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Financial Engineering: Applications and Implications

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ABSTRACT

Financial engineering always related to the use of derivative instruments for risk management. Derivative instruments are a contract to buy or sell at a specified asset, quantity, price and time, set today for delivery later. If properly used, it is meant for managing adverse price movements in stock, bond, money, currency and commodity markets, either at exchange-traded or over-the-counter markets. The former is related to futures and options, while the latter refers to forwards and swaps. Derivative markets derive their value from the underlying markets to provide price discovery and hedging mechanism that lead to hedging and speculating activities. However, derivative trading has become corporate nightmares as a result of the collapse of giant investment banks that advise big multi-national firms. The bankrupt of Baring Bank from UK in 1995 and Lehman Brothers from USA in 2008 after more than 200 years in global banking businesses are associated to the heavy losses in derivative markets; the former due to the defaults of index futures at Singapore International Monetary Exchange (regulated trading) while the latter due to the defaults of credit default swaps in USA mortgage markets (over-the-counter trading). However, heavy losses in derivative markets are seen to be associated to their misuse for speculative strategies; while many multi-national firms used them properly for hedging purposes to protect their cash-flows with the ability to pay lower as the potential buyers and receive higher as the potential sellers in their underlying markets. As such, financial engineering helps the hedgers to identify, measure and evaluate the financial risks that are expected to prevail in financial and commodity markets by pre-determining today their prices in the future. If this is put in practice, the firms have more time focusing on their core profits rather than speculating for extra-ordinary profits.

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INTRODUCTION

My name is Rosalan. I am an engineer", I introduced myself to a delegate of a conference on Business in August 2014 during a coffee break. Their faces looked stunned with my brief introduction as that conference was nothing to do with engineers.

Financial Engineer", I quickly noted before they asked further and deserved my clarifications on financial engineering.

Then what is "financial engineering"? This is very uncommon field of financial engineering as opposed to civil, electrical, mechanical or chemical engineering. Again, why finance involves engineering? To make it simple, unlike natural science, finance has passed through stages of description and analysis that makes financial engineering to arrive at the engineering stage.

Derivative, as the name suggests, has its value derived from the underlying instrument. The price of a derivative instrument is derived from the actual price of the underlying, either from the physical or financial asset. As such, derivative trading could not stand by itself, as it has to be backed by the more basic asset that underlies its transaction.

Derivative, by trading definition, is simply a contract to buy and sell which is set today, but it will be fulfilled at a stipulated date, later, referred as a maturity date. Therefore, derivative trading requires two instruments; derivative and physical instruments, and two markets; derivative and physical markets. In view on the presence of the underlying instrument and its derivative, both prices tend to influence each other. Therefore, the performance of the derivative market depends on the performance of the physical market. In most cases, the derivative prices lead the cash prices because of its economic function of providing an indication of prices in the future or price discovery.

The scope of each respective type must confine to the formation of the market, and hence, the presence of a buyer and seller to complete a business transaction. Therefore, any form of derivative markets must involve the contract between a buyer

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and seller that could be categorized further into four types of derivative markets:

Forward:

Forward contract forms the oldest type of derivative market. Forward, by definition, is an agreement to buy and sell a specified security at a specified price to be forwarded at the maturity date in the future. The agreement is privately arranged to fulfill the need of both contracting parties, a buyer and seller. If one party intends to close-out the contract, it must be at the consent of the other party. Therefore, a forward contract is technically referred to as a privately-negotiated agreement.

Futures:

Futures market develops as a result of insufficient trading requirement of forward transactions. Either party justifies this because forward as a private agreement, does not guarantee the fulfillment of the contract. A third party is required to act as the guarantor, namely the clearing house. It serves as a buyer for every seller, and vice versa. Its underlying issue is the counter-party role played by the clearing house to guarantee the financial integrity of either party; that is it acts as a buyer for every seller and seller for every buyer. As such, it facilitates the trading as either party could close-out the contract simply by taking an opposite position prior to maturity. This simple transaction is completed if buyer offsets with a sell position and seller with a buy position without having consent of either party.

