FINANCIAL ENGINEERING: AN OVERVIEW

Abstract

Every field has certain problems and to come up with solutions to those problems we need innovation. In Finance also we have complex problems such as interest rate volatility, tax, and regulatory changes, to deal with such problems we create new investments or financial products, services or processes. The process of creating new products, services, and processes to solve financial problems is called Financial innovation. In words of J.D. Finnerty, "Financial Engineering is the lifeblood of Financial Innovation." He defined Financial engineering as :

"A process that involves the design, the development, and the implementation of innovative financial instruments and processes, and the formulation of creative solutions to problems in finance."

Here, innovation refers to creative solutions to deal with corporate financial problems. The definition distinguishes three scopes of Financial Engineering-

Securities Innovation: Securities innovation is the creation of novel financial products, su ch as those primarily designed for consumer use, like new kinds of bank accounts, new mutual funds formats, new types of life insurance policies, and new residential construction mortgages. Newly developed financial instruments also include those created with corporate finance in mind new debt instrument options and other futures and new risk management techniques, new forms of preferred stocks, automobiles, new convertible securities as well as fresh forms of common equity instruments.

Innovative Financial Processes: The creation of creative financial procedures is the second subfield of corporate financial engineering. These new procedures, which

Author

Shubhangi Srivastava
Research scholar
Department of Commerce
Iswar saran degree college
Prayagraj, India.
Shubhangi19041997@gmail.com

typically come from technology advancements (such as electronic security trading) or legislative or regulatory reforms (such as the shelf registration process), lower the cost of carrying out financial transactions.

Creative Solutions to Corporate Financial Problems: The Third branch focuses on innovative answers to issues in corporate finance. It includes cutting-edge debt management techniques, cutting-edge cash management techniques, and specialized corporate finance arrangements like those used in various asset-based financing models.

I. FACTORS CONTRIBUTING TO THE GROWTH OF FINANCIAL ENGINEERING

There are certain factors that contribute to the growth of financial engineering, these factors can be divided into two categories external or environmental factors and internal or intra-firm factors. The external factors are not under the control of the firm but greatly concern the performance of the firm. These include price volatility, globalization of industry, tax asymmetries, etc. The firm has a certain control over internal factors or intrafirm factors, which include liquidity needs, risk aversion among managers and owners, agency cost, etc.
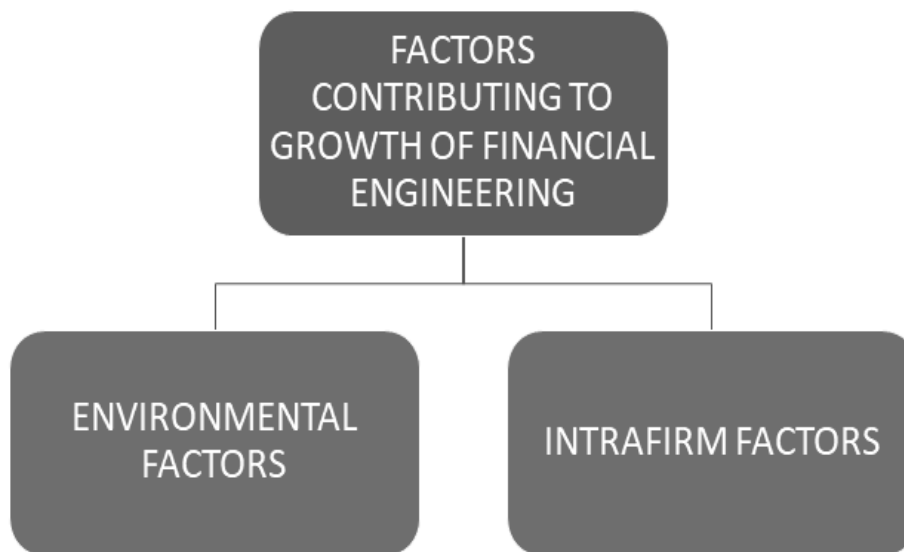
Figure 1: Factors Contributing to the Growth of Financial Engineering

1. **The Environmental Factors:** These factors are external to the firm but nevertheless, impact the firm's performance. We will look at different subsections of environmental factors as follows.

