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A Holistic Approach

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Synopsis

The purpose of this volume is to provide managers and entrepreneurs with a readily available tool to support their daily decision-making so that they know their decisions are mostly reliable and made on the basis of a sound scientific foundation, and scholars with a brand new approach to the research of managerial decision-making. To accomplish this practically significant and theoretically important outcome, instead of data mining and anecdotal analysis, this book establishes results by employing systems science and logic reasoning in general and the systemic yoyo model in particular. This abstract while intuitive in approach avoids all the serious limitations of econometric methods and anecdotal analyses.

This book is composed of five parts, entitled, respectively, "The Theoretical Foundation"; "The Present Era of Transient Competitive Advantages"; "The Innovativeness of Firms: Seen from Within"; "Development of Nationally Self-Sustained Momentum of Growth"; and "Going International or Staying Domestic?" The first part introduces the relevant details of systems science needed for the rest of this book and establishes a general theory on the dynamics of market competition and when and how micro entrants would enter a well-occupied market. The second part focuses on the fact that the business world is presently in the era of transient competitive advantages, where the once sustainable advantages become transient and short-lived. It explains why markets evolve faster and consumers become less patient than ever before, why companies are under both internal and external pressures to compete, and how companies can successfully ride the waves of transient competitive advantages.

The third part addresses the issue of how a firm can survive and succeed by looking internally at the concept of firms' innovativeness, which is the origin of growth. It investigates which of the numerous internal factors, identified empirically by many different scholars in the past, are actually the primary determinants of firms' innovativeness and which ones are secondary. Such knowledge is practically significant because managers and entrepreneurs can now focus their time and effort on developing the primary determinants instead of wasting resources on the secondary ones. The fourth part looks at the national economy by addressing the problem of

how an impoverished agrarian nation could develop a self-sustained momentum of growth. Considering the fact that it has been practically impossible, except China in recent decades, for any impoverished agrarian nation to develop an original Industrial Revolution, this part of the book represents a very important contribution to the literature on the Industrial Revolution. The fifth part of this volume considers the question of whether a firm should consider going international or not. To this end, this part first establishes the relationship between international trades and firm performance and then looks at the issue of trade dumping and antidumping.

Currently, important large-scale decisions in business are mostly made based on data mining or anecdotes. However, scientifically speaking, such ways of decision-making have been time and again shown to be flawed. That also explains why one magnificent business success of one location generally cannot be duplicated in another location although various scholarly conjectures or theories are developed on why the initial success was achieved. Because of this reason, this book is expected to open up a brand new territory of research valuable for working managers, entrepreneurs, and business/economics scholars. As shown within this book, many of the conclusions logically drawn on the basis of systems science can be practically applied to produce tangible economic benefits.

This book is written for those readers who are either graduate students, researchers, or practitioners in the areas of strategy, management science and engineering, economics, and decision science, either theoretical or applied. By studying this book, by referencing back to it regularly, and by employing systems methods, as presented in this volume, to resolve various demanding issues in business, the reader will master a brand new tool of analysis and an intuition. By employing the new tool and intuition, he/she will be able to make useful decisions relatively quickly without wasting unnecessarily the valuable time and a lot of the limited financial resources.

Preface

Because of our combined background and training in areas of mathematics and natural science, we find that there is a lot that needs to be done in the area of managerial decision-making in particular, and social science in general. The major difference we observed between mathematics/natural science and managerial decision-making (or social science) is that in the former case, as long as a new gadget (or a theorem) is produced with its functionality (respectively, consequences) well known, other people will most likely be able to design and produce (respectively, prove) a similar gadget (respectively, theorem) although the specific design (respectively, argument) of the original gadget (respectively, theorem) is not known. However, for the case of managerial decision-making (or social science), the situation is not the same. By observing business successes and by theorizing the reasons why these successes are achieved, people generally cannot duplicate the desired economic outcomes in another business setting in other parts of the world. To this end, the Industrial Revolution of England and the magnificent success of the Silicon Valley (California) are two of many such instances.

To answer the question of what leads to the challenge that faces decision-making managers and entrepreneurs, one only needs to compare how mathematics and theories of natural science are developed against how managerial hypotheses are conjectured. For the former case, each particular theorem or theory is developed based on some very intuitive and straightforward postulates or laws, accompanied by the consecutive introduction of specific terms. And the connection between the starting postulates/laws and each consequent result is established through rigorous logic reasoning developed on seemingly reasonable playgrounds, such as the n-dimensional coordinate system, $n = 1, 2, 3, \ldots$, consisting of n real-number lines that cross each other at a common point, known as the origin. On the other hand, managerial hypotheses are mostly conjectured based on some particular anecdotes or specific sets of data. To establish the hypotheses as propositions so that they can be more widely applied than where the anecdotes and data originally come from in business decision-making, econometric tools are mostly used. In this process of developing each and every managerial proposition, uncertainties inevitably appear

first, at the stage of conjecturing the hypotheses and second, at the stage of econometrically analyzing the data. It is because from the same set of evidences, different conclusions can be drawn depending on the decision-maker's background and because econometric tools are all, without any exception, constrained by their respectively strict requirements.