Options:

Since forward and futures trading obligates both buyer and seller to fulfill their contracts, a third form of derivative is introduced that provides an option or a right to one party and an obligation to the other party. Options are a contract that gives a right without obligation to the buyer, while the seller has an obligation if requested by the buyer, to buy or sell at a specified security at specified price and time. Its underlying issue is the buyer will be given the right simply because he has to pay non-refundable deposit to acquire the right; while the seller has the obligation because he has received a deposit paid by the buyer when the option contract is executed today This means to the buyer it represents a cash outflow while to the seller is cash inflow in which if the former decided to exercise his right to buy from the seller, the seller is obligated to sell to the buyer for specified asset, quantity, price and date.

Swaps:

Swap, by definition, is a private agreement to swap or exchange a specified security for specified cash flow. The swap transaction generally arises due to the need of international businesses between two countries. The common types of swaps are currency swap and interest-rate swaps. By trading procedure, swap is very similar to forward as both markets are not regulated, and hence, they are commonly traded at the over-the-counter (OTC) markets that are privately negotiated between the two multi-national firms from two countries.

The key common feature of the above four types of derivatives is a contract or an agreement to buy or sell (exchange) which is agreed today between the buyer and seller to be fulfilled at a later maturity date. However, this book will focus mainly on futures and options contracts because both derivatives are publicly traded at an exchange house, while forward and swap contracts are privately traded over the counter.

Some Definitions of Financial Engineering:

To understand better about financial engineering, we have to see some of their related definitions. For instance, Wikipedia (2002) defines financial engineering as multidisciplinary fields that lead to the creation of a new financial instruments and strategies. Likewise, financial engineering is also the creation or developing of new and improved financial products through innovative design or repackaging of existing financial instruments especially derivative securities, as defined by Investopedia (2003). More importantly, both definitions relate financial engineering to the process of employing mathematical, finance and computer modeling skills to make pricing, hedging, trading and portfolio management decisions.

As a finance academic, let us see some 10 related definitions of financial engineering by finance scholars from as recent as 2013 to as early as 1998:

Financial engineering is simply about any combination of financial instruments and products in which the process may involve a simple union between two products, or make use of several different products to create a new product that provides benefits that none of the other instruments could manage on their own, (Tatum, 2011).

Ealier, Swishchuk & Manca (2010) define financial engineering as a multidisciplinary field involving financial theory, the methods of engineering, the tools of mathematics and the practice of programming. It is about the securities, banking, and financial management and consulting industries, or as quantitative analysts in corporate treasury and finance departments of general manufacturing and service firms.

Interestingly, Choudhury (2009) perceives mainstream financial engineering as a study of methods that stand upon the assumptions of behavior, markets and institutions of the neo-classical vintage is critically examined.

In fact, Wei (2005) gives a detailed description of financial engineering as a process in which financial securities are designed and packaged with

innovative features. Typically, financial engineering involves creating certain type of derivative securities. House construction is to civil engineering what security packaging is to financial engineering. They both involve putting raw materials together to come up with something for a particular purpose. Civil engineers wear hard hats and heavy boots for protection and safety while financial engineers "wrap" themselves in legal papers full of cryptic fine prints.

About one and half decades ago, O'Brien (2001) refers a financial engineering as a development of pricing methodologies and hedging techniques of underlying financial derivative products. This means that it is the application of financial economics, mathematics, computer technology, and the scientific method of optimal sourcing, utilization and protection of financial assets.

Likewise, much earlier, Finnerty (1999) defines briefly financial engineering is the designing, developing, and implementing the innovative financial instruments and processes and the formulation of creative solutions to problems in finance.

Likewise, financial engineering is a process involving the creation and combination of a variety of financial instruments in order to achieve a defined financial objective within certain cost, tax and legal constraints, for instance, combining or dividing existing financial products to create new financial products (Gastineau & Kritzman, 1999).

However, sometimes, financial engineering also refers to the strategies companies use to maximize profits or other important performance metrics. Examples include creating derivatives that address unusual risks faced by a party to a transaction, structuring a purchase or sale in a way that better addresses the interests of the buyer and the seller, and using new methods to compute the fair market value of new or existing financial instruments (Zopounidis, 1999).

