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Plenary Session

Opening Speech

By

Professor J.D.Agarwal
Professor of Finance & Chairman
Indian Institute of Finance, Delhi
jda@iif.edu

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Opening Speech in Plenary Session on

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Professor J.D.Agarwal
Indian Institute of Finance, Delhi, India,
jda@iif.edu

Hon'ble Chairman I.A. Ryabinin, Chairman of the plenary session. Professor Solojentsev chairman of the National organizing Committee, Professor G.M. Reinstein Co-chairman National Organizing Committee; Professor V.V. Karassev Secretary National Organizing Committee Professor K.V. Frolov Academician (Russia-RAS) Chairman of International Program Committee and other hon'ble co-chairmen of International Program Committee, Hon'ble Scientists and Specialists, speakers, delegates, invitees, ladies and gentlemen, it is my privilege to have been invited to deliver this opening speech in the International Scientific School on Modeling and Analysis of Safety and Risk in Complex Systems (MA SR – 2007) organized by the Russian Academy of Sciences from September 4-8 2007 in Saint Petersburg Russia.

At the outset, I would like to seize this opportunity to compliment the organizers of this conference both for choice of the subjects to be debated and representation of such a large number of scientists and specialists from as many as 21 countries almost from all over the world, to share the results of theoretical and practical researches in the area of quantitative modeling and analysis of risk and develop the connection between different areas of risk for the construction of overall risk theory in business and engineering. In my opinion this may be one of the largest congregations of well known scientists and specialists on the subject presenting 70 research papers. To the best of my memory such a wide variety of scientific papers from engineering to business and finance coving areas risk in bankruptcy, risk in value of exchange, risk estimates of portfolio investors, wealth effects of financial distress on industry rivals, bank control and stability credit risk and risk probabilistic uncertainty of probabilistic measures in portfolio analysis are rarely handled in one scientific school.

This is a matter of pride for me to be a part of this scientific school, meeting and knowing about the work of such a galaxy of scientists and specialist in the historical and one of the most beautiful cities of the world. I am sure the conference would be a grand success to fulfill its main goal.

Introduction

Modeling and analysis of Safety and risk in Complex systems has assumed new dimensions with increasing complexities in the changing environment in the world economy. The world has become a global village. Information Technology, Satellite systems, Telecommunications, means of transportation have reduced the size of the world in terms of operations. The mouse of a computer and click of a button can handle transactions worth millions and billions in no time. Pressing of a button on the computer or in the laboratories may cause disasters for some, It may cause firms organizations, banks financial institutions, stock markets and even some economies to face serious economic and financial problems resulting in to virtual failure. From the economic point of view the borders of the nations have lost meaning. Even the cultures are being influenced through the satellite. As the world is shrinking in size in terms of economic operations, large systems are becoming more complex and vulnerable than ever before. Risk which was associated with time in the past has now become an instant phenomenon. In situations, when extreme steps are taken by some, systematic risk is overtaken by unsystematic risk.

Modeling, Scientists & Specialists:

Models are symbols of perfection and lead to perfection and make this world more beautiful, safer meaningful and facilitate living an enormously good life. Some people may be critical of model builders for them to be theoretical, living in white marble palaces and engaged in futile exercises far away from reality. Time has proved and proves that these very people have not only helped in the advancement of science but also made the life of the people of the world more comfortable. Models over the years have helped simple organizations to emerge as mega and complex systems and facilitated risk mitigation. Today's world is a result of yesterdays' models and contributions from scientists and specialists like you, who have gathered here in this scientific school to make this world great, risk free and people happy, prosperous and feeling safe.

The models may either evolve over a period or are a result of scientific thinking. Its not just adding another brick on the wall already constructed but born out of creativity, innovation, need to improve and of course a scientist's secret urge to make his/her humble contribution to his field of specialty to be a living human, across cultures, religions, geographical boundaries, many many years ever after his/her death. His desire to be referred, quoted and becoming a base for further discoveries in the world.

