Wireless Investor

An Introduction to Investment Engineering

■ Peter Blakey, Associate Editor

This column is the first in a series on investment engineering. The term investment engineering refers to procedures for accumulating wealth that have a well-defined conceptual framework and employ models and techniques that are quite similar to those used within conventional engineering disciplines. This article establishes an overall context and an underlying conceptual framework. The next article will present a model of price behavior that provides a foundation for understanding a range of topics in investment engineering, including technical analysis, modern portfolio theory, and option valuation. Subsequent articles will review each of these areas in turn. The goal of the series is to present the main concepts, models, and insights of modern finance in a way that is accessible to electrical engineers. The material is intended to be helpful to readers who manage their own investments and to those who are considering doing so.

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The Siren Call of Investing

Among nonfinancial professionals, doctors and engineers have an especially strong bias towards managing their own investments. Each group believes (sometimes correctly) that their domain-specific knowledge will enable them to identify promising investments at an early stage. Doctors tend to assume unconsciously that their power over life and death extends to power over financial markets. They are doomed to disappointment. Engineers tend to believe that their numeracy and analytical skills will provide them with an edge over other market participants. They are also likely to be disappointed, in part because markets are driven more by sentiment than by logic, at least over the short and medium terms.

An overall sanity check is in order. The impact of investment expenses guarantees that more than 50% of financial professionals will fail to match the performance of the market over the long term. Most amateur investors will do significantly worse. This suggests that the best approach for most amateur investors is to pursue a passive

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investing strategy that matches market returns as closely as possible. Such a strategy also has the advantages that it takes little effort and causes little stress. People who try to manage their investments actively can expect to pay a high price in terms of time, effort, relative or absolute financial losses, stress, and psychological discomfort. The costs are only worth paying if the journey itself has value as a source of intellectual challenge and enjoyment.

The Investment Jungle

Many metaphors are used to describe the perils of investing. Dangerous threats lurk in the investment jungle, and it is easy for the unwary to be eaten alive. Those who swim in the investing ocean may be devoured by sharks or drown. Being aware of the dangers is the first step towards long-term survival. Understanding the risks is the second step, and knowing how to mitigate them, and in some cases exploit them, is a third step.

The dangers that investors must face include:

- structural limitations of political systems
- short-term perspectives of politicians
- structural limitations of free markets
- the dishonesty and greed of company executives
- fantasies perpetuated by the financial industry
- salespeople who are disguised as financial advisors
- the self-destructive behavior of individuals.

Many of these issues have been covered in previous columns, but a few comments here may still be helpful. No form of social organization or economic enterprise is ideal. Democracy may be the best form of government ever devised by mankind, but democracies can degenerate. The primary concern of politicians is to be reelected. They buy votes with other peoples' money in either or both of two ways: by taxing one section of the population and using the proceeds to buy the votes of another section or by running deficits that will become taxes on future generations. Many western democracies have entered a downward spiral in which the dominant concern of aging populations is to receive ever higher levels of health care and pension benefits, without regard for the negative impact on all other societal needs and interests, including the education of young people. This trend cannot continue forever, but both of the possible outcomes (i.e., total collapse or drastic reform) are unpleasant. Governments manipulate economic data for their own purposes. Energy prices have approximately doubled in three years, house prices are going up 10–20% annually, the cost of health care is going up 10–15% annually, and tuition is going up 8–12% annually, but "core" inflation is only 2–3%! There are lies, damned lies, statistics, and hedonic adjustments.

Free markets may be the best economic system ever designed by mankind, but maintaining a workable balance between responsiveness, efficiency, abuse, fraud, and regulation is a never-ending challenge. Globalization brings many benefits but is also a source of many stresses, ranging from sustained economic imbalances within and between national economies to greatly increased levels of pollution. Financial assets are routinely priced at levels that are very high with respect to objective measures such as discounted cash flows. Individual companies routinely and systematically exaggerate their profitability, and senior executives divert increasing fractions of a company's cash flows to their own personal remuneration. The financial industry participates in a self-organizing conspiracy to deceive naïve investors. It is not really surprising that people whose business is selling stocks are always claiming that "the next bull market is now under way." Many so-called financial advisers are merely salespeople who have little or no understanding of financial matters. Individual investors sabotage themselves by making emotional buy and sell decisions that result in buying high and selling low. To quote Pogo, "We have met the enemy, and he is us."

