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Financial Engineering

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ABSTRACT : *Financial services constitute the foundation of a modern economy. Financial engineering is using mathematical techniques to solve financial problems and exploit financial opportunities. It involves using financial such as forwards, futures, swaps, options and related products to restructure cash flows so as to achieve particular financial goals. It is a multidisciplinary field drawing from finance, economics, mathematics, engineering, and computational methods. This paper provides a brief introduction to financial engineering. It is hoped that it will offer a starting point for those who are new to the field.*

Key Words: *financial engineering, computational finance, risk management, simulation*

I. INTRODUCTION

Finance is fundamental to investment in any economy. Financial engineering (FE) is the application of mathematical methods to solve financial problems. It combines tools from applied mathematics, computer science, statistics, and economics. FE is crucial to our financial system, which is the life blood of efficient and responsive capital markets. As shown in Figure 1, areas closely related to FE include financial markets, mathematical finance, economics, econophysics, and computational finance [1]. FE has changed the way we do business and also the daily life of average citizens in the leading economies. Due to FE, trading in options and other derivatives has grown dramatically. Important areas of FE include mathematical modeling of market and credit risk, pricing and hedging of derivative securities used to manage risk, asset allocation, and portfolio management. One major objective of FE is to meet the needs of risk management. In other words, the financial engineering theory is developed around the risk management. The goals of financial engineering research include developing empirically realistic stochastic models describing dynamics of financial risk variable and developing analytical, computational and statistical methods and tools evaluate financial products used to manage risk [2].

People use the term "financial engineer" to refer to someone who has a degree in FE. Commercial banks, investment banks, insurance companies, brokerage and investment firms, accounting and consultancy firms, treasury departments, public institutions such as federal government agencies, state and local governments, municipalities, and international organizations, and regulatory agencies employ financial engineers. Many problems in FE require solving partial/stochastic differential equations. The two major tools for solving the equations and providing solutions are the finite-difference method (FDM) and Monte Carlo (MC) simulation. Solving a partial differential equation using finite difference method requires formulating a difference equation and creating algorithms to solve the resulting set of discrete equations [3].

Simulation is a necessary tool for constructing the initial solution as well as evaluating it by computing lower and upper bounds. Monte Carlo simulation is a common method used in financial engineering to estimate expectations. It is easy to apply to many problems and its rate of convergence typically does not depend on the dimensionality of the problem. It also provides the confidence interval for the Monte Carlo estimate. Monte Carlo simulation has been implemented in practice for pricing of derivative securities valuing American and European options, and to compute risk measures of the financial portfolios [4,5]. However, computation speed is a major challenge to deploying MC simulations in many large and real-time applications. Using FDM and MC frees financial engineers from a dependence on closed-form solutions and tractable but unrealistic models. Other tools for implementing financial models including stochastic dynamic programming, data analysis, neural network modeling, Fourier methods, optimization techniques, and spectral methods.

II. APPLICATIONS

Financial engineering plays a key role in the customer-driven derivatives business. The main applications of financial engineering include trading, insurance, product development, derivative securities valuation, valuation of options, American option pricing, computing price sensitivities, portfolio structuring, risk management, and scenario simulation. Other applications of financial engineering include algorithmic trading, investment and portfolio analysis, hedging, consumption/portfolio optimization, incomplete and/or constrained markets, transaction costs, optimal portfolio selection, asset pricing models, volatility modeling and volatility derivatives, credit risk and credit derivatives, fixed income markets, commodities, and path-dependent options.

III. CHALLENGES

To improve the quality and credibility of research in financial engineering, it is crucial that financial models demonstrate sound engineering features of reliability and robustness and apply a repeatable process. Basic engineering practices such as repeatability, reliability, realism, and robustness are important [6]. One major challenge in FE is the solution of sparse linear systems. This is one of the most prohibitively compute intensive tasks. Therefore, the linear solvers should be carefully chosen and efficiently implemented in order to harness the available computing resources [7]. Several opinion-formers have drawn attention to the potentially harmful effects of "complex financial engineering" in the run-up to the crisis and ensuing credit crunch. The massive use of badly controlled innovative financial engineering tools is identified as a harmful practice associated with the sub-prime crisis [8].

