Financial Engineering: A Risk Management Strategy

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Abstract

this paper examines the relevance of financial engineering .as a risk management strategy in financial management. It is the creation and design of financial securities such as swaps, options, futures and forwards with custom — tailored characteristics, often regarding exposures to various risks. The study, therefore, argued that understanding the key variables of financial engineering with the unpredictable nature of asset prices would at least reduce to the barest minimum volatility of asset prices. This basic factor has led financial experts to proffer engineering solutions to the risks associated with the prices of financial securities.

Keywords: *Financial engineering, Risk management, financial management, Investment finance*

Introduction

Financial engineering (FE) is a more recent concept in the finance literature. It was developed as a result of rapid changes in the world of financial management and investment finance. The discipline of FE includes applications of statistical modeling, mathematical modeling, and computational technology to the dilemma in the financial management of non-financial organizations and financial industry. Financial engineering involves the development and design of financial strategies, products, and systems to meet the needs of corporations, financial institutions, households, and the government.

Financial Engineering Application Areas in Risk Management

Financial engineering application in risk management has the following advantages in risk management

1. Financial risk management for financial institutions, corporations, and public institutions (from hedging risks of individual transactions to enterprise-wide risk management systems).

2. Derivative securities (pricing, contract design, market making, investment, hedging applications, and trading).

3. Modeling stochastic dynamics of stock prices, interest rates, foreign exchange rates, commodity and energy prices.

4. Asset/liability management technology for corporations, banks, pension funds

5. Credit risk modeling and management and credit derivatives

6. Energy derivatives and energy industry

Conceptually, financial engineering is viewed from different perspectives, and people define it according to their understanding. However, the definition is given by Finnerty (1998) in Egai and Ajie (2004) is an embodiment of all the aspects it is intended to cover. He defined it as "the development, design, and implementation of innovative financial processes and formulation of creative solutions to problems of financial management. It has a lot to do with the application of investment techniques in an effort to solve financial problems. Therefore, it means more than mere analysis of financial problems. In other words, if financial analysis involves the decomposition of a company's financial structures for simplifies understanding, then financial engineering focuses on the application of relevant theory, instruments and processes together to engineer a solution to the financial problems (Egai and Ajie, 2004).

Nzotta (2004) noted that derivatives were used essentially over a long period as a risk management strategy by investors. These instruments developed as mechanisms for hedging against risks associated with exposures to interest am exchange rates changes as well as commodity and stock price movements. He also observed that derivatives alter the risk profiles of various investors.

The financial engineer makes use of conceptual and physical tools in designing structures to handle financial problems. The physical tools consist of instrument and processes. The instruments include fixed income securities, equities, futures options, swaps and so on while the processes involve electronic security trading

public offerings and private placement of securities and electronic funds.

The objective of this paper is to analyze the relevance of financial engineering as a risk management strategy, using various instruments such as swaps, options, and futures in the reduction of risks connected with exposures to exchange and interest rates changes.

To be able to achieve this objective, the paper is divided into three parts. The first part gives an introductory background; the second part gives the theoretical framework, the third part explains the mathematical forms of financial engineering and the last part concludes and made recommendations of the paper.

2.1 Review of Related Literature

The introduction of FE and rapid development of the risk management of financial institutions create a revolutionary change occurring. Compared with traditional financial risk management tools, financial engineering's application in risk management has the following advantages:

1. FE can help banks avoid systemic risk efficiently

2. The cost advantage of financial engineering is obvious.

3. Promote the development of financial engineering in financial risk management.

The rapid development of financial engineering promotes revolutionary changes in risk management techniques; however, the task of risk management of financial institutions does not seem to reduce. On the one hand, it makes the modern financial risk management has a new, more scientific solutions. On another hand, it appears financial risks become more complex and the risk characteristics of financial products increasingly difficult to grasp and understand. Managers also inevitably face the so-called pricing risk and model risk.