I salute these scientists and specialists (past and present) who have given this world so much at the cost of their own comfortable and luxurious living. A man has only one life. He has a right to enjoy it like everyone else, but, these scientists and specialists instead of spending and enjoying in opera spend their life in laboratories, in libraries, on their computers and dump themselves in their chairs for major part of their day, month after month, year after year, in their lifetime. The time, they are expected to be in intimate embrace with their wife and justifiably to have a feeling of oneness is spent embracing scientific issues building models, and merged in scientific equations. Even in their sleep, their sub conscious mind is working on some problem, discovery, or complexities of the model to seek solutions. Many times in the midnight their wives discover them in their study or lab lost in their own world seeking solution to some complex problem to make this world what it would be tomorrow while others are living their life comfortably and enjoying. In my young age my wife often found me missing on the bed and in a huff discovered me on my table. She was generally very kind to go to the kitchen and make a cup of tea and quietly keep it on my table in support of my work. Of course there were no computers (Laptops) at that time. Now she is tuned to the extent that when my children or relative ask for me she would with a sweet smile say "where else, see him in his study".

Most of the scientists are not expecting praise, position, publicity, power or money for their discoveries and contributions. They are satisfied if their models and discoveries are useful to the society and in their field of specialty. Result of the sacrifices of scientists and specialists and their models in the complex system are clearly visible.

Modeling & Analysis of Safety:

Safety is a matter of major concern for the state, corporates and people. The world is faced with several odds from time to time. The inequalities of incomes and wealth and consumption pattern amongst people and between nations have widened. A part of the world, unfortunately, suffered from extreme hunger, poverty, deprivation, underdevelopment, illiteracy, diseases such as HIV/aid and lack of the most basic necessities of life despite the best efforts of international agencies, the national governments and NGOs. Appropriate models for safety and security against these evils prevailing in the society, are required at global level.

Another major area of concern is safety from natural disasters such as earthquakes, floods, droughts, Tsunami etc. Japan where large numbers of earthquakes occur has devised mechanism to construct buildings which are earthquake prone. Similarly models for early forecasting of some of these natural disasters and facilitating early timely action have been evolved by scientists and specialists.

Another major area of concern, is models for safety of plants, factories and buildings. The fall of buildings, or collapse of a machine, aircraft crash, train accidents or sudden shut down of a factory etc may cause major catastrophe. Why should a train accident occur or a buildings fall. At time short circuiting of electricity or leakage of gas or use of outdated and very old machines or buildings, or human error is the cause. Probabilistic models using Monte Carlo simulation can help avert some of these catastrophes. Union Carbide gas leakage in 1984 in Bhopal, India, was one of the worst catastrophes resulting in the loss of thousands of lives and making thousands incapacitated. The commendable works of E.D. Solojentsev and I.A. Ryabinin deserve special mention in this regard. They have developed excellent logical Probabilistc models (LP models) for managing safety and risk management in both business and engineering. These models can be extended to other areas equally and efficiently.

Third, we need to develop models of safety against disasters which are man made such as terrorist attack on the World Trade Centre and the most recent devastating forest fire in Greece. A strict monitoring of air surveillance through proper modeling might have helped averting such events and providing safety of the twin towers and also life of people.

Fourth, Modeling and analysis of Safety against volatility of international/national markets, money laundering, corruption, foreign exchange fluctuations, bribing is of paramount importance. East Asia crisis of 1997-99, Harshad Mehta Security scam of 1992 in India, Enron and Arthur and Anderson episode in U.S. and massive money laundering taking place in the world economy are some of the examples. There are models available but not effectively used to monitor such situations. Some of the models even require refinements using extensively probabilistic models, simulations and stochasticity in the models. Scientists and specialists are involved in bringing refinements but at times the models fail because there is not enough support from the business or political leadership in implementing such models.

