

# SYSTEMS ECONOMICS: MAKING A NEW SCIENCE

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Communication University of China Press

中国传媒大学出版社

图书在版编目 (CIP) 数据

系统经济学：开创新学科 = SYSTEMS ECONOMICS: MAKING A NEW SCIENCE / 咎廷全著. —北京：中国传媒大学出版社，2006.12

ISBN 978-7-81085-881-6

I. 系... II. 咎... III. 系统科学：经济学—研究—英文 IV. F069.9

中国版本图书馆 CIP 数据核字 (2006) 第 151281 号

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## SYSTEMS ECONOMICS: MAKING A NEW SCIENCE

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## SYSTEMS ECONOMICS: MAKING A NEW SCIENCE (系统经济学：开创新学科)

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责任编辑 阳金洲

装帧设计 刘晓霞

出版人 蔡翔

出版发行 中国传媒大学出版社

社址 北京市朝阳区定福庄东街1号 邮编 100024

电话 65450528 传真 010-65779405

网址 <http://www.cucp.com.cn>

经销 新华书店总店北京发行所

印刷 北京中科印刷有限责任公司

开本 787 × 1092 mm 1/16

印张 18.5

版次 2007年1月第1版 2007年1月第1次印刷

ISBN 987-7-81085-881-6/K · 881

定价：78.00元

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## About the author

Zan Tingquan, Ph.D., professor, director of Chinese Center for System Economics Research, Dean of Media management School of Communication University of China.

Since 1980s, Prof. Zan Tingquan has been applying himself to the establishment of System Economics. So far, he has basically constructed the philosophical framework of System Economics, and developed such research subjects as Resources-niche Theory, Topological Model of Institution, the Eigenscales Theory and System Strategies which can be compared with some world-acknowledged works. At the same time, he obtained dozens of new results with mathematical formula, proposed hundreds of operational rationalities. As a result, his trinity academic thought system of “system era • system economy • system management” is gradually taken into shape.

# Preface

The nobel prize winner Prigogine ever pointed out in 1980s that the human society was at an age of big transition. After careful observation and serious consideration over ten years, I (1997) proposed the specific form of this transition and put forward a basic idea that the human society has entered or is stepping into the systems era. The rapid development in information technology and communication tools is the main technical impetus in systems era. The coming of systems era is radically bringing some irreversible profound changes in the human society, and changing the relationships between people and between people and nature. These changes cover many aspects including politics, economy, society and environment.

Systems economics is a new branch of economics under the backdrop of systems era. Strictly speaking, it belongs to the interdisciplinary of systems science, mathematics and environmental science etc. The famous American futurologist Toffler ever divided the society into three tides according to technical determinism. The American sociologist Daniel ever divided the human economic society into agricultural society, industrial society and post-industrial society. Economic Report of the President: 2001 pointed out that American economy experienced exceptionally high-speed development in 1990s, which was called "new economy". It could be reflected from the improvement of productivity, the increase of income, the decrease of unemployment rate and the low level of inflation rate etc. The Report concluded that the advent of new economy came from the effective combination of new and high technology, management innovation and economic policies. The Report explained in details several major reasons of inducing the new economy, including the horizontal and vertical boundary of new firms, the cause of industrial organization and the influence of globalization process on American economy. I (2003) believed that economy of systems was the essence of the so-called new economy. Economy of systems is a new form of economy emerging under the background of systems era. Industrial society went after economy of scales, while the dominant economy form will be economy of systems in systems era. The reason why American firms could win over Japanese firms is the right choice in critical strategy selections. Critical strategy refers to the choice in critical points. In the critical point when the new economy or economy of systems started to appear in the human society, American firms selected the

branch of economy of systems in time, while Japanese firms still moved on along the old branch. Although Japan tried its best to do a better job than its rivals, when economy of systems became the leading industry, Japanese firms would inevitably be left behind American economy. Therefore, developing economy of systems is the important critical strategic selection the human society faces now.

I started to explore systems economics in 1980s and stuck to the way used by mathematician and philosopher Whitehead to set up systems economics, that is, to propose a basic theory framework at first. I appreciate and agree to a word of one friend of mine very much: "Academic research should not only insist, but also focus." Over the last 15 years, I strived to do one thing, i.e. research on systems economics. Even when I served as a CEO in a company, I just took it an application case of systems economic theories. Up to now, I have roughly finished the preliminary establishment of systems economic framework at philosophic hierarchy, got over ten new research outcomes in mathematic forms, and completed five application cases at enterprise hierarchy. As a whole, there is still a long way for systems economics to go, and I will spare every effort to dedicate to this research work.

Systems economics is a motivating spirit kingdom and has become my basic living style. Through long -term serious science exploration, I continuously get new recognition, new understanding and new pursuit of science, society and life, and has gradually formed my own self-consistent view of science, namely, "systems era, systems economics and systems management mode". Systems era is the backdrop; economy of systems is the dominant economy form in systems era, and the research on economy of systems constitutes systems economics; systems management mode is the management mode corresponding to economy of systems.

