated a listing of the most important capabilities that an automated investment system should have. Each of the keys items described herein has three important attributes in common. First, that there is an obvious benefit by incorporating this particular aspect of the investment process as opposed to ignoring it. Second, that there is a meaningful body of published literature establishing the reasonableness of an existing method to address the issue. Third, we know that *each particular capability needed already exists within the systems already supplied by Northfield for wealth management,* so the marginal cost of including a given capability into an automated financial platform is small.

Making "Robo-Investing" Work: Key Requirements

Herewith is our listing of key requirements for automated investment systems. Please note that the order of presentation does not imply an indication of relative importance:

Time Varying Risk Aversion Tied to Household Financial Circumstances

Proper formation of investment portfolios requires appropriate trade-offs between return and risk. As there is no universal agreement as to the semantics of risk aversion ("conservative", moderate, aggressive), most automated systems do not properly discover investor preferences and more importantly do not discover sufficient information about the household's *ability* to bear risk, as opposed to the *willingness* to bear risk. To address this need, the *Discretionary Wealth Hypothesis* of Wilcox (Journal of Portfolio Management, 2003) has quickly become the industry standard. In essence, the household's ability to bear risk is formulated from a "life balance sheet" where all financial assets and liabilities are included. The present values of future financial events such as accumulation of investment savings, and consumption spending such as college tuition and retirement funding are represented as contingent assets or liabilities. The discount rate to determine such present values may be adjusted to reflect the importance of a consumption goal or the certainty of a future financial gain (e.g. an expected inheritance may be uncertain). As the financial circumstances of the household change over time, the optimal degree of risk aversion changes with it, automatically adjusting the portfolio composition appropriately.

Proper Incorporation of Household "Human Capital"

For many households that are not affluent, the bulk of the financial resources that they will use for major consumption expenditure (e.g. college tuition) and to provide retirement income do not yet exist. These resources will be accumulated in the future through the investment of savings taken from earned income, and from the long term compounding of the returns. While almost every automated investment system provides some provision for estimating the need for future savings by a household (often crudely), most do not consider the subtleties of how aspects of the future savings process should impact investment policy today and through time. A household may not realize any savings if the earning members die, are disabled or lose their employment. While the first two problems can be mitigated with insurance products, the third is more nuanced. Consider an individual who earns their living as a school teacher in the USA has a much higher degree of job security than would another individual who works as a financial analyst on Wall Street. In addition, the probability of losing a job as a financial analyst will be much higher in periods of poor financial market outcomes, while the job security of the typical teacher would be much less dependent on financial markets. Put simply, our teacher has a "low beta" job so the beta of present value of their future stream of savings is low. Our financial analyst has a very "high beta" job. After retirement their situations would be more similar. These differences and their likely progression over time should be incorporated into the investment policy and asset allocation processes. For background see Ibbotson, Chen, Milevsky and Zhu (CFA Publications, 2007).

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Retirement Income Needs

Most automated investment systems purport to address capital accumulation for retirement by giving the household a fixed dollar value target (e.g. 8 times desired annual income) to accumulate by the expected retirement date. This is a deeply flawed process. To the extent that a retail household has taken on their own mortality risk, the post retirement portfolio must provide a *steady stream of spendable income* over an indefinite future period (we don't know how long we will live). Consider the situation of investor who meets their hypothetical goal for portfolio value of eight times the desired annual income by the day before their retirement by holding a portfolio of zero yield growth stocks. If interest rates happen to drop suddenly the following day, it is likely that the household could not form a viable income portfolio, and would have to liquidate part of the portfolio from time to time to cover consumption expenditures. Given the uncertainty of life span, most investors are very uncomfortable with deciding how much of their portfolio they can liquidate without creating the potential for running out of funds before death. Moving to a more income oriented portfolio is a standard practice of most "target date" funds but those blindly rely on the year of retirement to formulate the "glide path" while ignoring the household levels of wealth, liabilities and a host of other factors. Analytical solutions exist for properly defining the "duration" of the retirement consumption liability (like a short position in a bond), which will result in an appropriate glide path more customized to the needs of the individual investor. In essence, the presence of mortality uncertainty requires that we reframe investment risk in terms of the ability to produce lifetime income rather than as volatility in wealth units or return outcomes. Merton (Harvard Business Review, 2014) provides an excellent summary of the issues.