Based on this recognition, this book attempts to develop a general theory of managerial decision-making on the basis of a few elementary postulates, by employing logic as the method of reasoning and the systems science in general, and the systemic yoyo model in particular, as the intuitive playground. By doing so, we are able to take individually background-based guesswork out of the development of the theory. Due to this reason, all established conclusions are expected to be generally employable in real-life applications.

Different from all branches of mathematics that are based on numerical variables, such as calculus, and various methods of econometrics, systems science focuses on the investigation of organizations and structures. That is why we adopt systems science as our way of intuitively seeing how business entities behave in their interactions with each other, because business entities generally possess their respectively different, yet rich, internal structures. For example, each firm has its specific organizational culture, tradition, operational routines, etc., constituting the unique background on which the firm forms its particular understanding out of what the market is presenting. Differences in these internal structures lead to varied firm-specific understandings of the same market signal. And, it is these internal organizational structures that make systems science more readily and more adequately employable for us to study business decision-making than any of the other available tools developed on numbers or numerical variables, such as calculus and statistics. Here, calculus helps decision-makers to make predictions by extrapolating the present situation (also known as the initial value) into the future, while statistics expand the past trend (also known as data or anecdotes) into the future. However, managerial decision-making is more or less about predicting such a future that is drastically different from both the present and the past. That explains why there is an urgent need for the theory of managerial decision-making to go beyond the capability boundaries of the classical calculus-based methods and statistics-based tools.

Although the concepts of numbers (and numerical variables) and systems are abstracted out of the same physical world, they represent the world from two different and harmonizing angles. In particular, when a business organization is treated as a collection of unrelated people, properties, etc., the concept of numbers comes into play. For example, firm X employs n employees, occupies m office buildings, etc. On the other hand, when the organization of the firm is viewed holistically, then the concept of systems naturally emerges. For example, this firm X is really a binding platform that connects such elements as employees, capital assets, properties, etc. to form an organic whole. It is these relationships that the firm exists both physically and intellectually. In other words, most problems of managerial decision-making are essentially about organizations or systems, be they individuals, seen as economic agents whose behaviors are dictated by their personal value systems, firms, markets, industries, economies, etc.

Even though the concepts of numbers and systems share the same origin—the natural world—they represent two very different aspects of the world. The former is small scale and local, while the latter is large scale and organizational. More importantly, numbers exist only postexistence. That is why using number-based theories to make predictions has not been very successful, just as we discussed earlier about calculus and statistics. In other words, when one uses post-event evidence to predict the appearance of a not-yet-occurring event is doomed to be not very successful. On the other hand, systems emerge at the same time when physical or intellectual existence comes into being. That is the very reason why the methodology of systems is more appropriate than all theories developed on numbers and variables for the investigation of economic entities when their internal structures cannot be ignored.

As promised, this book presents a general theory of managerial decision-making with results generally applicable in practice. At the same time, we attempt to make this theory satisfy the following conditions:

1. It is reader-friendly to as many people as possible.
2. It coincides with people's intuition.
3. It possesses certain beauty that can be felt easily.
4. It is capable of producing meaningful results and insights for practical purposes.

As is argued by Y. Lin (2009) in the monograph *Systemic Yoyos: Some Impacts of the Second Dimension* (CRC Press, New York), only with these characteristics, the theory developed herein has a chance to enjoy a glorious and long-lasting life.

In particular, to satisfy condition 1, each and every theoretical result presented in this book will be accompanied by nontechnical explanations. In other words, the arguments, be they logical or systemic or both, can be skipped over without affecting the reading of the rest of the book. To satisfy condition 2, established results will be illustrated as much as possible with systemic intuitions so that the reader can see why the results are generally true. To satisfy condition 3, various figurative presentations of the systemic yoyo model are provided. And to satisfy condition 4, this book considers an array of exciting topics where managerial decision-making is always located at the center square. In particular, among others, we will carefully and in details look at the following topics:

1. How market competition plays out dynamically
2. How monopoly can possibly lead profit stagnation
3. How markets always signal their invitation for competition and innovation
4. What makes markets evolve faster and consumers less patient
5. What a firm needs to do to successfully ride the waves of transient competition advantages
6. What factors internal to a firm primarily determine the innovativeness of the firm
7. What a national government could do to foster the development of a self-sustained momentum of economic growth
8. Whether or not a firm should consider going international or just staying domestic
9. How such trade behaviors as dumping and antidumping interact with each other.

We hope that you, the reader, will enjoy reading and referencing this book in your real-life decision-making practice and scholarly exploration. If you have any comments or suggestions, please let us hear from you by dropping us a message. Jeffrey Yi-Lin Forrest can be reached at jeffrey.forrest@sru.edu or jeffrey.forrest@yahoo.com, Professor Jeananne Nicholls at jeananne.nicholls@sru.edu, Professor Kurt Schimmel at kurt.schimmel@sru.edu, and Professor Sifeng Liu at sfliu@nuaa.edu.cn.