2.2 Theoretical Review

Meaning and Growth of Financial Engineering

Financial engineering is the creation and design of securities such as swaps, options, futures, forwards with custom – tailored characteristics, often regarding exposures to various risks in the financial market (Bodie 2007; Marshal 2007).

However, the growth of financial engineering was stimulated by a factor. These factors are in two categories. The first category relates to internal factors and is in two categories. These are the internal factors the external factors to the organization (Egai and Ajie, 2004). The internal factors that led to the development of financial engineering include liquidity needs, risk aversion, agency cost. The external factors include price volatility, globalization of financial markets, tax asymmetry, technological advances, competition, cost of the transaction, information and financial theory.

Principles and Processes of Risk Management

Risk management is an organized means of identifying measuring risk and developing, selecting and managing options for handling these risks. Ebiringa (2007) said it is a scientific management process proposed to deal with the problems involving decisions uncertainty by identifying, analyzing, evaluating, and monitoring variations indecision environment as they affect the future outcome, as well as generating a framework for the future decisions based on experiences and lessons learned.

According to the Project Management Institute Body of Knowledge (PMBOK, 2003), there are three definitions of risk management:

1. Risk management is the formal process by which risk factors are systematically identified, assessed and provided for.
2. Risk management, in the context of capital investment, is the art and also the science of analyzing, identifying and responding to risk factors all over the life of an investment and in the best interest of its objectives.

Ebiringa (2007) posited that several studies had suggested different approaches to the task of risk

management. Pritchard (1997); Barlcely et al. (1991) and Project Management Body of Knowledge (PMBOK) 2005 version adopt an elaborate six stage methodology of first setting up the structure for the methodology in a planning process before the risk identification, then the assessment, risk quantification, risk response planning and finally risk monitoring and control.

Meanwhile, Nzotta (2004) made the following submission on what strategy should be put in place to mage risks.

1. What strategy is necessary to prevent the risks from occurring and having occurred, to minimize the loss?
2. What measures are necessary to transfer the risks to some external agency or I body?
3. What strategy must be put in place to assume and retain the risk, if we cannot prevent them or transfer them?

Risk Avoidance and Minimization: This is a major strategy used by financial experts in managing risks. Some of the measures used include:

1. Avoiding long term exposure as much as possible.
2. Avoiding risk exposures, monitor credits and follow up of exposures.
3. Use hedging devices to minimize risks especially currency risks.
4. Adopt adequate control measure usually through good control mechanisms, good management, and computerization of operation.
5. Limit the scale of particular balance sheet activities, such as currency and interest rate swaps.

Risk Transfer: It involves the transfer to an external agency such as:

1. An insurance company.
2. The guarantee could be provided by the government and their agencies.
3. Nigeria Deposit Insurance Corporation.

Risk Retention: This is a form of self-insurance that involves:

1. Adoption of cost control measures
2. Increased capital resources help to absorb the loss.
3. Increased interest margins charged on operations and designed to lower operating expenses.

Financial Engineering Instruments in Risk Management

Financial managers need to make sure that potential economic fluctuations do not threaten the firm. In order to achieve this, they employ a variety of tools, known as derivatives; help to manage the risk of such events occurring.

Egai and Ajie (2004) defined derivatives as financial instruments that derive its value from the price or rate of some underlying asset. Also, Nzotta (2004) said derivatives are those assets which are based upon and derives their values from another asset. Van Horne (2002). Noted that derivate security derives its value from an underlying primary security and can insulate a corporation from different types of risk.

Derivatives allow investors to hedge when buying a certain asset. Hedging is a way to protect against a loss in value of an investment. Nzotta (2004) said derivatives were used essentially over a long period as a risk management strategy by investors. These instruments developed as mechanisms for hedging against the risk associated; with exposures to interest and exchange rate changes as well as commodity and stock price movement. Instruments such as forward contract, options, warrants, futures contracts, and swaps were generally referred to as derivatives.