Non-Mortality Life Uncertainty

In considering the long term financial circumstances of a household, there are many other areas of uncertainty beyond mortality risk. In saving for college tuition for our children, we really don't know if our kids will end up at Harvard or the local community college, so the required magnitude of the tuition consumption expenditure is uncertain. Most automated financial platforms assume that all financial goals are known with absolutely certainty both with respect to magnitudes and timing. In general, the greater the uncertainty of the input parameters of financial decisions, the more conservative the investment policies should be. A primary example of a great uncertainty would be the situation of divorce, which impacts more than half of all marriages. The investment policy implications of life uncertainty are well addressed in Wilcox and Fabozzi (Journal of Portfolio Management, 2009) and more specifically about divorce in Scherer (Proceedings of London Quant Group, September 2014).

Integrated Asset Allocation and Asset Location

Many automated investment systems try to address the accumulation of wealth to meet multiple consumption goals as multiple *separate* problems. For example, our college savings fund investment policies are unrelated to how our retirement fund, or other investments are structured. This leads to myopic and often very inefficient combinations. A more relevant distinction is that the financial resources of the household is likely to be split between tax deferred legal structures such as defined contribution retirement plans (e.g. 401K, 403B, IRA or foreign equivalents) and financial accounts that are immediately subject to local and national taxes. To the extent that different financial assets have different tax treatments (e.g. municipal bonds) it is imperative that asset allocation methods provide for asset *location* as well. This is often a subtle issue that involves time horizons, the expected split of returns between income and capital gain, and the need to rebalance the portfolio periodically to whatever is determined to be the optimal state at a point in time. An additional factor is the extent to which individual asset class portfolios are held as simple vehicles (e.g. an ETF) or as individual securities where more sophisticated tax management processes may be employed (e.g. tax loss harvesting). An excellent treatment of this issue appears in the aforementioned diBartolomeo, Horvitz and Wilcox (CFA, 2006).

"Householding"

Another variation on the asset location problem is that of "householding." Many households have human or legal members (husband, wife, children, dependent elderly, trust funds) that may have heterogeneous aspects as investors including different tax circumstances, legacy portfolios and levels of risk aversion. While one might choose to treat each of these entities separately, many households express a desire to have the investment policies and holdings for all members of the household be harmonized across tax circumstances and risk aversion so that the aggregate investment portfolio is optimal for the entire household, as compared to each person's portfolio consisting of what is best for them alone. While some automated investment platforms purport to do crude forms of "householding" these methods rely on the simplifying *but false* premise that the sum of optimal portfolios is an optimal portfolio. Stated differently, the real tension in the problem is that if the aggregate portfolio is optimal for the household does not imply that the individual portfolios will be optimal for the specific member to whom it belongs. Do we give priority to the household over the members or the members over the household, or a blending of the two? Structuring the portfolio to emphasize the household over the members is the more analytically challenging process. A suggested method that operates down to the level of individual tax lots of individual securities was presented in diBartolomeo (Northfield News, May 2005).