While these dangers are all real, there is little that individuals can do to change the environment in which investing occurs. The rules of the game are set. The goal of individuals can only be to play the game as effectively as possible. Two factors that are under your control as an individual investor are a) preventing third parties from filching a portion of your assets and b) ceasing to sabotage yourself as a result of making emotional buy and sell decisions. Control of these factors is easy to implement and has a big impact on investing success. Beyond this, it is necessary to devote significant time and effort to understanding business economics and the behavior of financial markets. This is much more difficult and is a challenge that most people should probably avoid.

Expenses Kill Returns

During bull markets, surveys often show that individual investors expect to achieve annual returns of 15–20% in perpetuity. This demonstrates a profound lack of understanding of the long-term impact of compounding. Starting from presently high levels of valuation, stocks are unlikely to provide long-term returns that exceed 6–8% in nominal terms and 3–5% in real terms (i.e., after allowing for the core level of inflation as calculated by the government). Bonds are likely to provide lower returns, and cash even less. In fact, after allowing for the impact of core inflation and taxes, the returns from cash will often be negative. The only reason to hold cash is that the returns from other assets may be even more negative for sustained periods of time.

Investment expenses can easily be high enough to swallow most or all of the anticipated long-term returns. Suppose that an individual investor pays an up-front sales charge of 4.5%, annual fees of 1.5–2% to a mutual fund company, and annual fees of 1–3% to a financial adviser. The long-term market returns are then almost all absorbed by inflation, mutual-fund companies, and financial advisors. There is simply nothing left for the investor! Dispensing with the financial advisor is not necessarily a panacea. Investors who make their own buy and sell decisions may lose another 5% or so annually (and in some cases much more) as a result of making emotional decisions. These figures explain why many investors lose money even when the market is going up, and why the two most important jobs for individual investors are to minimize investment expenses and to eliminate emotional decision making.

Passive Investing

Passive investing is an excellent way to stop investment expenses from eating into gross returns and to avoid making emotional decisions. The core ideas of passive investing are to:

- accept the market return
- keep expenses to an absolute minimum
- put buy and sell decisions on autopilot

It is easy to implement a passive investing strategy. Market index funds do all of the work involved in (almost) matching market returns. These funds, which can have expense ratios as low as 0.20%, can be bought directly from companies such as Vanguard or Fidelity. Another alternative is to use exchange-traded funds (ETFs) that hold a fixed basket of assets. Either of these approaches eliminates almost all management costs and sales commissions. (The purchase of an ETF involves brokerage commissions, but it is far cheaper to pay US$8 to a discount broker than several thousand dollars in fees and commissions to a financial advisor.) The impact of emotion on buy and sell decisions can be eliminated by using dollar-cost averaging implemented via automatic payroll deduction.

Employer-sponsored, tax-deferred 401(k) and 403(b) savings plans make it especially easy to implement a passive investing strategy. A potential drawback is that the expense ratios of available investment options may be significantly higher than 0.2%. However, the benefits and the simplicity of using passive investing in an employer-sponsored, tax-deferred savings plan are usually so compelling that this should be the default investing strategy for most people. There is little reason to consider other investment strategies until one is contributing the maximum allowable amounts to all available tax deferred savings plans, including regular or Roth IRAs.

