Financial Engineering- An Apparatus for Risk Management

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Abstract

The rapidity with which corporate finance, bank finance, investment finance have changed in recent years has given birth to a new discipline - Financial Engineering. The new field of financial engineering has attracted people with an assortment of back grounds and perspectives. Financial Engineering is the process of employing mathematical finance and computer modeling skills to make pricing, trading, and portfolio management decisions. For this purpose, it utilizes various derivative securities and other methods. Financial engineering aims to precisely control the financial risk that an entity takes on. Financial engineers use various mathematical tools in order to create new investment strategies.This paper presents an overview of using financial engineering as a risk management tool and it also deals with the use of simulation algorithms in the field of financial engineering. This paper examines different ways that financial risks can be quantified, the means by which risk can be allocated with in an asset class or portfolio and the ways risk can be managed effectively. The focus of this paper is on individual investors as well as the corporate investors.

Keywords: Financial Engineering,Risk management,Financial derivative.

INTRODUCTION:

Finance is one of the most important fundamentals of investment for any economy the world. The development of finance tools in order to the financial globalization requirements and the capital transfer among states has recently become the main concern of financial and banking experts, so financial engineering is the emergence of a new funding pattern differs from the traditional funding in vision of the risk levels in investments need funding. The rapidity with which corporate finance, bank finance, investment finance have changed in recent years has given birth to a new discipline - ***Financial Engineering.*** The new field of financial engineering has attracted people with an assortment of back grounds and perspectives. Financial Engineering is the process of employing mathematical finance and computer modeling skills to make pricing, trading, and portfolio management decisions. For this purpose, it utilizes various derivative securities and other methods. Financial engineering aims to precisely control the financial risk that an entity takes on. Financial engineers use various mathematical tools in order to create new investment strategies. The new products created by financial engineers can serve as solutions to problems or as ways to maximize returns from potential investment opportunities.

FINANCIAL ENGINEERING :

"Financial Engineeringinvolves design, development, and the implementation of innovative financial instruments and processes, formulation of creative solutions to problems in finance**".**Financial derivatives have been playing increasingly important roles in modern finance, not only with regard to the management of global investment and corporate risk, but also as a means for designing better personal investment and estimate planning portfolios. Necessarily, this makes the design of such products more difficult, placing in higher demand for experts trained in the advancedmathematics and investment techniques of modern finance. This leads to the incidence of financial engineering – the creation of new and improved financial products through innovative design or repackaging of existing financial instruments.

PRINCIPLES OF RISK MANAGEMENT:

The International Organization for Standardization (ISO 31000, 2009) identifies the following principles of Risk Management. An effective Risk Management should: Create value; be an integral part of the organizational processes; be part of decision making that explicitly addresses uncertainty; be systematic and structured; be based on the best available information; be tailored; take into account human factors; be transparent and inclusive; be dynamic, iterative and responsive to change; and be capable of continual improvement and enhancement.

LITERATUREREVIEW:

There are descriptive literature which discusses recent financial engineering and that advances various hypotheses about them has arisen (Van Horne 1985). Sharpe (1987) Arnott and Fabozzi (1992), and Bodie, Kane and Markus (1999) focus on asset allocation vast and addresses a board set of issues. Most Studies that consider derivatives in the context of asset allocation use option – pricing methods to gauge the economic value of the market – timing skills, Merton (1981), Henriksson and Merton (1981), and Evnine and Henriksson (1987). Carr, Jin and Maden (2000) solve the assets allocation problem in an economy where derivatives are required to complete the market. Carr and Maden (2000) consider a single – period model where agents are permitted to trade the stock, bond and European options with a continuum of strikes. Because of the inability to trade dynamically, options constitute a new asset class and impact of beliefs and preferences on the agent's positions in the three asset classes is studied. In a general equilibrium framework, they derive conditions for mutual – fund separation where some of the separating funds are composed of derivative securities. None of these papers explores the possibility of substituting a simple buy – and – hold portfolio for a dynamic investment policy. The other literature are relevant to our paper: : Merton's (1995) functional approach to understanding the dynamics of financial innovation Bodie and Merton (1995) and Merton (1997), the literature on dynamic portfolio choice with transactions costs, and the literature on option replication. There are many examples contained in Merton (1995) illustrating the importance of function in determining institutional structure is the example of the German government's issuance in 1990 of ten – year Schuldschein bonds with put – option provision . Merton (1995) observes that the put provisions have the same effect as an interest – rate stabilization policy in which the government repurchases bonds when bond prices fall and sells bonds when bond prices rise. More importantly, Merton (1995) writes that "the put bonds function as the equivalent of a dynamic, open market, trading operation without any need for actual transactions".Magill and Constantinides (1976)were among the first to point out that in the presence of transactions costs, trading occurs only at discrete points in time. More recent studies by Davis and Norman (1990), Aiyagari and Gertler (1991),Heaton and Lucas (1992, 1969), and Modest (1995) have contributed to the growing consensus that trading coasts have a significant impact on investment performance and, therefore investor behavior. Despite the recent popularity of internet- based day-trading, it is now widely accepted that buy-and – hold strategies such as indexation are difficult to beat-transactions costs and management fees can quickly dissipate the value-added of many dynamic asset- allocation strategies.