   - **Price Volatility:** Price changes of a commodity are referred to as "price volatility". The percentage difference in the commodity price from day to day is used to calculate volatility. A market is volatile if there is significant volatility, not if prices are high or low. Given that supply and demand determine price, volatility must be a product of the market's fundamental supply and demand dynamics. Therefore, extreme supply and/or demand qualities are reflected in high degrees of volatility.

   - **Globalization of the Markets:** The term "globalization" refers to the increasing interdependence of the world's economies, cultures, and inhabitants as a result of technology, cross-border trade in goods and services, and flows of capital, labor, and information. Over many years, nations have developed economic alliances to support these movements. The market has grown in size, and competition has greatly increased. Consumers benefited from this since they were able to buy higher-quality goods for less money. However, it has also made contemporary firms take big risks and, frequently, reduced their profit margins. Growing in size has also increased the

capital structure's usage of debt, which has raised the capital structure's reliance on leverage to boost returns. Multinational corporations are particularly exposed to hazards associated with interest rates and exchange rates.

- **Tax Asymmetry:** Tax asymmetry happens when one participant in a transaction has more or less information resulting in different net tax rates. These tax asymmetries can be exploited by tax engineers.

  It can also be resulted due to subsidized rates, special tax exemptions, double taxation, past performance of firm, etc..

- **Technological Advances:** Technological advantages in the computer field have become one of the most important inventions of the century. It has greatly developed the financial engineering field through the introduction of online exchanges, interest exchange rate swaps, future and option contracts, index funds, mutual funds, etc..

2. **Intrafirm Factors:** The firms have a certain control over the intrafirm factors, these factors are internal to the firm.

- **Liquidity:** Liquidity refers to the ease with which assets can be easily converted into cash. Individuals as well as firms all have liquidity needs. This created a lot of innovation in the financial engineering field such as money market, short-term debt, treasury bills, etc.

- **Agency Costs:** An agency cost is a specific kind of internal business expense that results from an agent acting on behalf of a principal. Core inefficiencies, dissatisfactions, and disruptions, such as conflicts of interest between shareholders and management, usually result in agency costs. The acting agent will get money for the agency fee.

- **Risk Aversion:** Financial innovation directed toward individuals and firms' aversion to risks has created many different financial tools such as hybrid stock, managed funds, guilt funds, index funds, etc.

II. TOOLS OF FINANCIAL ENGINEERING

Financial engineering employs a variety of conceptual and physical tools to design, analyse, and implement innovative financial products and solutions. These tools draw from mathematics, computer science, economics, and finance. Here's an overview of some key conceptual and physical tools used in financial engineering:
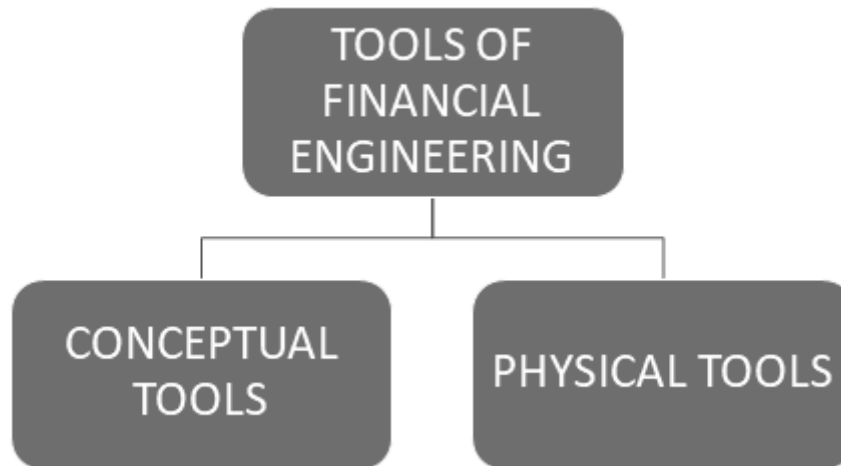
Figure 2: Tools of Financial Engineering