Some people feel overwhelmed by the range of options available in an employer's plan. It is advisable to keep things simple. The underlying goal of asset allocation is to obtain broad exposure to the entire market. Although total U.S. market index funds are sometimes available, funds linked to the SP500 index are more common. When using SP500 index funds, it makes sense to add some exposure to small-cap stocks. Depending on individual risk preferences, exposure to bonds can be obtained quite cheaply using bond market index funds or somewhat less cheaply using balanced funds that invest in a combination of stocks and bonds. Exposure to foreign stocks, energy and natural resource stocks, or real estate, can be added if desired. So-called *lifecycle* funds provide broad diversification and take care of the job of shifting into more conservative investments as one approaches retirement. These are worthwhile benefits, providing the associated expense ratios are not excessive. Overall, the precise allocation of assets in a passive strategy is much less important than a) getting started, b) saving the maximum allowable amount, and c) maintaining broad exposure to the market as a whole.

After a passive investment strategy has been established, it can run on autopilot. Minimalists can spend five minutes a year reviewing their annual statements. Other people may rebalance their assets periodically in order to maintain target allocations. Such rebalancing takes an additional few minutes once or twice a year. The process of increasing payroll deductions each year to reflect allowable contribution limits may also take a few minutes. There is no need to spend any additional time monitoring investments. Do whatever else it is that engages your interest. After ten years, you will be pleased with the progress of your investing strategy. After 20 years, your account balances will be surprisingly large. After 30 years, they will be shockingly large. During your comfortable retirement, you will complain at length about the tax you are paying on your required minimum distributions. Congratulations! You have maximized the outcome to effort ratio of your investment planning.

Active Investing

Various motivations cause people to become interested in either investing in or trading financial assets. (The difference between investing and trading is not always obvious but centers on anticipated holding periods. Warren Buffet has said that his preferred holding period is infinity. Day traders expect their holding periods to be seconds or minutes. A wide range of investors and traders occupies the territory that lies between these two extremes.) The motivations of individuals include naïve hope, having a socially acceptable outlet for an underlying addiction to gambling, having an intellectual fascination with trying to solve a complicated and ever-changing puzzle, or wanting to have a business that combines profit potential with personal autonomy. Leaving aside the gamblers, the most common starting point is naïve hope. The eventual loss of naïve hope leads to one of two responses: a strong aversion to active investing or a fascination with markets. Among those people who have a fascination with markets, some learn enough and accumulate enough capital that their activities evolve into a business activity. A few really skilled traders get to the point where their business becomes a routine job.

The acquisition of investment skills is usually a laborious and slow process. As in any field of human endeavor, there are people who have a natural talent that is much greater than average. There are also some people who find themselves temporarily in tune with a current trend but who are unable to adjust when market conditions change. Over the long term, for most people, investment success is correlated with factors such as motivation, effort, persistence, adaptability, and the willingness to acknowledge and learn from mistakes. It takes time for individuals to experience a wide range of market conditions, to develop an intellectual understanding and an emotional acceptance of the principles of successful investing, to integrate this experience and understanding into a viable methodology, and to have the discipline to implement the methodology consistently. The time that is required may be measured in decades, and many people never complete the journey. There is no silver bullet, i.e., no single best investment methodology. Different people gravitate towards different methodologies depending on their view of the world, their understanding of markets, and their personalities. Achieving a high level of congruence between these three factors is a key to long-term success.

Some initial advice for would-be active investors is "Don't do it! Implement a passive investing strategy and then take up hobbies that will be cheaper and less stressful!" For those who are unwilling to follow this advice, the next piece of advice is "Start small!" In other words, use passive investing as the foundation of your overall investment strategy and maintain a separate small account in which to pursue active investing. Regard this as your investing apprenticeship account. (Do not refer to it as your "fun money" account, because this would predispose you psychologically to expect losses.) Acknowledge, analyze, learn from, and correct the mistakes you make in your apprenticeship account. This is not a monotonic process, more a case of taking two steps forward and only one step back. Read several books on investing—certain principles are well known but have to be experienced and validated firsthand before they can be internalized. As your apprenticeship account starts to flourish, you will naturally increase the scale and scope of your active investing. If the account flourishes for long enough, it will eventually dwarf the balance in your passive investing accounts. If not, you will still have the fruits of passive investing to fall back on.

