

UNIT V – FINANCIAL ENGINEERING

Meaning of Financial Engineering

Financial engineering involves utilization of mathematical techniques in solving financial problems. This process uses tools and knowledge from the fields of economics, statistics, applied mathematics and computer science. These tools not only assist in solving the prevailing financial issues but also help in devising innovative financial products. Financial engineering is also known as quantitative analysis. Investment banks, commercial banks and insurance agencies use this technique.

The term financial engineering together can be explained as the process of using engineering tools and techniques of mathematics, statistics, computer science to solve the financial problems of the organizations, investors, government etc. It helps in simplifying the activities related to investment or we can say it is the application of scientific principles to the art of investment.

Financial engineers

The persons who apply these techniques are known as financial engineers. The financial engineers are different from financial analysts. The financial analysts only analyses the information available for the Risk management whereas Financial engineers find out innovative ways, products, instruments, models to either eliminate or reduce or optimise the risk.

For example: If an individual investors wants to reduce risk or improve profitability they can approach these engineers who can create portfolio in such a way that investors get satisfied.

The financial engineers not only manage the risk but also help in formulating strategies, new financial products, instruments for the firms, government, households, individuals etc. to maximise their wealth in this competitive business. Financial engineers create, design and implement new financial models and processes in order to find solutions for problems. They always seek new financial opportunities. Preparing such models requires a great deal of research and they rely on in-depth data analysis, simulations, risk analysis and stochastics.

Factors Influencing Financial Engineering

The following are the factors that influence the growth process of financial engineering:

Environmental Factors

These are the factors which exist in the external environment. Environmental factors have a direct impact on the firm.

These factors are not controllable. Political, Economic, Social and Technological (PEST) analysis can be conducted to determine these factors and their impact on the business. Common examples of environmental factors are technological advancements, new inventions, competitiveness and political and economic changes.

1. **Price volatility:** With the advent of globalization, there has been increase in the volatility in the financial market. A slight change in the global market can send waves in the national market. The **recent example of this fact was the Global Recession of**

2008 where the recession in the global market sent shock waves to financial markets of various countries.

- The demand and supply forces determine the price in the market
 - Higher volatility increases risk and thus the need of Financial engineering also increases as these financial engineers help in finding ways to deal with these volatilities.
 - The volatility also increases the investment opportunities and the experts can exploit these opportunities in their favour and earn huge profits.
2. **Globalization:** Globalization has opened up the market globally. The investors' base has increased and with the help of automated computer systems, this has become even more popular. Now the investors can trade in international market also but this has also increased the exposure towards risk. This increase in the volume of trade and investment has **increased the demand of financial engineers**.
 3. **Tax Asymmetries:** The difference in the tax structure of different countries can be exploited by the financial engineers as they are experts in this field. Tax Asymmetries exist for number of reasons:
 - Granting special tax exemption to some industries.
 - Existence of different tax burdens in different countries and even different tax law for domestic and foreign firms doing business within a country.
 - Nature of past performances has left some firms with sizable tax credits and write offs which effectively eliminate any tax obligations for some years to come.
 4. **Technological advances:** Improvement in computer technology along with advances in telecommunication led to high speed data transmission. Synergy of these technologies with software programming led to advent of spreadsheet programs. With the introduction of spreadsheet programs currency and interest rate swap blossomed. Technological advances have motivated a great deal of financial engineering. Many of technological breakthroughs involve the computer, high speed processors, powerful desktop units, network systems, and enhanced methods of data entry, and so on.
 5. **Development of new markets and market linkages:** There has been an explosive growth of futures and options exchanges worldwide. 24 hour trading has become possible on futures and options exchanges across the globe. The Chicago exchange has developed a computer system on which trade can now be carried out at any time, replacing human activity on the floor.
 6. **Regulatory change and increased competition:** Increased competitive pressures, better risk management techniques, coupled with the 1980's atmosphere of deregulation led to the growth of financial engineering.
 7. **Transaction and information cost:** Enormous technological development decreased the cost of information, on which many transactions feed. Thus, the cost of transacting itself declined significantly during the decade of 1980's. Unlike today under 1970's transaction cost, arbitrage opportunity does not exist.

Intra Firm Factors

These factors are controllable by the firm and directly affect the financial engineering process. Examples of intra firm factors are accounting policies, risk aversion, agency costs and liquidity needs.