1. **Conceptual Tools**

   - **Mathematical Modelling:** To explain and evaluate financial instruments, markets, andrisks, financial engineers employ mathematical models. Differential equations, stochastic calculus, and probability theory are frequently used in these models to describe the intricate dynamics of financial systems.
   - **Option Pricing Theory:** Concepts from option pricing theory, such as the Black-Scholes model and its variants, are fundamental for valuing derivatives and designing hedging strategies.
   - **Portfolio Theory:** The mean-variance framework and the Capital Asset Pricing Model (CAPM), two methodologies for portfolio optimization, assist in creating effective portfolios that strike a balance between risk and return.
   - **Risk Management:** Concepts like value-at-risk (VaR), stress testing, and scenario analysis are used to quantify and manage financial risks.
   - **Stochastic Processes:** To model asset price movements and market behaviour, financial engineers use a variety of stochastic processes, such as Brownian motion and jump-diffusion models.
   - **Monte Carlo Simulation:** Monte Carlo methods are employed to simulate complex financial scenarios, especially when closed-form solutions are not feasible.
   - **Time Series Analysis:** techniques from time series analysis, like autoregressive integrated moving average (ARIMA) and GARCH models, are used to model and forecast financial time series data.
   - **Optimization Techniques:** Risk management, trading strategy optimization, and portfolio rebalancing all use linear and nonlinear optimization techniques.

2. **Physical Tools**

   - **Computational Tools:** Financial engineers use programming languages like Python, R, and MATLAB to implement mathematical models, run simulations, and analyze data.

- **Quantitative Libraries:** Pre-built tools are available for pricing derivatives, risk management, and more in libraries and frameworks designed for quantitative finance, such as QuantLib and QLNet.
- **Database Systems:** Relational databases and data management tools are essential for storing and retrieving financial data used in modelling and analysis.
- **Algorithmic Trading Platforms:** Tools for algorithmic trading enable the automation of trading strategies and execution in various markets.
- **High-Performance Computing:** Complex simulations and calculations in financial engineering often require high-performance computing clusters or cloud resources.
- **Financial Data Feeds:** Financial data feeds in real-time and the past give essential market data for making decisions and formulating strategies.
- **Visualization Tools:** Graphing and visualization tools help communicate complex financial concepts and results effectively.
- **Blockchain and Smart Contracts:** For applications involving cryptocurrencies and distributed ledger technology, tools for blockchain development and smart contract creation may be utilized.

These conceptual and physical tools are used in combination to create innovative financial products, manage risks, optimize investment strategies, and address complex financial challenges. Successful financial engineering requires a deep understanding of both theoretical concepts and practical tools to implement them effectively in real-world scenarios.

III. FINANCIAL ENGINEERING PROCESS

The process to create financially engineered products is no different from developing any new product. It consists of five stages, namely, identification of need, idea generation, testing of product, pricing, and restructuring of product, and launching of product.

Figure 3: Financial Engineering Process

1. **Identification of Need:** The first stage in the development of any new product is the identification of needs in the market. To develop a financially engineered product we first need to search for the problem that is required to be solved. Suppose we find that investors have risk aversion towards equity then we can introduce some debt funds or hybrid funds to solve this problem.

2. **Ideation:** This is the stage where the concept of the product is developed. Engineers study the market needs and potential to generate new ideas about the products.

3. **Testing of Products:** The prototype of the product is then tested by senior managers or customers to find issues, if any, with the product. This can be done by running some simulated future scenarios.

