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Evaluation of the importance of mathematical modelling in finance through a discussion of its uses and misuses

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Having analysed different aspects of using mathematical modelling tools in the financial sector, this article concentrates on the use and misuse of such models for influencing the forecasting and decision-making in financial institutions. Some reasons for general limitations and possible solutions to improve the usefulness of mathematical models in an application area are discussed.

Mathematical modelling is the method of translating the problems from real-life systems into conformable and manageable mathematical expressions whose analytical consideration determines an insight and orientation for solving a problem and provides us with a technique for better development of the system [1]. A wide range of mathematical models is used extensively in various fields including natural sciences, engineering, and social sciences. As in many fields of science, mathematics plays a relevant role in finance. The basis of financial theory is an analysis of actions of 'economic agents' on an effective use of resources under uncertainty, and as a complex procedure, it makes necessary the use of advanced methods of mathematical modelling, the application of which has a direct and considerable impact on the financial world [2]. The use of such methods in finance might take different directions regarding various aspects of financial market types, each of which might involve sophisticated analytical and numerical techniques [3].

Now, let us evaluate the importance of using mathematical modelling tools in finance through a brief historical overview and a discussion of its positive and negative influence on financial markets. Although at the present time much of the research in finance theory on the application of mathematical modelling techniques is widely accepted within financial organizations, the influence of mathematical models on practice in finance was not always significant [2]. For example, Louis Bachelier's doctoral thesis "Theorie de la Spéculation" (published 1900 in Paris) discussed the use of the concept taken from the field of physics as Brownian motion to evaluate stock options and today this work is considered as the historical origin of mathematical finance; however, the author's innovativeness was not appreciated for about 50 years [2]. With the beginning of the period of modern finance in the 1960s this thesis anticipated other outstanding works in the financial theory and practice. Examples include the development of the risk measuring models by Treynor (1961), Sharpe (1964), Lintner (1965), Mossim (1966), and Markowitz (1979), extensive research on the area of investments by Samuelson-Fama (1965), then the most influential work on applied financial theory – the development of the Black-Scholes model (1973) – became the basis of mathematical finance presently adopted by many practitioners of financial institutions [4]. A substantial amount of fundamental work on more sophisticated models has been done in this field thus far which encouraged effective communication between finance practitioners and applied mathematicians. The history of mathematical finance illustrates, therefore, that mathematical methods and models of financial analysis are hugely important to value innovative financial instruments, to make decisions related to derivative securities, investment, risk management or hedge funds, which provide with better understanding of the mechanisms of financial operations [4].

However, this use of mathematical modelling techniques has not always had a positive effect on the financial sector. Unfortunately, when the complexity of mathematics in finance reaches higher levels and finance theory becomes more sophisticated, the level of its misuse and abuse also increases [5]. There have been some announced cases of huge losses incurred by many large global and small local companies due to their lack of comprehension of financial instruments [5]. One representative example that demonstrates this problem is the breakdown of one of the largest consumer goods companies, Procter and Gamble (P&G) in the 1990s, when business dealings with derivatives including the speculation on the direction of interest rates had an opposite effect [5]. In this case, it became evident that the built financial model was not appropriate for five years and calculations of the income showed wrong numbers [5]. As a result, instead of the potential realization of 7.5 million dollars, P&G lost approximately $200 million [5]. Such a situation illustrates that even if the financial instrument can be modelled sufficiently accurately with the usage of high-level analytical and numerical methods, it is difficult to predict the market for a longer period.

Therefore, with enormous fluctuations occurring frequently in the financial markets the demand for better forecasting and decision-making methods is increasing. Since organizations responsible for producing economic and financial forecasts have a huge amount of information to process and a growing variety of techniques, the forecasting failures might occur spontaneously and the crucial ones may lead to severe consequences. A classic example of such situation is the financial crisis in 2008, after which the public started to blame most practition-

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ers of the financial institutions, whose developed models in fact worked efficiently before the recession. All claims related to ineffective and exorbitant use of mathematics demonstrate that although financial models can bring a significant value to understanding financial systems and can assist greatly in forecasting and the decision-making process, it also has some limitations. In his article Mr. Rodney Sullivan states that most important among the limitations of modelling techniques is the incapability to effectively capture change in uncertain directions of markets, so models might cause risks to those who rely too heavily on them as no single model can contain all the necessary information to predict outcomes [6]. In addition, sophisticated mathematical models can be difficult to understand, so they may inadequately consider variables of a dynamic financial system and in this manner can hide dangerous weaknesses [7]. Thus, financial models are far from accurate representations of complex, dynamic modern economic and commercial systems. Moreover, accuracy can be improved by developing financial models that are more robust to changes with the use of precise historical and contemporary data to analyze trends more accurately [7]. Being critical of current financial services because of the limitations of models, Professor Roman Frydman was quoted in *The Economist* saying that "the forecaster in financial markets should act like an entrepreneur, not a scientist, he uses quantitative methods, but he also studies history, and relies on intuition and judgment" [8].

In conclusion, the history of financial modelling and the current state of the subject illustrate that analytical and numerical techniques have a significant influence in finance on practice. Financial modelling is often tackled with the full force of mathematical technology and applied to activities such as cash flow forecasting, business valuation, capital budgeting, financial analysis, risk management, product innovation and many others. Using the high-level mathematical modelling methods is a powerful way of predicting and decision-making in financial markets. However, there are different sources that might cause failure of these processes in financial markets such as gaps in statistical knowledge by virtue of inaccurate data, limited knowledge of financial institutions and unexpected changes in the economy as a result of wars, natural disasters, et cetera. In spite of the fact that financial models have some limitations related to the uncertainty of markets and the complexity of mathematical models, the need for a close look at the role and effectiveness of financial models is considerable. Modelling is a fundamental tool and, as financial models are constructed by people, there might be some errors which probably lead to inaccurate or wrong outcomes, so financial practitioners must not only heavily rely on them, but on their intuition and judgement. Only the proper use of mathematical models in finance with consideration of all accurate financial data, trends of financial markets, and useful variables of a system might bring a good understanding of dynamic markets and assist practitioners to make financial projections and decisions adequately.

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