Interestingly, financial engineering initially works in other environments as well. The financial theory of offering several existing products under one package has become very common in the telecommunications industry. Many providers today offer bundled service packages that include local phone service, unlimited national long distance, Internet service, and cable or digital satellite television. The end result of this type of arrangement means one lower price to obtain three or more services at significant cost savings to the consumer (Smithson, 1998).

On the basis of the above 10 definition, the term "engineering" is generally referred to the nature of job of a technical engineer, be it civil, mechanical, electrical or chemical, with main duties to design, construct and analyze the proposed product or project. For financial engineer, the first duty is also to design the product or instrument, commercially known as structured financial products. Structured financial product generally defined as a creation of new financial instrument or re-packaging of existing financial instrument which is a contract between a buyer and seller to trade based on pre-determined type of security, quantity, price and date. In this early stage, the financial engineer involves in the stage of innovations, either inventing new product or up-grading the old product. Once the product has been designed, as in the case of civil engineer designing the bridge has to construct its technical specifications such as size, weight and length, financial engineer has also to construct its contract specifications such as the size, type and maturity of the proposed structured financial products.

As noted by the above 10 definitions, financial engineering is a multidisciplinary field involving financial theory, the methods of engineering, the tools of mathematics and the practice of programming. It has also been defined as the application of technical methods, especially from mathematical finance and computational finance, in the practice of finance. Financial engineering draws on tools from applied mathematics, computer science, statistics and economic theory. In broadest definition, anyone who uses technical tools in finance could be called a financial engineer, for example any computer programmer in a bank or any statistician in a government economic bureau. However, most practitioners restrict the term to someone educated in the full range of tools of modern finance and whose work is informed by financial theory. It is sometimes restricted even further, to cover only those originating new financial products and strategies (Wikepedia, 2013), with the main applications of financial engineering are related to:

- corporate finance
- derivatives pricing
- execution
- financial regulation
- portfolio management
- risk management
- structured products
- trading

Financial Engineering as Derivative Instruments:

What are the types of financial engineering? Financial engineering can be applied in to many different types of currencies and pricing solutions. These include equity such as stocks, fixed income such as bonds, commodities such as fuel or gold, as well as derivatives, as noted earlier such as swaps, futures, forwards and options.

Generally derivative is a type of financial engineering. Derivative securities would refer to a financial security or asset whose value is derived in part from the value and characteristic of an underlying asset. Underlying asset is an actual financial or physical asset that underlies its trading in

its underlying market, or actual cash or physical market. This means that the price of derivative instrument is derived from its cash instrument, which draws the performance of derivative market depends on the performance of its cash market.

By trading procedure, derivatives deal with derivative instruments and derivative markets that are derived from cash markets and cash instruments. Therefore, derivative market or instrument could not stand by itself as it has to be backed by its underlying market or instrument. Generally, derivatives could be commodity-based such as agricultural (notably soya-bean, palm oil and cocoa), live-stocks (notably live cattle and sheep), and mineral products (notably fuel, gold and copper) and financial products such as stocks, bonds, money and currency markets.

Financial Engineering as Risk Management Tool:

As listed in its main application, financial engineering deals risks in financial markets. Financial markets are exposed directly to trading risks in the money, stock, bond and foreign exchange markets, as well as indirect trading risks in the dominant commodity markets, notably fuel, gold and agricultural markets. The actual or potential owners of the physical instruments have to go outside of their cash markets in order to protect their trading businesses from expected undesirable price movements. This means that they expect their cash markets to be unfavorable, referred as price risk, the potential risk that is expected to move against their favor, causing them to have lower revenues for potential sellers or higher costs to potential buyers. Therefore, they are ready to hedge against falling or rising prices that they use derivative markets and instruments as a hedging mechanism to reduce their losses and protect their cash-flows in their underlying cash markets and instruments.