This book collects some representative academic articles I published in the process of exploring systems economics in recent years, with the purpose that we could make readers know the gradual process of systems economic ideas rather than put final conclusions in front of them arbitrarily. I believe for the systems economics in the introduction stage, doing so could play an irreplaceable role in the construction of the newly emerging discipline. I published this book based on this judgment, and I hope this judgment could positively contribute to the research on systems economics.

A person needs to absorb all kinds of nutrition to grow up, needs to strive for supports from many aspects, and needs to integrate resources from different sources. There is no exception for the establishment of systems economics. Here, I would like to extend my sincere appreciations to all teachers, classmates, friends, supervisors, colleagues and institutions that ever cared, supported and helped me, especially to the supervisors in Zhengzhou University. Thank them for allowing me to enroll a Ph. D student of nonlin-

ear analysis and systems economics under the major of mathematics (this is the only institution enrolling Ph. D students of systems economics in China up to now). Undoubtedly, it could greatly push the development of systems economics. Finally, thanks a lot for the hard work done by editor Li Min during the process of editing this book in Science Press.

Zan Tingquan

Jan. 20th, 2007

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# ***Part I***

## ***Basic Principles of System Economics***



# Three Basic Hierarchies of Economic Research: Philosophical Perspective, Mathematical Perspective and Technological Perspective\*

——Concurrent Analysis on the Criteria and Categories of the Economist

## I. Introduction

Since 1776, the year in which Adam Smith published *ŒWealth of NationsŒ*, economics has already had a history of 200 years so far. During this process, economists have carried on a large amount of researches around the main economic issues of different times. Some researches concentrate on the basic concept and theories of economics; some emphasize on the mathematical model of economics; while some other focus on the application of the economic theories. In accordance with their different emphases, various economic schools and academic theoretical systems have been developed.

In order to have a clear understanding of the academic works of those economists, and of their position and role in the whole economics mansion, this article divides the content of economic research into three hierarchies, namely, philosophical perspective hierarchy, mathematical perspective hierarchy and technological perspective hierarchy. According to this point of view, we can easily *ŒprojectŒ* the works of those economists in history onto these three basic hierarchies. We can clearly understand that different economists focus on different hierarchies. Some economists have made contribution to two or three hierarchies at the same time.

## II. Three basic hierarchies of economic research: philosophical perspective, mathematical perspective and technological perspective

Through serious exploration and thinking, we believe it is highly possible that all

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\* First published in Chinese in the Journal of *Quantitative & Technical Economics*, 2001.12.

the economic research can be divided into three basic hierarchies of philosophical perspective, mathematical perspective and technological perspective associated with the economic system. The philosophical perspective of economic research mainly refers to the systematic outlook of economic research, which essence lies in creativity, universality, macroscopic strategy and enlightening thinking. The traditional philosophy pursues universality, i.e. explores various  $\forall x$ , satisfies  $P(x)$ . The mathematical perspective of economic research emphasizes on the model, ration and accuracy, which pursues various  $\exists$ existing  $x$ , satisfies  $P(x)$ . We regard both the philosophical perspective and mathematical perspective of economic research as the economic theory. The technological perspective concentrates on the application of economic theory, which means its main research areas are the application method, techniques and the concrete application rationales of economic theory.

Let  $P$ ,  $M$ ,  $T$  represent the hierarchies of philosophical perspective, mathematical perspective and technological perspective respectively, and  $ER$  stand for the economic research, then all the economic research can be projected onto the philosophical perspective hierarchy ( $p$ ), mathematical perspective hierarchy ( $M$ ), and technological perspective hierarchy ( $T$ ). In that case, we have

$$ER = P \cup M \cup T$$

In order to understand visually, we can regard philosophical perspective ( $P$ ), mathematical perspective ( $M$ ) and technological perspective ( $T$ ) as three coordinate axes which prop up a three-dimensional Cartesian coordinate system, and then any economic research can be regarded as one vector of the above-mentioned three-dimensional Cartesian coordinate system, which can be expressed as

$$ER = ER|_P + ER|_M + ER|_T$$

Here,  $ER|_P$ ,  $ER|_M$ ,  $ER|_T$  express the projections of economic research( $ER$ ) on the three axes respectively. According to the projections of different economists' research on these three axes, we can identify the types of different economists easily, such as whether they focus on philosophical perspective, mathematical perspective or technological perspective, or whether they are encyclopedic types who involve in different hierarchies.

Not only can we divide the whole economic research into three hierarchies; in fact, economic research ( $ER$ ) to a concrete question ( $Q$ ) can also be divided into three hierarchies of philosophical perspective, mathematical perspective and technological perspec-

tive and can be launched according to these three hierarchies.

### III. The relationship and transformation among philosophical perspective, mathematical perspective and technological perspective

Zan Tingquan (1993) discussed the relationship between qualitative analysis and quantitative research in systems science research. The conclusion can also be applied to economics. The qualitative analysis there corresponds to the philosophical perspective hierarchy in this article and the quantitative research there corresponds to the mathematical perspective hierarchy. Qualitative analysis is the foundation of quantitative research. Without qualitative analysis, quantitative research will lose its direction; without quantitative research, qualitative analysis will appear to be very incompetent. That is also the basic relationship between the research of philosophical perspective and mathematical perspective in economics.