TOOLS OF FINANCIAL ENGINEERING:

The tools of the financial engineering are broadly categorized into two: **Conceptual** and **Physical.** The Conceptual tools involve the ideas and concepts which make finance as a formal discipline. Many of these conceptual tools are taught as part of modern financial management curriculum. But organized or presented in such a way as to readily lend them to a systematic study of financial engineering. Examples of the conceptual tools are valuation theory, portfolio theory, hedging theory, accounting relationships and tax treatment under different forms of business organizations.

The Physical tools of the financial engineering include the instruments and the processes which can be pieced together to accomplish some specific purpose. At a very broad level, the instruments include fixed income securities, equities, futures, options, swaps and dozens of variants on these basic themes. The processes include such things as electronic securities trading, public offerings and private placement of securities, shelf registration and electronic fund transfer by combining the physical tools in different ways, the financial engineer is able to custom design solutions to an incredible array of seemingly bewildering problems.

Financial Engineering –An Apparatus for Risk Management:

Generally speaking, "risk" in the financial markets essentially comes down to adverse changes in price. What exactly is meant by the term "adverse" varies as per the investor and his strategy. An absolute return investor could have a higher tolerance for price variability than a relative return investor. And for an investor who is short the market, a dramatic fall in prices may not be seen as a risk event but as a boon to portfolio.This concept covers three main aspects in risk management. Firstly, different ways how financial risks can be quantified, Secondly, the means by which risk can be allocated with in an asset class or portfolio, and lastly, the ways risk can be managed effectively.

1. QUANTIFYING RISK:

In this aspect of quantifying risk, risk is quantified with reference to Bonds, Equities, Currencies, Forwards and Futures, Options and Credit.

a) Bond Price Risk-Duration and Convexity:

In the fixed income world, interest rate risk is generally quantified in terms of duration and convexity. Using a three-month investment horizon, it is clear that return profiles are markedly different across securities. The 30-year Treasury bill offers the greatest potential return, if yields fall. However, at the same time, the 30-year Treasury bill could well suffer a dramatic loss, if yields rise. At the other end of the spectrum, the six-month Treasury bill provides the lowest potential return, if yields fall yet offers the greatest amount of protection if yields rise. In an attempt to quantify these different risk/return profiles, many fixed income investors evaluate the duration of respective securities.Duration is a measure of a fixed income security's price sensitivity to a given change in yield. The larger a security's duration, the more sensitive that security's price will be to a change in yield. A desirable quality of duration is that it serves to standardize yield sensitivities across all cash fixed income securities.

b) Equity Price Risk – Beta:

The concepts of duration and convexity can be difficult to apply to equities. The single most difficult obstacle to overcome is the fact that equities do not have final maturity dates, although the issue that an equity's price is thus unconstrained in contrast to bonds(where at least we know it will mature at par if it is held until then) can be overcome.One variable that can come close to the concept of duration for equities is beta. beta can be defined as equity's price sensitivity to a change in the S&P 500. As already stated, beta is a statistical measure of the expected increase in the value of one variable for a one –unit increase in the value of another variable. The formula for beta is:

Beta = cov (a, b) /sigma square (b)

Cov (a, b) = Rho, correlation coefficient (a, b) X sigma (a) X sigma (b)

Sigma is a standard variable in finance that quantifies the variability or volatility of a series. A correlation coefficient is a statistical measure of the relationship between two variables. A correlation coefficient can range in value between positive 1 and negative 1. A positive correlation coefficient with a value near 1 suggests that the two variables are closely related and tend to move in tandem. A negative correlationcoefficient with a value near 1 suggests that two variables are closely related and tend to move opposite one another.