Complex Systems:

Complex systems is therefore often used as a broad term encompassing a research approach to problems in many diverse disciplines. Design and development costs for extremely large systems could be significantly reduced if only there were efficient techniques for evaluating design alternatives and predicting their impact on overall system performance metrics. Complex Systems is a new approach to science that studies how relationships between parts give rise to the collective behaviors of a system and how the system interacts and forms relationships with its environment. Complexity theory takes its roots into Chaos theory, which has its origins more than a century ago in the work of the French mathematician Henri Poincaré. Chaos is sometimes viewed as extremely complicated information, rather than as an absence of order. The point is that chaos remains deterministic. With perfect knowledge of the initial conditions and of the context of an action, the course of this action can be predicted in chaos theory. As argued by Prigogine, Complexity is non-deterministic, and gives no way whatsoever to predict the future. The emergence of complexity theory shows a domain between deterministic order and randomness which is complex. When one analyses complex systems, sensitivity to initial conditions, for example, is not an issue as important as within the chaos theory in which it prevails. As stated by Colander "The study of complexity is the opposite of the study of chaos. Complexity is about how a huge number of extremely complicated and dynamic set of relationships can generate some simple behavioural patterns, whereas chaotic behaviour, in the sense of deterministic chaos, is the result of a relatively small number of non-linear interactions". Due to the systems' analytical intractability, simulation is the most common performance evaluation technique for such systems. However, the long execution times needed for sequential simulation models often hamper evaluation. The slow speeds of sequential model execution have led to growing interest in the use of parallel execution for simulating large-scale systems. Widespread use of parallel simulation is easier now than ever before for integrating parallel model execution into the overall framework of system simulation. One drawback to widespread use of simulations is the cost of model design and maintenance. The simulation environment, developed at UCLA attempts to address some of these issues. It consists of three primary components: a parallel simulation language called Parsec (parallel simulation environment for complex systems), its GUI, called Pave, and the portable runtime system that implements the simulation algorithms.

Risk & Uncertainty in Complex Systems:

Risk management is managing (preparing for) future uncertainties. A leading example, originating from finance, is the problem of choice among mutually exclusive investment opportunities or portfolios having uncertain returns. Uncertainties are risks. They are the unknowns associated with future events. The decisions we make today create the risks that we must manage tomorrow. Risk management and decision-making is effectively the same thing. Both involve the dismantling of choices so as to understand uncertainty of outcomes associated with a particular option. High quality decision-making serves the purpose of risk management. If decisions include a thorough consideration of uncertainties, then future risks are simplified or minimized.

The problem of risk and uncertainty in economics is not new. The treatment of uncertainty in decision-making is traced as far back as 1738 with Petersburg Poradox[1]. But in the work of Knight[2] (1921) risk and uncertainty have been recognized as the pertinent areas in economics. Knight stated that the problem of risk and uncertainty has been recognized and discussed primarily in three connections (i) insurance, (ii) speculation, and (iii) entrepreneurship. Knight pointed out that uncertainty must be taken in a sense radically distinct from the familiar notices of risk from which it has never been separated. According to him, 'risk' refers to those cases where a quantity is susceptible of measurement, while 'uncertainty' refers to the case of non-quantitative type. The work of Knight has primarily been recognized as referring risk to a situation where the probability of occurrence of each outcome of a decision is known while uncertainty has been recognized as referring to situation where the probability of occurrence of each outcome of a decision is not known. Miller[3](1977) is of the opinion that no such attention is paid to this distinction today because in either case the future is unknown.

Every decision is a balance between what we believe to be true and what we are forced to predict. Every decision involves the analysis of available information and ultimately the selection of a choice among alternatives with varying degrees of uncertainty. It follows that to better our information and the more balanced and thorough analysis, the higher can be the quality of our decisions. Better decisions are informed, reasoned, and balanced. Making better decisions means living with less risk. Poor decisions are risky. They are made without a full understanding of what might go wrong. It is not that if you make a poor decision you are necessarily going to be proven wrong, but that the decision was made without a full understanding of the uncertainties or risks involved. With poor decisions, risks are understated and returns exaggerated. High quality decisions imply a complete understanding of the uncertainties involved. Making high quality decisions involves recognizing what risks you are taking. It is about making informed decisions. Risks are the residual uncertainties left behind when decisions are made without perfect information. But of course we never have perfect information. We therefore make decisions based on what we believe to be true and take a chance (accept the risks) of being wrong. High quality decisions are decisions in which the magnitude of the risk of being wrong is understood

There are three sources of uncertainty inherent in decision-making.