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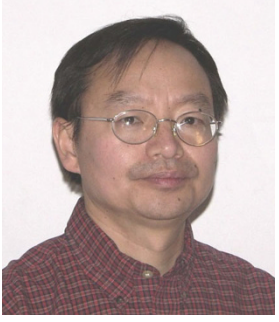

Jeffrey Yi-Lin Forrest also known as Yi Lin, holds all his educational degrees in pure mathematics and had 1 year postdoctoral experience in statistics at Carnegie Mellon University. He had been a guest professor of economics, finance, mathematics, and systems science at several major universities in China, including Nanjing University of Aeronautics and Astronautics. And currently, he is a professor of mathematics and research coach for the School of Business at Slippery Rock University, Pennsylvania, and the president of the International Institute for General Systems Studies, Inc., Pennsylvania. He serves either currently or in the past on the editorial boards of 13 professional journals, including *Kybernetes: the International Journal of Systems, Cybernetics and Management Science*, *Journal of Systems Science and Complexity*, *International Journal of General Systems*, *The Journal of Grey System*, etc. Currently, he serves as the editor in chief of three book series, "Systems Evaluation, Prediction, and Decision-Making" (CRC Press, New York), "Communications in Cybernetics, Systems Science and Engineering" (CRC Press, Balkema), and "Communications in Cybernetics, Systems Science and Engineering – Proceedings" (CRC Press, Balkema).

Some of his research was funded by the United Nations, the State of Pennsylvania, the National Natural Science Foundation of China, and the German National Research Center for Information Architecture and Software Technology. As of the end of 2018, he has published well over 400 research papers and nearly

50 monographs and special topic volumes. Some of these monographs and volumes were published by such prestigious publishers as Springer, Taylor & Francis, World Scientific, Kluwer Academic Publishers, Academic Press, etc. Over the years, his scientific achievements have been recognized by various professional organizations and academic publishers. In 2001, he was inducted into the Honorary Fellowship of the World Organization of Systems and Cybernetics. His research interests are wide ranging, covering areas like economics, finance, management, marketing, data analysis, predictions, mathematics, systems research and applications, philosophy of science, etc.

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Sifeng Liu is senior member of the IEEE, honorary fellow of WOSC, and senior fellow of Marie Curie International Incoming Fellowship under the 7th Framework Programme of the European Union. He received his PhD in systems engineering from Huazhong University of Science and Technology, China, in 1998. He is currently a distinguished professor of Nanjing University of Aeronautics and Astronautics and a research professor of De Montfort University. He is serving as the founding director of the Institute for Grey Systems Studies, the founding president of the International Association of Grey Systems and Uncertainty Analysis, the founding chair of TC of the IEEE SMC on Grey Systems, and the founding president of Grey System Society of China. He is also serving as the founding editor of *Grey Systems: Theory and Application* (Emerald) and the editor in chief of *The Journal of Grey Systems* (Research Information). He had worked at Slippery Rock University in Slippery Rock and New York Institute of Technology in New York, USA; Sydney University in Sydney, Australia; and De Montfort

University in Leicester, UK, as a visiting professor. And he led the College of Economics and Management, NUAA, from 2001 until 2012.

His main research activities are in grey system theory and applications. He has directed more than 50 research projects from China, the UK, UN, and EU. He has published over 600 research papers and 26 books by Science Press, Springer-Verlag, Taylor & Francis Group, and John Wiley & Sons, Inc. He is currently serving as the editor of the book series *Grey Systems* published by Science Press. His works cited 32 thousand times by others and had translated to Korean, German, and Romanian. Over the years, he has been awarded 18 provincial and national prizes for his outstanding achievements in scientific research and applications. In 2002, he was recognized by the World Organization of Systems and Cybernetics. His H-index is 55.

He has won several accolades such as the "National Excellent Worker of Science and Technology," "National Excellent Teacher," "National Advanced Individual for Returnee," "Expert Enjoying Government's Special Allowance," and "National Expert with Prominent Contribution."

Chapter 1
Facing the Challenge Holistically

This chapter describes the challenge this book will address that faces decision-making managers and entrepreneurs and explains why there is an urgent need to resolve related issues in order to meet the challenge. After this challenge is clearly presented, this chapter turns its attention to illustrate why systems science and systems methodologies are the appropriate approach for managers and entrepreneurs to use in their daily decision-making while pointing out weaknesses existing in the widely employed methodologies – anecdotal analysis, calculus-based tools, and statistics-based methods.

The rest of the chapter is organized as follows: Section 1.1 describes the very issue this book attempts to address. Section 1.2 introduces the basics of systems approach and explains why it is an appropriate tool for studying issues of managerial decision-making. Section 1.3 focuses on the topic of scientific irregularity – what it is, why it appears, and how it influences the lives of decision-making managers and entrepreneurs. Section 1.4 details the contributions of this work. And Sect. 1.5 concludes this introductory chapter by outlining the contents of this book.

1.1 The Issue This Book Attempts to Address

There are major differences between natural and social sciences. For example, in natural science, scholars traditionally investigate lifeless objects and the operational laws underneath the evolutions of physical things. Experience and rapid development of technology of the past several hundred years have witnessed the magnificent success of this approach. And, in social science, academics widely examine events and social processes involving people based on past data and known anecdotes, producing various data-specific and/or anecdote-specific theories hoping that they can be generally applicable to scenarios beyond the limitations of the original data and anecdotes. As consequences, in natural science, predictions are produced based on the basic laws; their accuracies can be checked quite readily later on by

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comparing what are predicted and what actually happens over time. And, in social science, predictions are generally made by using data or anecdotes of the past through extrapolating the existing pattern observed in the data or anecdotes into the future. However, the accuracies of the predictions are very difficult to check, because after learning about what is expected (or predicted), human participants generally modify their behavioral patterns according to their respective needs for the future to be. For example, when meteorologists forecast what weather conditions are forthcoming, the prediction does not have any bearing on the occurrence of the weather event. However, when influential financial analyzers predict how the stock market is going to move, be it upward or downward or sideway, in the coming weeks or months, individual investors generally position themselves accordingly, making the prediction mostly incorrect.