- 1. Balance between liquidity and profitability:** The need to maintain liquidity is a driving force behind financial engineering. The liquidity and profitability do not go hand in hand. If an investor wants liquidity, it will have to play safe and make only those investments in which he is sure of reasonable returns but the profitability will decline. In order to improve profitability, the investor will have to invest in aggressive securities and thus the liquidity declines. The financial engineer can easily manage the balance between liquidity and profitability by innovating new products which can balance the both.
- 2. Risk aversion:** A rational investor will always want to avoid the risk. The risk cannot be eliminated completely but can be limited by making careful choice of investments. The investors will be ready to bear the risk only if they are compensated for bearing the risk. There are various financial products in the financial market that can balance the risk exposure of the investors. Financial engineers help them in making such decisions.
- 3. Agency costs:** Financial engineering also helps reducing agency costs by innovating various strategies to deal with the issues related to ownership and control. The conflict of ownership and control is difficult to sort but financial engineers are experts and they may generate new methods to sought these issues.
- 4. Technical knowledge of investment managers:** Sound technical knowledge of the financial managers can help the growth of the financial engineering in the economy. They can also provide training to investment professionals to deal with the situations.

Tools Required for Financial Engineering:

It is the knowledge of the financial engineer that can help the investors from financial crisis. The financial engineers use various financial products and services for the benefit of economy at large. In relation to tools requirement of financial engineering process, basically, two types of tools are used named

- Conceptual Tools
- Physical Tools

Conceptual Tools:

This category involves the combination of concepts and ideas that can be used in finance studies and are considered as formal disciplines. Mostly these types of tools are taught in business programs especially at graduation level. For instance, hedging theory, valuation of theory and its application, portfolio theory, risk and return measurement, accounting relationships, and tax treatment under different forms of business organization, understanding interest rates and exchange rates, speculation, arbitrage and market efficiency etc.

Physical Tools:

Special process and instruments that are used by Financial Engineers in combination to gain a specific task or purpose are called as physical tools. The examples include variants, securities, futures, swaps, options, and equities.

At a very broad level, the basic instruments are cash market instruments and derivatives.

1. Cash market instruments including debt market instruments like fixed income securities, and equity and equity related securities.
2. Derivatives include, forward contracts, future contracts, swaps and options.

New Product Development and New Product Strategy

The financial industry is always coming up with new and innovative investment tools and products for investors and companies. There are hardly any financial instruments which have not been innovated by financial engineering. The underlying motive of this innovation is the risk and reward trade-off. The financial instruments are increasingly being designed to minimize the uncertainty associated with the investments and maximize the returns. Using mathematical modeling and computer engineering, financial engineers are able to test and issue new tools such as new methods of investment analysis, new debt offerings, new investments, new trading strategies, new financial models, etc.

Financial engineering and equity and debt products: Non-voting shares, differential voting rights, employee stock options, sweat equity shares, callable and puttable common shares, ADRs, GDRs, IDRs, warrants, World Equity Benchmark Shares (WEBS) etc. are the innovative financial products came into existence through financial engineering in equity class. Whereas, convertible bonds, zero coupon bonds/ debentures, deep discount bonds, secured premium notes, floating rate bonds, catastrophic bonds, dual currency bonds, foreign bonds and eurobonds, Triple Option Convertible Debentures (TOCD), index bonds, Indian Corporate Collateralized Debt Obligation Fund (ICCDO Fund) are come under the debt category. There are hybrid instruments too like convertible preferred shares.

Financial engineering and mutual funds: Mutual fund is a financially engineered product which comprises of the characteristics and benefits of direct stock market investments. It is an investment tool through which investors can achieve diversification at low investments and with lower cost of fund management. Mutual funds have diversified investments spread in calculated proportions among securities of various economic sectors. In Indian financial markets, some of the mutual funds provide the life insurance cover to the investor. In Indian financial markets, some of the mutual funds provide the life insurance cover to the investor.

Financial Engineering and Insurance: In the past, the higher amount of premium in the traditional insurance policy, narrow product line for the insurance policy was available to the people to choose a suitable policy. In the individual customer segment, endowment and money back plans were available while in the corporate segment group insurance, gratuity and superannuation plans were available. But, after the liberalization of Indian financial market, many new and private insurers came with innovative engineered products, which focused on providing customized products – products that contain innovative features – to the customers. It was observed that in the Indian market, only endowment and money back policies were popular among consumers. Private insurers came up with need-based insurance policies such as whole life policies, term insurance policies as well – products designed

according to needs of the customer. Even to deliver more benefit to the customer they have identified and introduced riders attached with the product. ULIP is one such product which has come about as a result of financial innovation where part of the premium paid is used for insurance and the other part is used for investment to give a certain amount of return to the investor on the money invested. Majority of the private life insurance companies have introduced the children's education plan, retirement and pension plan to meet the specific need based upon the time frame. Moreover, to get the benefit of capital market investment, ULIPs came into existence, which is an important outcome of the financial engineering in the insurance segment. The basic principles on which ULIP is operational are:

1. Offering insurance cover to an investor and
2. Investing the savings element in the capital market which offers market linked returns.