A correlation coefficient with a value near zero, regardless of its sign, suggests that the two variables have little in common and tend to behave independently of one another. There are three categories in this: betas = 1, betas > 1, and betas < 1. Each of the betas was calculated for individual equities relative to the S &P 500. A beta equals to 1 suggests that the individual equity has a price sensitivity in line with the S&P 500, a beta of greater than 1 suggests an equity with a price sensitivity greater than the S&P 500, and a beta of less than 1 suggests an equity with a price sensitivity that is less than the S&P 500. After calculating betas for individual equities and then grouping those individual companies into their respective industry categories, industry averages were calculated.

c) **Quantifying Risk – Currencies:**

As there are number of currencies that are being in practice in a home country but which is not fit for foreign exchange purposes as it leads to price risks for imports and exports. Coming to the currency classification first layer of currency types comprise the countries with their own unique national currency, example which includes united states as well as other group of 10 (G – 10) members. The next layer of currency types would include those countries that have adopted a G-10 currency as their own. An example of this would be panama, which has adopted the U.S. dollar as its national currency. Onesmall step from this type of arrangement, there are other countries whose currency linked to another at a fixed rate of exchange. A number of countries in Western Africa have currencies that trade at a fixed ratio to the Euro. Indeed, where arrangements such as these exist in the world, it is not at all uncommon for both the local currency and “sponsor” currency to be readily accepted in local markets since the fixed relationship is generally well known and embraced by respective economic agents. Perhaps the next step from this type of relationship is where a currency is informally linked not to one sponsor currency, but to a basket of sponsor currencies. In most instances where this is practiced, the percentage weighting assigned to particular currencies within the basket has a direct relationship with the particular country’s trading patterns. The next step away from this type of set up is where a country has an official and publicly announced policy of tracking a basket of currencies but does not formally state which currencies are being tracked and /or with what percentages. Singapore is an example of a currency – type in this particular category.

d) **Quantifying Risk – Forwards and Futures:**

Forwards and futures are essentially differentiated from spot by cost of carry. It is not difficult to show how spot based risk measures such as duration and convexity can be extended from a spot to a forward context. Here, we can also discuss unique considerations pertaining to financial risk for all products, especially for bonds and conclude by showing how forwards and futures can be used to hedge spot transactions.Calculating a forward duration or convexity is simple enough. We already know from the duration and convexity formulas that required inputs like price, yield, and time. These are the same for forwardcalculations. However, an important difference between a spot and forward duration or convexity calculation is that now dealing with a security that has a forward settlement date instead of an immediate one. Accordingly, when a forward duration or convexity is calculated, an existing spot securities duration and convexity are truncated by the time between the trade date and the expiration date of the forward agreement. The same concept applies for future contracts. Price sensitivity is linked directly to the carry component of the forward.Recallingthebasic formulae for a bond forward is F= S (1+T(R-Yc)) (where S for a bond is the bond's price, and duration is a measure of a bond's price sensitivity), it is the carry component (the ST(R-Yc) component) that effects the price sensitivity (or duration) of a forward transaction. Note that because R and Yc tend to be small values, carry also will tend to be a small value. Observe also that because carry is a function of time (T), the incremental duration contribution made by carry will shrink as the expiration date of the forward approaches, and eventually disappears altogether at the forwards expiration. As a forward expiration date lengths, carry will become larger (via a larger T value), and carry's positive or negative contribution to overall price sensitivity of the forward will increase. Whether the contribution to duration is positive or negative depends on whether carry is positive or negative. If carry is zero, then the duration of the forward over its life will be the duration of the underlying spot as calculated at the expiration date of the forward agreement. Indeed, as expirations lengthen, the importance of R and Yc's contributions increase as well. Parenthetically, with longer-dated options as with LEAPS (long term equity anticipation securities), unit changes in R can make as important a contribution to the value of the option as a unit change in the underlying spot.

d) **Quantifying Risk – Options:**

There are five variables typically required to solve for an option value; price of the underlying security, the risk – free rate, time to expiration, volatility, and the strike price. Except for strike price (since it typically does not vary), each of these variables has a risk measure associated with it. These risk measures are referred to as delta, rho, theta, and Vega (sometimes collectively referred to as the Greeks), corresponding to changes in the price of the underlying, the risk - free rate, time to expiration, and volatility, respectively. Delta and rho are introduced as option – related variables that can be used for creating a strategy to capture and isolate changes in volatility. Delta and rho are also very helpful tools for understanding an option‘s price volatility. By slicing up the respective risks of an option into various categories, it is possible to better appreciate why an option behaves the way it does. Risk can be reduced by hedging for main stream options. Options can also be embedded with in products as with callable bonds and convertibles. By virtue of these options being embedded, they cannot be detached and traded separately. However, just because they cannot be detached does not mean that they cannot be hedged. Since callable bonds traditionally come with a lockout period, the option is in fact a deferred option or forward option. That is, the option does not become exercisable until some time has passed after initial trading.

e) **Quantifying Risk – Credit:**

Credit risk is quantified every day in the credit premiums that investors assign to the securities they buy and sell. As these security types expand beyond traditional spot and forward cash flows and increasingly make their way into options and various hybrids, the price discovery process for credit generally will improve in clarity and usefulness. Yet the market place should most certainly not be the sole or final arbiter for quantifying credit risk. Aside from more obvious considerations pertaining to the market's own imperfections (occasions of unbalanced supply and demand, imperfect liquidity, the ever-changing nature of market benchmarks, and the omnipresent possibility of asymmetrical information), the market provides a beneficial though incomplete perspective of real and perceived risk and reward.