Because the methodologies and approaches used in natural and social sciences are different, scientists tend to use affirmative terms to state their conclusions, while scholars in social science generally use such words as "believe," "should," and "would." For example, Kotler et al. (2010), Krauss (2011), and Stengel (2011) *believe* that today's customers want to be treated as whole human beings and be acknowledged that their needs go beyond pure consumerism. In this instance, the word "believe" means, scientifically speaking, that these scholars are not quite sure about the correctness of what they are saying. Because Philip Kotler is considered as one of the most influential marketing thinkers (Kaul 2012), the example given above simply indicates that most decisions in the area of marketing are made based on anecdotes or data mining or both so that the decision-maker also knows that his/her decision could be wrong in general and when applied to scenarios beyond the limitations of the data or anecdotes employed in their studies. In fact, in natural science and mathematics, neither anecdotes nor data mining are recognized as reliable ways to produce dependable theorems and theories beyond potential facts finding; and by employing data mining, one can also easily discover "realities" that only exist with the particular sets of data used in the analyses (Lin and OuYang 2010).

When we narrow our general discussion in the previous paragraphs to the case of managerial decision-making, the following situation emerges, representing a great and exciting opportunity of scholarly research. When a technological breakthrough appears, by using the laws of science, engineers from different parts of the world are generally able to design and produce a similar technology without knowing the protected details of the original breakthrough. However, contrary to this situation in natural science, the case with managerial decision-making is not the same. For example, by closely observing business successes and by theorizing the reasons why these successes are achieved, people generally cannot duplicate the desired economic outcomes in another business setting in other parts of the world. To this end, the Industrial Revolution of England and the magnificent success of the Silicon Valley (California) are two of many such instances. Many developing countries have tried very hard in the past 100 plus years to launch their own versions of Industrial Revolution without luck (Rostow 1960; Wen 2016).

When the product market indicates that an increasing proportion of consumers make their purchase decisions based on whose price is more competitive, it can be recognized as an invitation the market sends out for innovation and additional competition; see Chap. 3 for more details. However, due to differences in their backgrounds, such as knowledge, skill, and philosophical value systems, and in availabilities of their respective resources, managers and entrepreneurs react to such market invitations differently. Due to the differences in understanding the market and in the consequent reactions responding to the market call, these risk-taking managers and entrepreneurs experience varied degrees of success. That is, decision-making managers and entrepreneurs generally face the challenge of how to appropriately understand a market signal and how to choose a suitable reaction in order to produce their desired business success.

In order to see what has led to this both theoretically and practically difficult challenge that faces decision-making managers and entrepreneurs alike, let us do a quick comparison without any detailed deliberation between how theorems in mathematics and theories of natural science are developed and how managerial hypotheses are first conjectured and then confirmed before practically used.

In mathematics and natural science, scholars first carefully develop a set of basic and intuitive postulates and laws, respectively. The validity of these postulates and laws is supported by some relevant and unquestionable knowledge or by repeated confirmation of lab results. Then each time when a new concept or term or phenomenon is introduced or considered, a group of theorems or a theory is established by using logic reasoning so that each conclusion is derivable directly or indirectly from the initial set of postulates or laws (Kline 1972; Bauer 2015). Here, the development of knowledge exploration in mathematics and natural science is similar to how a dictionary is composed – all words are explained by some very basic words, whose meanings are assumed to be clear without any further explanation or are explained by each other. For example, a set is defined as a collection of elements, while an element is defined as a member of a set (Kuratowski and Mostowski 1976), where "set" and "element" are two very basic words that are used to define each other and other words. Speaking differently, the initial sets of postulates and laws capture the essence of all mathematical scenarios and physical phenomena. As the mankind expands its exploration of nature, these sets also grow accordingly.

Additionally, other than logic reasoning is universally employed, seemingly reasonable playgrounds, such as the n-dimensional coordinate system, $n = 1, 2, 3, \ldots$, consisting of n real number lines that cross each other at a common point, known as the origin, are mostly utilized to support the background intuition that underlies rigorous logic reasoning. In fact, beyond playing the role of intuition, the one-dimensional coordinate system (i.e., simply the real number line) has been used to develop the theory of real numbers – the Dedekind cuts – that confirms the existence of irrational numbers; the two-dimensional coordinate system has been used to establish some of the most basic results of calculus, including $\lim_{x \to 0} sinx/x = 1$; the reason why we say that such a playground as the n-dimensional coordinate system is seemingly reasonable is because it does not exist in real life. Even so, it has been very useful and helpful in human understanding of nature.