4. **Pricing and Restructuring of Products:** After testing of products, they are priced accordingly. At this stage some products might be highly-priced than their benefits, to make them lucrative to customers they are then restructured.

5. **Product Launching:** The final stage is the publicly launching of the product or the solution.

IV. FUTURE DIRECTIONS IN FINANCIAL ENGINEERING

The discipline of financial engineering is a developing one that integrates mathematical methods, computer programming, and financial expertise to produce ground-breaking approaches to reducing financial risk and improving investment strategies. Future development in financial engineering can take the following forms:

1. **Artificial Intelligence and Machine Learning (AI/ML):** The fusion of AI and ML techniques is probably going to have a big impact on financial engineering in the future. These technologies can improve customer service, algorithmic trading, risk assessmen,fraud detection, and portfolio optimization.

2. **Monetary Policy Modelling:** Financial engineers may continue to research and create models that assist central banks and policymakers in comprehending the effects of unconventional monetary policies like negative interest rates and quantitative easing.

3. **Climate Finance and ESG:** Financial engineers may build tools and models to assess and manage climate-related risks as well as produce novel financial products that are in line with sustainability objectives as environmental, social, and governance (ESG) factors become more significant.

4. **Blockchain and Cryptocurrencies:** New financial products and risk-management techniques may be developed in this area as a result of the use of blockchain technology and the rising popularity of cryptocurrencies.

5. **High-Frequency Trading (HFT) and Algorithmic Trading:** Further developments in market microstructure and liquidity management may result from the development of algorithmic trading tactics, including high-frequency trading.

6. **Derivative Innovation:** To meet the unique risk management requirements of people and institutions, financial engineers may continue to create new types of derivatives and structured products.

7. **Behaviour Finance and Robo - Advisors:** Investment plans that are more individualized and successful may result from incorporating behavioural finance insights into automated investment advising services (robo-advisors).

8. **Regulatory Compliance and Risk Management:** Financial engineering techniques can be used to create risk management frameworks that adapt to changing regulatory standards, assisting financial organizations in more successfully managing compliance and operational risks.

9. **Predictive Analytics and Alternative Data:** Using non-traditional data sources (alternative data) and alternative data may increase the accuracy of financial models and improve decision-making.

10. **Personalised Financial Products:** Financial engineers could construct customized investing and risk management strategies using big data and AI to develop personalized financial goods and services that are catered to individual needs.

It's vital to keep in mind that a mix of technical improvements, regulatory changes, economic trends, and market demands will probably influence the future of financial engineering. Financial engineers will need to adapt and develop as the financial environment changes in order to take advantage of fresh opportunities and difficulties.

V. CONCLUSION

As financial engineering deals with complex financial products and risk management strategies, ethical considerations are of utmost importance. Financial engineers must ensure transparency and fairness in their models and avoid contributing to excessive market volatility or creating products that could potentially harm investors or the broader financial system.

In conclusion, financial engineering is a dynamic and critical field that continues to shape the modern financial landscape. By combining quantitative skills with a deep understanding of financial markets, financial engineers contribute to more efficient, innovative, and stable financial systems worldwide.

BIBLIOGRAPHY

[1] Finnerty, J. D., Financial Engineering in Corporate Finance:An Overview, Financial Management, Winter 1988, Pp. 14-33.
[2] Marshall, John.F and Bansal, Vipul K, Financial Engineering: A Complete Guide to Financial Innovation, Printice-Hall of India,New Delhi, 1996.
[3] Mason, S P., Merton, R.C., Perold A. F., and Tufano P., Cases in Financial Engineering: Applied Studies of Financial Innovation, Prentice Hall, Englewood Cliffs, New Jersey, 1995.
[4] Miller, M H. Financial Innovation: The Last Twenty Years and the Next, Journal of Financial and Quantitative Analysis, December 1986, Pp. 459-71.