2) ALLOCATING RISK:

Risk is allocated in the context of products, cash flows, and credit by highlighting the relationships that exist across products and cash flows .In particular; it shows how many investors have a false sense of portfolio diversification because they have failed to fully consider certain important cross-market linkages. The very notion of allocating risk suggests that risk can somehow be compartmentalized and then doled out on the basis of some established criteria. Since an investor‘s capital is being put in risk when investment decisions are made, it is certainly appropriate to formally establish a set of guidelines to be followed when determining how capital is allocated.

a) **Product Interrelationships:**

To explain about an interrelationship between products and credit risk, studies have been done to demonstrate how S&P 500 future contracts can be effective as a hedge against widening credit spreads in bonds. That is, it has been shown that over medium – to – longer –run periods of time, bond credit spreads tend to narrow when the S&P 500 is rallying, and vice versa. Further, bond credit spreads tend to narrow when yield levels are declining. In sum, when the equity market is in a rallying mode, so too is the bond market this is not altogether surprising since the respective equity and bonds of a given company generally would be expected to trade in line with one another; stronger when the company is doing well and weaker when the company is not doing as well.

b) Cash Flow Interrelationships:

Let us now use the triangle approach to highlight these interrelationships by cash flows and their respective payoff profiles. Assume that all of firm's cash flows have been distilled into one of the three categories - spot, forward, futures and options. The aggregate spot position may reflect a net positive outlook for market prices; the net forward and future position also may reflect a net positive outlook though on a smaller scale; and the net option position may reflect a negative outlook on volatility.We can think of quantifying risk as an exercise that can fall along a continuum. At one end of the continuum we can let each strategy stand on its own as an individual transaction, and at the other end of the continuum we have the ability (though only with some strong assumptions) to reduce a complex network of strategies into a single value.

c) **Credit Interrelationships:**

Credit risk always will exist in it own right, and while it can take on a rather explicit shape in the form of different market products, it also can be transformed by an issuer's particular choice of cash flows. The decision of how far investors ought to extend their credit risk exposure is fundamental. All investors have some amount of capital in support of their trading activity, and a clear objective ought to be the continuous preservation of at least some portion of that capital so that the portfolio can live to invest another day. While investments with greater credit risks often provide greater returns as compensation for that added risk, riskier investments also can mean poor performance. Thus, it is essential for all investors to have clear guidelines for just how much credit risk is acceptable and in all of its forms.

3.MANAGING RISK:

Risks can be managed on a day – to – day basis. For some investors, it all begins with one fundamental consideration - probability. Accordingly, investment related decisions are made on the basis of how a particular choice appears relative to available data, and those data typically are based on previous experiences. However, such an orientation can be made even more meaningful when it can be combined with a forward looking approach, as with scenario analysis. Once a probability assessment is made, decisions inevitably follow. At its very essence, the managing of the risk comprises probability, time and cash flows. Probability plays a central role in attempts to characterize an investment's total return. In the absence of uncertainties, probability is 100%. As layers of risk are added, a 100% probability is whittled down to something other than complete certainty. In the classic finance context of a trade-off between risk and reward, riskier investments will generate higher returns over a long run relative to less risky investments, assuming there is some diversification with in respective portfolios.

CONCLUSION:

Financial engineering aims to precisely control the financial risk that an entity takes on. Financial engineers use various mathematical tools in order to create new investment strategies.The present study summarizes the financial engineering as a risk management apparatus in the field of financial engineering. It examines different ways that financial risks can be quantified, the means by which risk can be allocated with in an asset class or portfolio and the ways risk can be managed effectively. The emphasis is on individual investors as well as the corporate investors. There are consequences for every investment decision that has taken as well as for each one that is differed. In addition to the various risk classifications presented in this paper, there is also something called as Event risk. Simply put, Event risk may be thought of as any sudden unanticipated shock to the market place. It is not prudent for most portfolio managers to structure their entire portfolio around an event that may or may not occur. However, it can be instructive for portfolio managers to know what their total return profiles might look like in the event of a market shock. Scenario analysis can assist with this. Further, it also may be instructive for portfolio managers to know how products have behaved historically when subjective to shocks. By thinking of creative ways in which to better understand, classify, and manage risk, investors will be better equipped to handle the vagaries of risk successfully.

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