Forward Contract: It is an agreement between two parties to buy or sell a financial instrument or commodity at a predetermined price, quantity, delivery date and location as specified in the contract. The party buying at a future date is said to be taking a long position, while the counterparty, who will deliver at

the data is said to be taking a short position (Nzotta, 2004). Also, forward contracts are over - the - counter traded. This accounts for their illiquidity, the relatively cumbersome trading, and low speculative activities. Van Horne (2002) noted that **"forward contract** is a futures contract in economic function, but different in detail. It is non-standardized and sold in the over — the — counter market as opposed to an exchange market". Sharpe et al. (2004) observed that a contract made now wherein money will be loaned a year now and paid back two years from is known as a forward contract.

Futures Contact: Ezirim (2005) defined a futures contract as a contractual arrangement that calls for the delivery of a specific underlying commodity or financial instrument at some future date at a price currently agreed. It could also be said to be a marketable obligation to deliver a specified quantity of a particular asset on a given price. Similarly, Van Horne (2002) opined that futures contract is standardized and traded on an exchange; it calls for delivery of a specific instrument, one out of a basket of approved instruments, or a cash settlement based on some index, all of which pertain to a specific future date. Also, Sharpe et al. (2004) made the following submission about futures: "a contract that involves the delivery of some specific asset by a seller to a buyer at an agreed — upon future date. Such a contract also specifies the purchase price, but the asset is not to be paid for until the delivery date". There are different types of futures contracts. These are an index, interest rates, and currency related futures.

According to Eales (1995), the advantages of future contracts include:

1. Market transparency
2. Standardized contract sizes and delivery dates
3. Ease of buying and selling contracts
4. Market regulated by rules laid down by the exchange

Futures were used to reduce risk through hedging. A major reason for trading on future contracts is to transfer risks from one party to another party who is willing to take the risk. Thus, it serves a useful purpose in risk management. Futures contract are particularly useful in risk management when the quantity of the underlying set to be hedged is known. The major benefits of the future contract include the enhancement of portfolio returns and the reduction of risk through hedging.

Options: According to Sharpe et at (2004), the option is a type of contract between two people wherein one person grants the other person the right to buy a specific asset at a specific time period. Ezirim (2005) also noted that option contracts provide the holder the right to buy or sell a typical financial asset at a specified price on before a specified date. Managing any risk position can be achieved through options as the starting point. Options are so described since they give the holder, the freedom of choice to exercise or not to exercise his right. Van Horne (2002) opined that options permit hedging one sided risk as opposed to both sidesj as occurs with futures and forward contracts. According to Nzotta (2004), the benefits of options could be summarized as follows:

1. It enhances the returns on the portfolio of assets.
2. It is useful in reducing risks.
3. They are useful in specifying the risk limits to be assumed by an investor.

Swaps: Marshal and Bansal (1992) viewed swaps as the exchange of one set of payments for another. They are used to reduce the cost of capital, managing risks, exploit economies of scale, arbitrage world of capital markets, enter new markets and create synthetic instruments. Nzotta (2004) defined swap as a contract between two counterparties who agree to exchange payments based on the value of one asset, in exchange for a payment based on the value of another asset. He noted that swaps are derivative securities and risk management instruments just like future contracts. The various types of swaps commonly used include Interest rate swaps, currency swaps, debt swaps, and commodity swaps.

Call and Put Options: A call option is a contract that gives its holder the right but not the obligation to buy some specified quantity of an underlying asset (e.g., fixed number of shares of stock of a particular company) at a predetermined price (strike price) on or before a specified date in the future (option

expiration). A put option is a contract that gives its holder the right but not the obligation to sell some specified quantity of an underlying asset (e.g., a fixed number of shares of stock of a particular company) at a predetermined price on or before a specified date in the future. Derivatives are better known for their use in managing investment risks. The use of derivatives to combat the adverse effects of risks plaguing financial market participants has been defined as financial engineering (Osiegbu, 2005).