Four Stages of Investing

Many authors have indicated that investors tend to go through either three or four stages of development. Descriptions of each stage vary, but a representative outline is as follows. (In the interest of brevity, the investor is referred to as "he." This is to be interpreted as shorthand for the semantically more accurate and politically more correct "he or she.")

Stage 1: The investor makes emotional buy and sell decisions based on hunches, tips, elation, and despair. Except during periods of market mania, he experiences consistent losses. A Stage 1 investor who gets lucky for a while is likely to lose it all back. Only a very few Stage 1 investors get lucky, recognize that they got lucky, and get out while they are ahead.

Stage 2: The investor starts to learn from his mistakes and starts to experience a pattern of many small profits punctuated by a few large losses. The investor either loses money or makes profits but lags the market. An excellent time for investors to proceed through this phase was during the bull market that occurred between 1982 and 2000.

Stage 3: The investor makes significant progress in understanding the principles of investing and his own psychological tendencies. He develops methods that integrate this understanding and develops the self-discipline to implement the methods consistently. His focus becomes the consistent application of methodology (trading well) rather than day to day profits and losses. He becomes consistently profitable and achieves rewards per unit of risk that exceed the market. He experiences sporadic periods of significantly enhanced profits. This level is as far as most people can reasonably aspire to.

Stage 4: Investing has become a routine that it is almost boring. The investor starts to devote significant time and energy to other activities. (The author of this column has read about but has never met such people.)

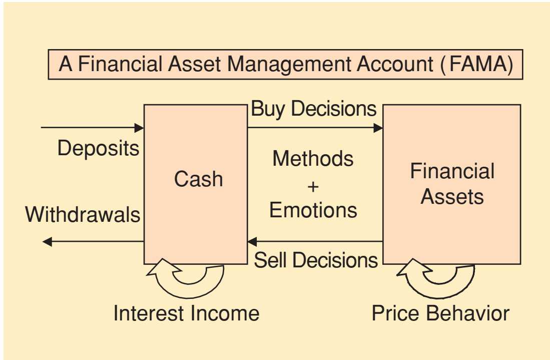

Figure 1. *A system-level block diagram of a FAMA.*

The Conceptual Model

In order to be consistently successful, an investor must integrate his world view, his understanding of market behavior, and his personality into an effective methodology. Previous columns have presented a world view that acknowledges the flaws in and limitations of political, economic, and financial systems. The goal of this series of articles is to provide an improved understanding of market behavior. Readers must take individual responsibility for the personality part.

The conceptual model for understanding investment engineering starts with Figure 1. This is a system-level block diagram of a financial asset management account (FAMA) that captures cash flows, decision points, and outcomes. The acronym serves as a small tribute to Prof. Eugene Fama, a pioneer of modern financial theory. The assets held within a FAMA are a combination of cash and noncash financial assets. Cash flows occur as the result of deposits and withdrawals, the purchase or sale of financial assets, and the receipt of interest income. The value of financial assets changes as a consequence of their price behavior. Buy and sell decisions are affected by the methods that the investor is seeking to implement and the emotions (fear and greed) that he is experiencing. In practice, most individuals hold a collection of FAMAs. These can include a bank account, an employer-sponsored savings plan, a rollover IRA that holds the assets accumulated with previous employers, a regular IRA, a Roth IRA, and one or more taxable investment accounts. The system model of a FAMA is able to handle all of these situations.

This figure encapsulates a very popular model of investing that centers on the roles of method, mind, and money management. A noteworthy feature of the figure is its explicit acknowledgment of the role of price behavior. This is appropriate for two reasons. First, both methods (including money management techniques) and emotions are in large part responses to price behavior. Second, most aspects of modern finance theory, including portfolio theory and the pricing of financial derivatives, are built around a specific model of price behavior, the so-called *lognormal price model*. The next column will present this model and will survey its applications and limitations. Subsequent columns will focus in more detail on the different application areas.

Feedback on this column is welcome and can be sent to pblakey@yahoo.com.