Fig. 1.1 The blind men tempt to conceptualize what an elephant is like

In terms of managerial decision-making, various hypotheses regarding individually specific populations are mostly conjectured based on some particular anecdotes or repeated experience or associations of both. When an economic potential and/or theoretical value of some hypotheses is seen, researchers are aroused to test the hypotheses by using data and econometric methods in order to establish propositions so that they can be more widely applied in business decision-making than the range within which the anecdotes and data originally come from. The entire process of initially developing hypotheses, followed by testing, and then establishing general propositions is similar to the situation described in the proverb of "the blind men and an elephant" (Goldstein 2010, p. 492). In this proverb, a group of several blind men attempt to learn and conceptualize what an elephant is like by touching it, because none of them has ever come across an elephant before. If each blind man can only feel a different part of the elephant's body, such as the side, the tusk, a leg, an ear, the nose, the back, and the tail, they then hypothesize how the elephant looks like very differently from one another based on their limited experience and knowledge, although their sensing abilities are perfect, Fig. 1.1.

In this analogy, we imagine to treat the elephant as the population of concern, the blind men's initial touches of the elephant as the anecdotes from which hypotheses are developed. As for data collection and econometric testing, they can be seen as that after their hypotheses are developed, the men go back to where they are allowed to touch the elephant to collect additional evidences and then confirm whether or not their hypotheses are sufficiently supported. So, they individually make their completely different inferences about how the elephant looks like. In this fictitious scenario, none of these men has obtained the correct answer. To this end, one naturally questions the imposed constraint that each of these men is only allowed to touch the elephant at a particular location, because in reality these men naturally

want to explore the elephant in its entirety as much as possible before making their inferences.

To address this question corresponding to our discussion here, let us return to issues facing decision-making managers. When anecdotes and data are employed to formulate hypotheses, one always runs into such problems as sampling error, missing representation, etc. For example, in the study of market entry and entry timing, conclusions have been drawn on the available data of some successes, while those data of failed attempts are simply not available (Zachary et al. 2015). In the analysis of the innovativeness of manufacturing firms, the very concept of innovativeness is defined in dissimilar ways partially due to the reason of data availability, while specific-data-backed conclusions are universally stated (Becheikh et al. 2006). In the investigation of the relationship between a firm's market reach – domestic, or importing, or exporting, or any combination of these three options – and its performance, conclusions are mostly drawn on the data collected from a few developed countries because data from other countries are simply not available (Wagner 2012a, b). In the examination of the Industrial Revolution, most needed data are not possible to collect, because the event occurred long time ago and the process leading to the eventual recognition of the Revolution traversed a few hundred years (Rostow 1960). In all these listed and other unlisted studies, the "blind men" are the researchers, who are only allowed to "feel" particular parts of the underlying population, although they want to explore more than what is allowed. Hence, in terms of managerial decision-making, managers have to ask themselves the following question:

> How much can they place their faith on the "general" conclusions derived empirically in their decision-making?

Other than what is discussed above, two additional issues that are worthy of our attention are that (1) from the same set of evidences, different conclusions can be drawn depending on the decision-maker's background and knowledge structure, and (2) econometric tools, which are widely used in testing hypotheses, are all, without any exception, constrained by their, respectively, strict requirements.

Summing up the discussions in the previous paragraphs, the issue this book attempts to address is how to

> Develop a general theory of managerial decision-making in a similar fashion as that is commonly the approach used in mathematics and natural science.

That is, on the basis of a few elementary postulates, general conclusions are derived through logic reasoning on the intuition of a playground that is appropriate for us to imagine how organizations evolve and interact with each other. Considering the fact that the concept of systems is the right tool for visualizing structures and organizations, this book will employ systems science in general and the systemic yoyo model in particular as the intuitive playground. By doing so, we are able to take individually background-based guesswork out of the development of the theory. And because of this very reason, all established conclusions in this book are expected to be generally employable in real-life applications.

1.2 The Systems Approach

Different from all branches of mathematics that are based on numerical variables, such as calculus, differential equations, etc., and various methods of econometrics, systems science focuses on the investigation of organizations and structures or various kinds of systems (Lin 1999; Klir 1985). Because business entities generally possess their, respectively, different, yet rich, internal structures, we adopt systems science in this book as our way of intuitively seeing how business entities evolve, respectively, and behave in their interactions with one another.

System (or organization or structure) really exists everywhere, especially in investigations of issues related to managerial decision-making. For example, each human being is a very complex biological system, which is made up of smaller systems. Simultaneously, the person is also a member of many social and economic systems, such as a family, neighborhoods, communities, etc. Each day the person interacts with a range of various man-made systems, such as a car, an ATM machine, retail stores, the company she works for, etc. These systems, be they natural, social, or artificial, interact with each other constantly. So, beyond employing the concepts of numbers and variables to investigate problems and issues of managerial decision-making, which has been what is mostly done in the literature, we see an urgent need to employ the concept of systems and relevant methods to study events and social and economic processes in order to obtain brand new while practically useful understandings and conclusions. Here, what do we mean by "urgent"? When employing readily developed methodologies to help with managerial decision-making, we generally use either a calculus-based method or a statistics-based tool or a combination of both. However, any calculus-based method in essence helps decision-makers make predictions by extrapolating the present situation (or known as the initial value) into the future, while each statistics-based tool expands the past trend (or known as data or anecdotes) into the future. So, if we understand managerial decision-making as being more or less about predicting such a future that is drastically different from both the present and the past, then there is an urgent need for the theory of managerial decision-making to go beyond the capability boundaries of the classical calculus-based methods and statistics-based tools. In other words, after having tried various methods developed for data mining and anecdote analysis without producing many reliable scientific conclusions, now is the time for us to go straight to the underlying fundamental principles underneath the surface of numbers, numerical variables, and anecdotes that can lead to scientifically sound conclusions and practically reliable consequences.