One major benefit of derivatives is its use as hedging instruments. It enables investors to transfer unwanted market risk to those who are ready and better placed to assume such risks. They are also used as speculative instruments to assist individuals, and corporate bodies derive income from trading in such instruments. The speculator undertakes the risk which the hedger is unwilling to assume with the expectation that prices would move in the anticipated direction and thus assist him in enhancing his returns. It assists individuals and organizations to hedge against adverse movements in the value of their asset holdings. This is possible because someone is willing to take on the risk for an expected return. The willingness and readiness of the speculator to take on such risks create activity in the market. Investors and investment managers tend to resort to a hedging mechanism for their investments, and this is in the form of derivative securities.

Underlying Assets or Variables in Derivatives

i. Stocks and stock market indexes
ii. Commodities (e.g., oil, gas, coal, gold, silver, aluminum, copper, corn, wheat, soybeans, paper)
iii. Bonds
iv. Interest rates
v. Exchange rates
vi. Credit events (defaults)
vii. Economic variables (e.g., inflation)

There are two types of derivatives:

Exchange-traded: Futures, Options

Over-the-Counter (OTC): Forward contracts, Swaps, CDS

2.3 Empirical Review

Felix, Rebecca & Onyeisi, (2015) studied the role of financial engineering in the growth of the financial market in Nigeria. The study appraises sound ideas and opinions and stimulates financial engineering expertise into philosophical interaction which imbibes laws and regulations into sequential growth and quantitative financial market. The study concludes that the policies reformation has not been properly pronounced with a corresponding framework to steer the objectives of guaranteeing growth and stability of the financial markets. It was thus recommended that the policymakers should domesticate background that is encouraging as well as supporting financial markets for quickened growth and development.

Wanjohi, Wanjohi & Ndambiri (2017) empirically investigated the effect of financial risk management on the financial performance of deposit money banks in Kenya for 4 years from

2008 – 2012. The study linked the current risk management practices of the deposit money banks with their performance measured with return on assets for the period under study. Questionnaires were administered across banks to generate data for the study and the data generated was analyzed using the multiple regression analysis. The result revealed that majority of deposit money banks in Kenya were practicing good financial risk management and it has a positive relationship to the financial performance of deposit money banks in Kenya. It was recommended that banks should devise modern risk measurement techniques such as simulation techniques, value at risk and risk adjusted return on capital.

Yongming & Xioli (2014) in their study examined financial engineering and the risk management of deposit money banks in China and found that risk management is one of the external themes of the deposit money banks in China. The study also revealed that to prevent and resolve deposit money banks operating risks efficiently, achieve sustainable development and enhance the core competitiveness of deposit money banks.

Mathematical Forms in Financial Engineering

1. Cost of Capital and Wealth of Equity Stockholders

The stock of capital is a concept in financial engineering that deals with the management of projects used for evaluating capital investment projects for determining the ideal capital structure and setting up the breakeven for the wealth of the equity holder. Cost of capital represents the weighted average cost of various financing structure such as equity, preference share, long and short term debt.

2. Cash flow Role in Financial Engineering

Cash flow is a spreadsheet that arranges cashflow by the event of the time. It summarizes cash flow activities as financial activities, investment activities and operating activities which are summarized as cash flow structure of a business (Osiegbu & Onuorah, 2011).

3. Project Appraisal

In the financial worth of an organization, from investing in the capital project, financial engineering functions in the mathematics of finance. This is on calculated functions of net present value (NPV) and internal rate of returns (IRR).

4. Risk Measures of Financial Engineering

In a capital investment decision, there is a possibility of getting exposed to danger. The danger of the project becoming a failure and the danger of the project not getting the expected return on the investment. Though as we understand the term "risk" in a general sense, it could be measured by range, standard deviation, the coefficient of variance, variance, and semi-variance.