To give more flexibility to the investors, ULIPs offer the various funds so that the risk can be diversified and return can be secured. These funds are consisting of various levels of debt, equity and fixed income securities. Insurance has successfully entered into capital market with "insurance backed bonds" making almost all the risk tradable. Insurance companies in association with the banks have started the bundling of various risk like weather, mortality, emissions, environmental shocks etc. and issuing the bonds against them. Some of the insurance policies have started to provide insurance cover against life lost or disability incurred due to terrorism attacks.

Under the general insurance policy, the marriage insurance policy has been innovated, wherein the insurance companies would insure the cost of weddings against the postponement or cancellations wedding ceremonies for certain reasons, under which claims would be entertained only for losses due to external factors like accidents, catastrophes or unintentional man-made disasters or disruptions.

Financial engineering and banks: Banking sector has brought not only the product/ service innovation but also organizational and technological innovations, which has replaced the traditional portfolio of the banks. Consumers have started to demand anytime-anywhere delivery of financial services along with an increased variety in deposit/investment and credit products. Severe competition forces the banks to focus on customer relationship management by delivering the sophisticated services with the use of technology. e-Banking services, mobile banking, electronic mode of payment methods, ATM, platform automation, PC banking, reverse mortgage, etc., are the revolutionary innovations which can be termed as financial process engineering, have taken place in the banking sector.

Financial engineering and Stock exchanges: With the increased awareness and increased participation of direct investment in the capital markets, stock exchanges have brought in innovation in terms of technology, processes and introduction of trading of new securities. To overcome the limitations of physical handling of the securities, dematerialization of the securities has been done. With the introduction of the same there was a need to create another financial institution/body, which can take the custody of the securities, facilitate the trading between the parties etc. As a result of these, NSCCL, Depositories, Depository participants and other intermediaries came into existence and which has replaced traditional brokers. Exchanges also started the trading of the new investment tools like ETFs, Gold ETFs, and REITs.

Financial Engineering and derivatives: Derivative instruments are an outcome of financial engineering. To appreciate the contribution of financial engineering by quantifying risk,

allocating risk and managing the risk through derivatives. Under which the currencies, futures, options, swaps and commodities are traded on the exchanges.

Role and Functions of Financial Engineer

1. The financial engineers are specialists making use of mathematical formulas, programming and engineering methods in financial theories, and analyses market trends to build data backed financial models.
2. Companies often employ people with advanced degree in Financial Engineering and these specialists work as investment managers, bankers or traders using their financial engineering background to improve the quality of existing investment products. An investment product is a product (such as stocks, options, futures, bonds, mutual funds, certificates of deposit, money market investments, ETFs and annuities) purchased with the expectation of earning a favorable return.
3. This knowledge is used by engineers to develop simulations and predict market behavior. Of course, the predictions aren't always accurate, any unexpected issue may happen in the financial market but the risk potential reduces. Since a financial engineer knows about market trends and previous market performances, the knowledge is used to make future investment predictions.
4. Apart from knowledge in finance, the engineer needs to possess sufficient computer programming skills. Programming skills are needed to build simulating financial models to learn about market behavior. Through these simulations, the financial engineer is expected to generate results, as much as accurately possible.
5. Most of the financial engineers work in the field of financial risk management and as financial analyst. With the knowledge of computer simulations and market trends, the engineer helps to develop profitable investment plans for individuals and companies. Often these investment plans have high risk factor, which might seem counter-productive to the goal of hiring financial engineers, but that's a strategy used by risk management firms to yield higher return than comparatively stable investments. Companies and high net-worth individuals often take help from financial engineers to design a portfolio which places the complete investment capital at risk.
6. As a financial analyst, the financial engineer creates real time financial simulations to predict the future behavior of the market.

Conclusion

Financial engineering can benefit organizations in finding solutions to various problems such as risk management, scenario simulation and new product development. However owing to the ever-increasing financial innovation, there is a perpetual demand for highly skilled financial engineers.