Historically, the concept of systems has been directly or indirectly introduced by scholars in different disciplines over the recorded history in various languages. In order not to deviate away from our main focus here, let us look at two recent cases as examples. In the area of economics, Rostow (1960) wrote that: "The classical theory of production is formulated under essentially static assumptions ... to merge classical production theory with Keynesian income analysis ... introduced the dynamic variables: population, technology, entrepreneurship, etc. But ... do so in forms so

rigid and general that their models cannot grip the essential phenomena of growth . . . We require a dynamic theory . . . which isolates not only the distribution of income between consumption, savings, and investment (and the balance of production between consumers and capital goods) but which focuses directly and in some detail on the composition of investment and on developments within particular sectors of the economy." In other words, Rostow had realized the need to investigate economics in a systemic fashion. And, in the area of biology, von Bertalanffy (1924) pointed out the fact that because the fundamental character of living things is their organization, the customary investigation of individual parts and processes cannot provide a complete explanation of the phenomenon of life. Since these and other earlier works on the urgent need for systems thinking and methodology of our modern time, many others, such as Porter (1985), Klir (1985), Lin (2009), etc., also demonstrate how powerful holistic way of thinking and relevant methodology can be in terms of producing conclusions that are realistically reliable and practically usable regarding organizations, such as business entities, and how these organizations, such as economies or markets, etc., interact with each other. As a matter of fact, since the 1920s, such a holistic view of nature, organizations, and social events has permeated the spectrum of knowledge (Lin 2009) with the exception that in some areas, it is more widely applied than other areas. For example, applications of holistic thinking and advanced systems methodologies in the area of managerial decision-making have been seriously lacking. Hopefully, this work will help make up this deficit.

As for the concept of systems, similar to how numbers and algebraic variables are theoretically abstracted from the physical world, systems can also be proposed out of any and every object, event, and process that exist in nature. And although both the concepts of numbers (and numerical variables) and systems are abstracted out of the same world, they represent the world from two different and harmonizing angles. For instance, when a firm is seen as a collection of parts with their relationships ignored, then the firm can be described by using numbers, such as n employees, m offices, $\$x$ of venture capital investments, etc., and some superficial relationships between these numbers. However, to investigate any business firm appropriately in terms of managerial decision-making, the firm needs to be seen as an organization with deeply embedded culture, strictly followed philosophical values, and day-to-day routines of operations, among others. It is these organizational relationships that the firm exists both physically and intellectually. That is, most problems of managerial decision-making are essentially about organizations or systems, be they individuals, seen as economic agents whose behaviors are dictated by their personal value systems, firms, markets, industries, economies, etc. In other words, behind each organization, such as a business firm, a market, a regional economy, etc., there is an abstract, theoretical system within which the relevant whole, component parts, and their interconnectedness are emphasized. As a matter of fact, it is because of these interconnected whole and parts that the totality is known as a firm, market, industry, economy, etc. Speaking differently, when internal structures can be ignored, numbers and algebraic variables can be very useful in terms of describing numerical relationships without touching the essential concept of organization; otherwise the world consists of dominant systems (or structures or organizations).

Even though the concepts of numbers and systems share the same origin – the natural world – they represent two very different aspects of the world. The former is small scale and local, while the latter large-scale organizational. More importantly, numbers exist only post existence. That is why using number-based theories to make predictions has not been very successful. In other words, when one uses post-event evidence to predict the appearance of a not-yet-occurring event, he/she is doomed to be not very successful. On the other hand, systems emerge at the same time when physical or intellectual existence comes into being. That is the very reason why the methodology of systems is more appropriate than all theories developed on numbers and variables for the investigation of economic entities when their internal structures cannot be ignored.

When studies of various kinds of systems and organizations are put together as an area of knowledge, we have the so-called systems science. This science investigates the systemhood of all things, be they lifeless objects, social organizations, or evolutionary processes. That is what makes it different from the traditional science that is classified by the thinghood it studies. With systems science and the traditional science coexisting, it gives rise of a two-dimensional spectrum of knowledge, where the traditional science constitutes the first dimension and the systems science forms the genuine second dimension (Klir 2001). Speaking differently, systems research focuses on those properties of systems and associated problems that emanate from the general notion of structures and organizations, while the division of the traditional science has been done largely on properties of particular objects. Therefore, results of systems science naturally transcend all the disciplines of the traditional science, making the existing disciplinary boundaries irrelevant and superficial.

The importance of this second dimension of knowledge cannot be in any way over-emphasized. By making use of this extra dimension, the exploration of knowledge has gained additional strength in terms of the capability of solving more problems that have been challenging the very survival of the mankind since the beginning of time. Such strong promise that systems research holds relies materialistically on the particular speaking language and intuition behind systemic logic thinking – the systemic yoyo model (Lin 2007), Fig. 1.2, similar to how the Cartesian coordinate system plays its role in the development of the traditional science (Kline 1972).