Range: The range of a distribution is the difference between the highest value and the lowest value. It can be mathematically expressed as:

Range = Highest value – Lowest value

Standard Deviation: This is expressed as the square root of the variance in the distribution. This can be mathematically expressed as:

$\delta = \sqrt{var}$

Standard Deviation, = Σ pi $(XI - X)^2$ ½

Coefficient of Variance: In investment analysis where different investments are involved and each of these investments mean or average return have different standard deviations and mean or average returns and the investor is faced with a decision to select which one to invest in one factor that could aid investor in making sound decision is the use of relative measure of risk referred to as coefficient of variance. This factor measures what the risk per N1 of return is. It can be mathematically expressed as:

Coefficients of variance (COV) = $\frac{Standard\ Deviation}{Mean\ return\ (average\ return}$

Variance: Variance is expressed as the square of the standard deviation.

5. Risk Adjusted Discount Rate

In this method, the discount rate is adjusted to reflect the project risk. The cash inflows are discounted using the risk adjusted discount rate to arrive at the risk adjusted present value of cash inflows (Osiegbu & Onuorah 2011).

Practical Questions

(1). Supposing XYZ company have four items that posed incremental cashflow.

(a)	Cost of new machinery	₦200,000
	Cost of new wiring	₦30,000
	Cost of additional item	₦500,000
	Increase to working capital	₦60,000

(b). If the interest on loan is ₦15,000

(c). What will happen to the initial outlay in a given additional of ₦1,500,000

Solution to Risk Management Problem that involve Financial Engineering Concept

(a) Using Incremental Cashflow

Cost of new machinery	₦200,000
Cost of new wiring	₦30,000
Cost of additional item	₦500,000
Increase to working capital	₦60,000
	₦790,000

(b) This has to be ₦790,000 – ₦15,000 = ₦775,000

This would reduce the need for new working capital and lower the initial investment of the project.

(c) ₦790,000 + ₦1,500,000 + = ₦2,290,000

Question 2a

If the company's cash flow members must include at future inflation rate of 0.6% in a five years project inflows of ₦8,000, ₦8,480, ₦8,989, ₦9,528 and ₦10,100 for an outflow of ₦25,000

Solution

Year	Number
0	-25,000
1	8,000(1.06) = 8,480
2	8,480(1.06) = 8,989
3	8,989(1.06) = 9,528
4	9,528(1.06) = 10,100
5	10, 100(1.06) = 10,706

Without inflation in the cash flows, the forecasted flows would be lower. For a standard project (-, +), this would reduce forecasted inflows and bias the analysis toward a lower net present value and internal rates of return (Nagarajan, 2012).

Question 2b

Suppose an outflow of 70,000, occurs after immediately at 0.09 inflation rate for seven year and the inflows are 10,000, 10,900, 11,881, 12,950, 14,116, 15,386 and 16, 771. What will be the position of inflation in the economy?

Solution

Year	Number
0	-70,000
1	10,000(1.09) = 10,900
2	10,900(1.09) = 11, 881
3	11,881(1.09) = 12,950
4	12,950(1.09) = 14,116
5	14,116(1.09) = 15,386
6	15,386(1.09) = 16,771
7	16,771(1.09) = 18,280

Since the 70,000 outflow occurs immediately, there is no time for it to change due to inflation. The inflows, coming later in time, are subject to price changes (Osiegbu, Onuorah & Nwakanma, 2013)

Conclusion and Recommendation

Managing financial and other risks is critical to successful investment management. In this regard, derivative security as an instrument of financial engineering derives its value from an underlying primary security. To hedge risk, the financial manager must first identify the relevant risk. Hedging simply involves taking a position opposite to the risk exposure involved. It is, therefore, a characteristic of every rational investor to device measures of averting risks. With the unpredictable nature of asset prices, shareholder has had the concerns for controlling or at least reducing the engineering solutions to the risks associated with prices. However, financial experts, analysis, engineers, and managers should evolve a more strategic and proactive methodology to minimize risks associated with financial assets so as maximize shareholders wealth in corporate entities.

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