- Known-unknowns
- Unknown-unknowns
- Analytical-bias

Known-unknowns are areas of uncertainty that are recognized and integrated into the decision-making process. This is the stuff about which we know and we should be concerned. In deciding which type of new car to purchase, the known-unknowns include future repair costs (after the warranty period is over) for one brand versus another or residual value (sale price) after a number of years of use. These are issues that we know to worry about but do not know just how worried to be.

Unknown-unknowns are risks (uncertainties) that are relevant to decision but not included in the analysis. This is the stuff that is”off our radar”. Your level of knowledge about a particular situation determines unknown-unknowns. The more informed you are, the fewer (or more obscure) the unknown-unknowns.

The third element of risk, analytical-bias, relates to imperfections in our understanding and analysis of choices. This is the stuff of habit, prejudice, and mental laziness. Analytical bias may be referred to as the unknown-unknowns of the known-unknowns. It is a consequence of being human. Every analysis is a reflection (to some degree) of the person doing analysis. Analytical bias is the difference between what we believe to be true and what is actually true. It is the difference between fact and perception.

A large number of problems in production planning and scheduling, location, transportation, finance, and engineering design particularly in complex systems, require that decisions be made in the presence of uncertainty. Uncertainty, for instance, governs the prices of fuels, the exchange rate fluctuations, the availability of electricity, and the demand for chemicals. A key difficulty in optimization under uncertainty is in dealing with an uncertainty space that is huge and frequently leads to very large-scale optimization models. Decision-making under uncertainty is often further complicated by the presence of integer decision variables to model logical and other discrete decisions in a multi-period or multi-stage setting. Decision quality is measured in terms of residual risk left behind as a result of imperfections in knowledge and analysis. The highest quality decisions have little or no uncertainly, the poorest are based on ill informed guesswork; they are "a stab in the dark." So, to understand the quality of a decision one must understand the weaknesses in the inputs that have gone into the decision-making process and in the approaches taken to reaching decision. The degree to which various sources of risk in a decision are considered determines the quality of the decision. Decision quality is risk management.

The effect of risk and uncertainty on asset prices, on rational decision has increasingly engaged the attention of economists and other researchers.

Modeling & Analysis of Safety & Risk in Complex Systems:

Another area of concern or managing risk and uncertainty in complex systems is capital investment and portfolio investment. Most of the literature in capital investment and portfolio decisions under risk and uncertainty has mainly followed three trends: (1) Simplistic Approach, (2) Portfolio Theory Approach and (3) Mathematical Programming Approach.

The first type of approach is to use a simple criterion by suggesting a simple modification in the deterministic criterion. Some of the capital budgeting decision techniques that have been suggested in the past and belonging to this type are payback, risk adjusted discount rate, and certainty equivalent approach. This approach although in practice is highly tractable, cheap, quick and easily understood, but as Wilkes very rightly stated is less intellectually satisfying.

The Portfolio Theory Approach includes techniques such as probability distribution simulation approach, decision tree analysis, utility theory and sensitivity analysis to measure the return and variance on capital employed, as a surrogate measure of risk. The portfolio analysis approach so far gains only limited acceptance

Therefore a more recent approach has been to treat some of model parameters as random variables. The major contributions of this approach, referred as Mathematical Programming Approach, have come from Naslund (1968), Beck (1967) and Benhard (1969). Most of these approaches were based on an erroneous assumption that firms pursue single goal while firms pursue multiple goals and conditions of certainty never exist. A stochastic goal programming model and fuzzy goal programming models developed by me could provide a possibly good solution.

Capital Investment in the production area involved selection of fixed assets under conditions of uncertainty regarding future product demand. The fixed assets are generally chosen with consideration given to their income generating capacity; however that consideration is frequently secondary to other decision criteria, such as the desire to satisfy demand or perhaps minimize excess production, achieve quality control standards, space utilization, meeting environmental requirements etc.