Specifically, what this systemic yoyo model says is that any system of concern, be it a physical entity or an intellectual thought, be it tangible or intangible, a living being, an organization, a culture, a civilization, etc., can be seen as a kind of realization of a certain multidimensional spinning yoyo with an eddy field around. It stays in a constant spinning motion as depicted in Fig. 1.2a. If it does stop its spinning, it will no longer exist as an identifiable system. What Fig. 1.2c shows is that due to the interaction between the eddy field, which spins perpendicularly to the axis of spin, of the model, and of the meridian field, which rotates parallel to axis of spin, all the materials that actually return to the input side travel along a spiral trajectory.

In terms of why each system possesses such an abstract structure, it can be seen from different angles (for details see discussions in Chap. 2). Speaking briefly, on the

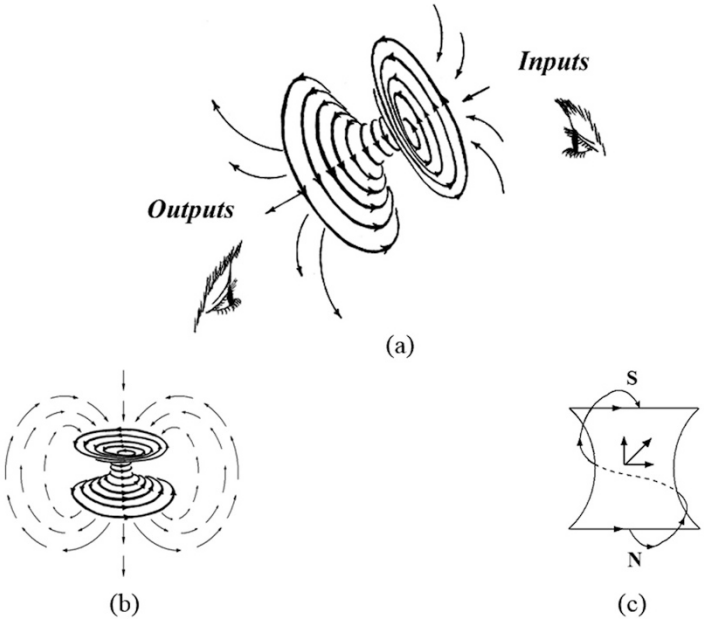

Fig. 1.2 The systemic yoyo model shown in three-dimensional space. (**a**) Eddy motion model of the general system. (**b**) The meridian field of the yoyo model. (**c**) The typical trajectory of how matters return

basis of the blown-up theory (Wu and Lin 2002), a general theory of development and evolution, and the discussion on whether or not the world can be seen from the viewpoint of systems (Lin 1988; Lin et al. 1990), the concepts of inputs, outputs, and converging and diverging eddy motions are coined together in the model shown in Fig. 1.2 for each thing and every system imaginable. That is, each system is a multidimensional entity that spins about its axis. If we fathom such a spinning entity within the three-dimensional space in which we live, we will have a structure as artistically shown in Fig. 1.2a. The input side pulls in all things, such as materials, information, energy, profit, investment, etc. After funneling through the "neck," all things are spit out in the form of outputs. Some of the things, spit out from the output end, never return to the other side and some will (Fig. 1.2b). For the sake of convenience of communication, such a structure as shown in Fig. 1.2a is referred to as a yoyo due to its general shape.

As expected, this yoyo model has successfully played the role of intuition and playground for scholars who investigate the world and explore new knowledge holistically, just as what the Cartesian coordinate system did for the traditional science (Lin Y 2009; Lin and Forrest 2011; Forrest 2013, 2014; Forrest and Tao 2014; Ying and Forrest 2015). In particular, this yoyo model of general systems has been successfully applied in the investigation of Newtonian physics of motion, the concept of energy, economics, finance, history, foundations of mathematics, small-

probability disastrous weather forecasting, civilization, business organizations, and the mind, among others. Along this same line of logic, in this book we will use this model as our intuition to establish our conclusions.

1.3 Scientific Irregularities: The Norm of Business Life

With the business world being increasingly globalized, many well-established companies have either disappeared or become irrelevant (McGrath 2013). Underneath such drastic changes in the business landscape is how forces of competition have been reshaping the strategies companies design and employ (Porter 1979). In other words, when a firm is incapable of forecasting and accordingly making appropriate adjustments to the fast-changing trends or paradigm shifts, the firm will definitely exit the market soon. In this regard, there are plenty of sad stories, such as those of Kodak, Xerox, and Motorola's one-time dominance in the analog cellular telephone business (Barker 1993). In the present business world, clinging to established competitive advantages and accustomed routines of operation is no longer viable. That is, managers and entrepreneurs have to be futuristic and visionary, which generally requires them to be confident and narcissistic in their actions that correspond to their predictions of the future (Navis and Volkan 2016). They are the key for their firms and organizations to stay abreast of the speed of business. In other words, companies that cannot successfully foresee the future and adjust quickly become victims of rapidly shifting business landscapes (McGrath 2013). That is because there are very few blue oceans, as explained by Kim and Mauborgne (2005), whereby there is little to no competition. This realization, for example, was deployed by Cirque du Soleil when they transformed the picture of a circus from animals to acrobatic, nimble human performers. That is the very reason why in the previous section, we stated that managerial decision-making is more or less about predicting such a future that is drastically different from both the past and the present. In this section, from a different and more fundamental angle, we demonstrate why there is an urgent need for the theory of managerial decision-making to go beyond the capability boundaries of the traditional science in general and classical calculus-based methods and statistics-based tools in particular.