Tax Sensitive Portfolio Rebalancing at the Tax Lot Level, Across Asset Classes

Many automated investment systems restrict the set of securities that may be held to simple portfolios of ETFs that represent passive participation in different asset classes. While the benefits and drawbacks of active versus passive investment management are subject to wide debate, there are a couple of key concepts to keep in mind. The first is that ability to engage in tax beneficial transactions arises from the dispersion of returns among the assets of a portfolio. Greater dispersion of gains and losses leads to greater economic benefits which can arise from intelligent offsetting of capital gains and losses. The dispersion of returns can arise in three ways. We can purchase the same asset repeatedly at different times to create dispersion in level of realized capital gain and loss across tax lots. This process takes a considerable period of time to become operational. See Horvitz and Wilcox (Journal of Wealth Management, 2003). Another way to create dispersion is to simply hold lots of individual securities as opposed to traded baskets such as ETFs or mutual funds. The cross-sectional variation of the individual securities will be far greater than the volatility of the related index basket. A good illustration of this is in diBartolomeo (2008, **http://www.northinfo.com/documents/275.pdf).** Finally, we can invest across asset classes either as baskets or (even better from a tax perspective) as individual securities. An excellent paper on tax management of US municipal bonds is Kalotay and Howard (Journal of Portfolio Management, 2014).

Ability to Handle Concentrated Legacy Positions:

Most "robo-investing" systems assume that the investor's entire portfolio is on their system and that the portfolio always starts from cash. Transition of any legacy portfolio positions must be able to be accomplished in a tax-sensitive fashion which rationally balances the desire to move to the new optimal portfolio with the costs and tax implications of doing so over a particular time horizon. Given the large tax effects which may arise from liquidation of concentrated legacy positions, this process must be based on an economic objective function that balances considerations of return, risk, trading costs and taxes over multiple periods. Many automated platforms either rely on simple heuristics to prevent "tax dumb" transactions, or ask investors to specify a "tax limit" at which point any rebalancing process is constrained from any transaction which would create a net realized capital gain. Methods to incorporate taxes into rebalancing objectives is covered in diBartolomeo (2003, Chapter 5 in Advances in Portfolio Construction and Implementation). A "complementarity portfolio" approach to concentrated positions is covered in diBartolomeo, Horvitz and Wilcox (CFA 2006).

Non-Parametric Treatment of Investor Preferences

Traditional approaches to asset allocation (Markowitz, Journal of Finance 1952, 1959) require that all investor preferences be reduced to a balance between two variables, return and risk. Real world investors often have a broad variety of preferences, either described explicitly or arising implicitly from particular aspects of their financial goals. These preferences could take on a myriad of issues from the desire for a socially-responsible investment portfolio to the avoidance of investments expected to do very poorly under the extreme conditions of a global depression. Put simply, the investment policies and implementation should reflect all of the investor's preferences and attributes. Many automated investment platforms offer some kind of multiple- choice questionnaire as the mechanism to elicit information about investor wants and needs. Unfortunately, investor responses to the questions are often evaluated in a completely ad hoc fashion with little analytical rigor. A very well developed non-parametric method for investment allocations is to use the AHP from Saaty (The Analytic Hierarchy Process, 1980). While there is a fairly extensive literature on use of AHP for investment allocation problems, the most directly on point is from two Northfield former associates, Bolster and Warrick (Journal of Wealth Management, 2008).

Protection from Great Anomalies

Many automated systems are based on Monte Carlo simulations that assume that once an investment portfolio is formed, it is always rebalance back to the original allocation. Implicit in such a process is that an asset class or other investment that has fallen in value (and hence portfolio weight) should *always* be bought in order to restore the original allocation. Clearly this would have been a bad policy for investors at the time of the 1929 stock market crash, or when the Russian markets went to zero in 1917 or the shut-down of the Chinese markets in 1949. While such events are rare, they do occur and can have profound impacts on the financial health of households. The aforementioned *Discretionary Wealth Hypothesis* offers a resolution to this problem. As the value of investments within the portfolio falls, the investor becomes "poorer" relative to their liabilities and their ability to bear future risk is diminished, calling for a more risk-averse tradeoff between return opportunities and risk, which may be fully counterbalanced by increases in expected returns. As such, a very wealthy household may have an incentive to buy at the same time. The balance between changes in appropriate risk aversion and changes in expected return will be different for investors with different starting ratios of investment wealth to discretionary wealth. A good discussion of the impact of rare events can be found in Barro (NBER, 2005).