IV. CONCLUSION

Financial engineering is a fast-growing, dynamic field that combines finance, applied mathematics, and computer science. It is becoming increasingly important in the new global, digital economy and is playing an important role as a major discipline within finance. The need for qualified people with specific training in financial engineering continues to grow. Several engineering schools and mathematics departments in universities are conducting multidisciplinary courses in FE. For example, Columbia University offers FE as a multidisciplinary field at levels ranging from undergraduate to PhD [9].The International Association of Financial Engineers (www.iafe.org) is a non-profit organization formed in 1991 to promote financial engineering profession. The Association publishes peer-reviewed *Journal of Financial Engineering*, and sponsors several annual conferences. Additional information on financial engineering is available in several books in Amazon.com.

REFERENCES

[1] N. K. Hwa and J. Ng, "From rocket scientists to financial engineers," Engineering Science and Education Journal, February 2002, pp.

[2] J. R. Birge and V. Linetsky, "Introduction to the handbook of financial engineering," Journal Handbooks in Operations Research and Management Science , vol. 15, no. C, 2007, pp. 3-12.

[3] D. J. Duffy, Finite Difference Methods in Financial Engineering. Chichester, UK: John Wiley & Sons, 2006.

[4] N. Chen and L. J. Hong, "Monte Carlo simulation in financial engineering," Proceedings of the 2007 Winter Simulation Conference, 2017, pp. 919-931.

[5] P. Glasserman, Monte Carlo Methods in Financial Engineering. New York: Springer, 2003.

[6] G. D. Boetticher, "Engineering financial engineering," IEEE Conference on Computational Intelligence for Financial Engineering & Economics, 2014, pp. 231-238.

[7] A. Gaikwad and I. M. Toke, "Parallel iterative linear solvers on GPU: a financial engineering case 18th Euromicro Conference on Parallel, Distributed and Network-based Processing, 2010, pp. 607-614.

[8] C. Clarke, "Financial engineering, not economic photography," Journal of Cultural Economy, vol. 5, no. 3, 2017, pp. 261-278.

[9] M. Broadie et al. "Financial engineering at Columbia University", Quantitative Finance, vol. 12, no. 1, 2012, pp. 11-14.

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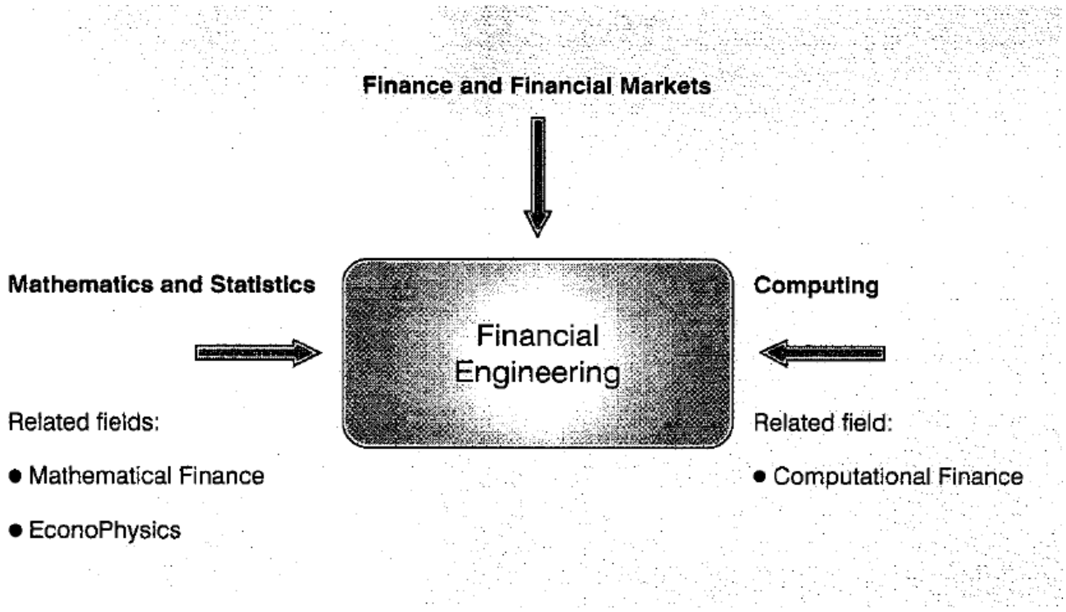

Figure 1: Areas related to financial engineering [1].