1.3.1 Long-Term Expectations and Short-Term Predictions

For illustration purposes, let us use human life as our metaphor. In this regard, no one suspects the accuracy of the following long-term expectation: each person dies sooner or later. However, in life the really significant issue is the short-term or imminent prediction of how and when a person dies, where prediction is defined as the foretelling of the imminent future that is different of the present or the past or both. When attempting to address such problems scientifically, Bergson (1963),

Koyré (1968), Prigogine (1980), and OuYang et al. (2001) realize that the traditional science is such a science that is about invariances without involving evolutions of small scales and imminent changes. That explains why the traditional science does not have the ability to foretell immediately forthcoming breakoffs in trends and paradigms in general and disruptive innovations in particular.

However, over time things do evolve and business landscapes do shift disruptively. Therefore, there are corresponding laws of evolutions and theories and methods for investigating evolutions that can be used to support managers to make their decisions regarding the future. To meet this challenge, results and methods of the traditional science have been conventionally employed to develop various theories and methods for forecasting purposes although no part of the traditional science essentially involves evolution, leading to not quite satisfactory outcomes. Such attempts lead to the appearance of the concept of small-probability information or the so-called irregular information (Lin and OuYang 2010), which has not been addressed by the traditional science developed on the ideals of quantitative regularization and stabilization of time series. In fact, as a philosophical problem, the concept of irregular information touches on the central problem of Lao Tzu (time unknown), "Any Tao that can be explained is not the Tao." It exists exactly at the very central problem that the traditional science has walked away from – the essence of the multiple varieties of the natural world – when it pursues after the generality and uniformity by using quantities. For further details, see Chap. 1 (Lin and OuYang 2010). So, efforts need to be devoted to investigate ways of thinking, tools for intuition, and methods of reasoning beyond the well-developed quantitative system of the traditional science in order to help decision-making managers and entrepreneurs to effectively predict the future.

In the Eastern world, especially in China, knowing has been facilitated by using the epistemology of structural transformations of mutual interactions since thousands of years ago. People there place more emphasis on the materialistic morphologies caused by blocked movements and relevant changes in the attributes of moving things. To this end, the "Book of Changes" (Wilhalm and Baynes 1967) is the classic of evolution theory and has been employed as the standard of knowing and understanding. When facing a challenge, Chinese people's first reaction is to analyze how things and/or events constrain each other mutually, leading to theories and action plans of mutual existences and constraints.

Speaking differently, the essence of the traditional science is a collection of formal analyses based on quantities. So, each analysis has to comply with the rules of quantitative calculus. On the other hand, when analyzing evolutions through studying movements, one needs to be clear about the things and events involved instead of merely the extracted quantities. That explains why the quantitative calculus most likely does not hold true when employed to study evolutions and interactions of organizations and why using such methods of invariances for decision-making managers to investigate changing events and social processes has to face difficulties and challenges.

As for the currently available principles and techniques of prediction, which are established on the basis of the traditional science, they are essentially versions of live

monitoring what has already happened or is happening instead of predicting what is about to occur. This fact is well illustrated in Laplace's statement (Kline 1972): "If I know the initial value, I can tell you everything about the future," and represents a serious challenge facing decision-making managers and entrepreneurs who need to know when and how the next major disruptive technology appears.

Fortunately, because of the development of high-speed computers, we are able to directly digitize observational data and handle irregular information that cannot be effectively dealt with before by using quantitative means. This end helps us uncover a passage to connect modern technology with the ancient science and methodology. As a consequence, scholars will be able to propose the epistemological foundation of evolution science on which decision-making managers and entrepreneurs will be able to analyze evolving things, events, and processes (Lin and OuYang 2010).

1.3.2 The Essence and Origin of Quantities

Pythagoras of the ancient Greece believed that numbers are the origin of everything; numbers and their properties represent the key for comprehending all things in the universe. Such belief eventually influenced the development of the traditional science as the religious foundation (Kenny 2012). Correspondingly, Zhan Yin of ancient China, who lived in the time of warring states, pointed out that there are things numbers cannot describe (Qu 1985). That explains how later generations of Chinese people treated numbers and the reason why they did not admire numbers nearly as highly as Westerners.

It is clear that quantities cannot appear before events or existence, representing merely post-event formal measurements or records. This fact reduces the hope of using quantities to predict the occurrence of future events and existences. Specifically, numbers dwell in Cartesian coordinate systems (also known as Euclidean spaces) as measurements of the imaginary linear axes. That leads to the issue of unboundedness of the quantitative ∞. However, the natural world is curved and never reaches this quantitative ∞. This fact reveals the limitation of quantitative analysis and where the quantitative reasoning and systems thinking are different epistemologically.

To know the world and to predict what is going to happen in the near future through analyzing movements systemically, one has to consider the attributes and systemic structures of moving things, such as functions, locations, internal organizations, etc., and individual things' specifics, and how they interact with one another. Speaking in the contemporary language of science, interactions of things and organizations of parts belong to non-inertial systems. That is the difference between how the traditional science uses quantities and inertial systems of the first push and how systems science employs structures and organizations as the target of focus and non-inertial systems of the second stir (Lin and OuYang 2010). Because the movements of things with and without internal structures are of different characteristics, the epistemologies and methodologies needed to deal with these movements have to