As financial engineering primarily deals the application of derivative markets and instruments, its main purpose is to manage the risks in financial and commodity markets. The risks could not be eliminated, but they could be reduced systematically in stages of managing the risks:

Identifying the type of risk:

Firstly, the chief financial officer (CFO) has to identify the type of potential risk that may inherent in their underlying market and instrument between today and next few subsequent months. For instance, rising fuel prices may hurt the airline firms as it will raise their operating expenses, while rising interest rates may worry the potential corporate borrowers as they have to pay higher interest expenses. Therefore, once they identified their related price risks, they are busily hedging against rising fuel prices or rising interest rates to protect their cash-flows against unfavorable price movements in the future foreseeable months.

Measuring the impacts of the risk:

This is workable by drawing the hedge strategy either establishing a buying (long) hedge or selling (short) hedge and subsequently quantifying by facts and figures between what they have today and what they expect to have later in the cash markets, and their actual hedging transactions in the futures between today (open position) and later (offset position). The CFO at this second step has to draw the flows of transactions in the cash and derivative markets.

Evaluating the benefits of hedging:

Once the hedge strategy is executed and measured, the duty of CFO in the last step is to prove that it pays to hedge by showing his price objective. This means his price objective is achieved if he could prove that by hedging he has obtained his better price; for the potential seller better price means he has an ability to receive higher revenue while the potential buyer to pay lower cost as compared to without hedging.

As such, hedging strategy allows a CFO to pre-determine today either his buying or selling price for forward prices in one month or few months later. This means that as a hedger he has booked his trading prices in advance without worrying the prevailing prices in the cash market later. When comes later, those prices represent their trading prices which are higher (selling) or lower (buying), and hence, have time to focus on his core businesses rather than speculating themselves to extra-ordinary profits or losses due to changes in financial or commodity markets.

Derivative Losses by Global Investment Banks:

Derivative trades could lead to heavy profits and losses, referred as speculative activities. This is possible due to the leverage effects of derivative trading between margin and contract value. As such, a small change in prices could lead to big returns, either profits or losses. As mentioned earlier, derivative trades could be in the form of hedging and speculation.

In most cases, it is interesting to note that speculative activities executed by prominent investment banks that advise multi-national firms are seen to record initially huge profits. However, once the derivative trades start to record continuous losses, they will become corporate nightmares to the banks as their stock prices fall sharply and quickly that wiped their market value that lead to the filing of bankruptcies, as evident by Baring PLC of UK in 1995 and Lehman Brothers of USA in 2008, the major global investment banks.

In the case of Baring bank, it recorded losses of $1.3 billion as a result of trading losses in speculating Nikkei-225 futures traded at Singapore International Monetary Exchange (SIMEX) in early 1995. SIMEX (now renamed as Singapore Exchange) is the biggest futures market in Asia after

Tokyo and Hong Kong. For Lehman Brothers, it recorded losses of about $6.82 billion for two quarters due to speculating on Mortgage-Backed Securities and Credit-Default Swaps in 2007-2008. These two derivatives are traded over-the-counter (OTC) markets that have spill-over effects rooted from USA sub-primes crises to the other global financial markets. Interestingly, this sub-prime crisis has become global financial crisis because it affects Euro countries into Euro-Debt Zone led by Ireland, Portugal, Spain, Cyprus and even Greece is still struggling to re-build its financial markets till August 2015.

Summary:

In conclusion, by effectively practicing the financial engineering can largely reduce the unforeseeable risk in business activities. Through financial engineering, risk can be identified, measured and evaluated. In addition, the creation of new financial instruments can effectively reduce the use of external funding, optimize the financial cost and improve the corporate decision of capital structure as part and parcel of strategic financial management.

The uncertainty of the future can makes financial engineering such an interesting subject. Yet it is certain that issues of public policy will be raised about the role of financial engineering in the markets. Informed decisions will require an understanding of the evolution of the field, the role of technology in that evolution and knowledge of the challenges that technology poses for public policy makers. Ultimately, policy must be driven by the economic realities of the new finance embodied in the financial engineering field as described by ten definitions of financial engineering.

To become a financial engineer, one must have a strong understanding of financial economics, mathematical tools such as probability and statistics such as differential equations, as well as an understanding about the structure of financial markets and instruments. To reflect the importance of risk management by using derivative instruments, one has to understand on the applications and implications of financial engineering for better investment decisions in the financial and commodity as well as property markets.

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