Over the second half of the 20th century, optimization found widespread applications in the study of physical and chemical systems, production planning and scheduling systems, location and transportation problems, resource allocation in financial systems, and engineering design. From the very beginning of the application of optimization to these problems, it was recognized that analysts of natural and technological systems are almost always confronted with uncertainty. As such, the traditional approach to capital budgeting, i.e. maximization of net present value, break down when the complexities of production environment are considered. In order to deal with this problem, a hierarchical optimization model with ability to reflect multiple conflicting goals is necessary. Moreover, in order to adequately describe the decision environment problem of uncertainty and multiple conflicting goals are introduced using a chance constrained integer goal programming model.

Beginning with the seminal works of Beale (1955),Bellman (1957), Bellman and Zadeh (1970), Charnes and Cooper (1959), Dantzig (1955), and Tintner (1955), optimization under uncertainty has experienced rapid development in both theory and algorithms. Today, Dantzig still considers planning under uncertainty as one of the most important open problems in optimization (Horner, 1999). Approaches to optimization under uncertainty have followed a variety of modeling philosophies, including expectation minimization, minimization of deviations from goals, minimization of maximum costs, and optimization over soft constraints. Early attempts to formulate the capital budgeting problem employed mathematical programming. In particular linear programming was used for maximizing net present value of project selected subject to some budget constraint by H.M. Weingartner. In these models multiple conflicting goals were not assumed to exist or it was assumed that the benefits from these goals could be easily translated into monetary benefits and incorporated into the existence of objective function.

Theories and models, both mathematical and non-mathematical, developed in the West erroneously postulate the attainment of single objective of profit maximization and assume conditions of certainty. Firms in general pursue multiple objectives and conditions of certainty never exist. It is also generally seen that a decision maker faces a number of potentially serious problems choice among a large number of alternative projects, financial and non-financial constraints on capital resources, critical manpower problems, unreliable or income relationships. Each of these problems together with many others requires special consideration and may pose different constraints on decision making. All the techniques, theories and models based on single goal hypothesis, are outdated, irrational, misleading and give erroneous results, as firms and people pursue multiple goals with priority structuring incorporating risk and uncertainty. Maximum return with minimum risk is the dictum which everybody follows.

Unfortunately, the existence of multi-conflicting goals measured in incommensurable units may preclude this translation. For this reason Agarwal (1976) developed capital budgeting model dealing with multiple conflicting goals, within a hierarchical optimization framework and ordinal priority structuring. While this model provides for inclusion of multiple goals, they do not reflect the problem of uncertainty of future product demand. However, by employing chance-constrained capabilities as a supplement to regular Integer Goal-Programming Model, this deficiency can be compensated for. This solution approach to the capital budgeting problem in production area provides practical advantage over linear programming. It allows inclusion of multiple conflicting goals measured in incommensurable unit.

Agarwal (1978) model on Stochastic Goal Model for Capital Budgeting Decisions under Uncertainty takes care of uncertainty situations as well as multiple goals. The model which is primarily an extension of his Goal Programming model for Capital budgeting decisions (1976) is primarily a mathematical programming model but involves various quantitative techniques particularly probability theory, times series iterations, mean variance approaches, simulation and sensitive analysis to incorporate and handle parameters affected by uncertainty. The information about some of the models developed by me, is available in my books and articles and also on our website: http://www.iif.edu

At the end, I must take this privilege to thank the organizers particularly Professor E.D.Solojentsev and Professor Aman Agarwal for giving this honor to me to share my views on the subject with such august gathering. I wish I were have been one of you - scientists and specialists, presenting my own work.

With this, I have attempted to perform my most earnest duty assigned to me by the organizing committee.

I once again salute the scientists and specialists who significantly contributed through their modeling and discoveries to make this world a place for better living for all.

It has been my earnest desire to visit Russia ever since 1966 when as a young boy, I got an opportunity to meet and spend about two days and was highly impressed by a Russian Scientist visiting India. I am glad 40 years later it is fulfilled today.

I must also thank the members of this august house, the scientists and specialists, ladies and gentlemen, for their very kind patient hearing. I am sure each one of us would be wiser and wealthy with the research work sharing with other scientists during the international scientific school.

Once again I would like to congratulate the organizers and the Russian Academy of Sciences for organizing International Scientific School and giving all of us an opportunity to share our seminal work. I wish the conference a grand success.

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