For the economic system at the same hierarchy or for the economic question at the same hierarchy, usually it traces from the qualitative analysis to the quantitative research and from the philosophical perspective hierarchy to the mathematical perspective hierarchy, which can be shown as below:

philosophical perspective hierarchy ( $P_n$ )  $\rightarrow$  mathematical perspective hierarchy ( $M_n$ )

$n$  here refers to the hierarchy of an economic system or the hierarchy of an economic question. Through deep research on the economic systems or the same economic question at different hierarchies, we find out the relationship and transformation law of research at different hierarchies. The appearance of each new research direction of economics is always led out when the mathematical model on the original hierarchy is unable to explain the economic reality. So here comes:

Mathematical perspective hierarchy ( $M_n$ )  $\rightarrow$  philosophical perspective hierarchy ( $P_{n+1}$ )

That is to say, when the limitation appears in the analysis at mathematical perspective hierarchy ( $n$ ), it is required to seek the break-through at a higher philosophical perspective hierarchy ( $n+1$ ), put forward a new frame of philosophical perspective to expand the explanation range of the original theory and dissolve the limitation.

Generally, the development of the economic theories goes along a track like this:

philosophical perspective ( $P_n$ )  $\rightarrow$  mathematical perspective ( $M_n$ )  $\rightarrow$  philosophical perspective ( $P_{n+1}$ )  $\rightarrow$  mathematical perspective ( $M_{n+1}$ )  $\rightarrow \dots$

In natural science, the most typical example is physics, especially theoretical physics which is the best subject to pay equal attention to the three hierarchies of philosophi-

cal perspective, mathematical perspective and technological perspective. It can play a role as a model with great inspiration for the construction of economics as a subject.

We consider the economic research on the two hierarchies of philosophical perspective and mathematical perspective as the research on economic theory, that is

economic theory = philosophical perspective (P)  $\cup$  mathematical perspective (M)

The relationship among philosophical perspective, mathematical perspective and technological perspective in the economic research includes the relationship between economic theory and technological perspective besides the above-mentioned relationship between philosophical perspective and mathematical perspective. We know that the purpose of economic theory is to explain and guide the economic practice and finally to accept the inspection of the reality. We have already pointed out that the technological perspective hierarchy of economic research is the bridge and intermediary where an economic theory applies to practice in economy. To economic theory, the research and breakthrough of its corresponding technological perspective hierarchy will have a huge impact on the performance of the function in practice of this theory. On the other hand, only after the economic theory is tested in real world can it be called a real scientific theory. Only practice provides perpetual impetus for the development of economic theory. This resembles the relationship between theoretical physics and applied physics. The fundamental particle theory of Yang Zhenning and Ding Zaozhong was recognized by the world and awarded the Nobel Prize as a real scientific theory only after it was proved by experimental physicist Wu Jianxiong in the laboratory.

To sum up, economic research can be divided into three hierarchies of philosophical perspective, mathematical perspective and technological perspective, that is

economic research (ER) = philosophical perspective (P)  $\cup$  mathematical perspective (M)  $\cup$  technological perspective (T)

Economic theory includes the philosophical perspective hierarchy and mathematical perspective hierarchy, that is

economic theory = philosophical perspective (P)  $\cup$  mathematical perspective (M)

Applied economics mainly belongs to the technological perspective hierarchy. The relationship between economic theory (theoretical economics) and applied economics (technological perspective hierarchy) resembles the relationship between theoretical physics and applied physics.

#### IV. The criteria and categories of economist

We put forward the following criteria of economist according to the research in this article:

An economist should conduct a relatively systematic and original research on the three hierarchies of philosophical perspective, mathematical perspective and technological perspective, or at least on one of the hierarchies. Strictly speaking, those who conduct relatively systematic and original research only on one of the hierarchies should be called as economic experts. This idea can be expressed as below:

economist = philosophical perspective (P)  $\cap$  mathematical perspective (M)  $\cap$  technological perspective (T)

economic expert = philosophical perspective (P)  $\cup$  mathematical perspective (M)  $\cup$  technological perspective (T)

According to this criterion, it is easy for us to classify who can be called as economist and who, although claiming himself or called by the media "economist", is actually not qualified to get this title or at most can be regarded as "economic expert". Usually both economist and economic expert are generally called as economist by people.

G.Frege, the founder of modern symbolic logic and analytical philosophy once pointed out that a good mathematician is half a philosopher at least; and a good philosopher is half a mathematician at least. Obviously, this statement goes a bit far to extremes, but it really has certain rationality. According to the criteria of economist and the statement above, we hold the opinion that an outstanding economist should have fairly good philosophical training and pretty high mathematical thinking level.

On basis of the above-mentioned criteria of economist and the studying of this article, it is safe for us to classify economists into different categories. First of all, we classify them into theoretical economists and application economists (technological economists); then, theoretical economists can be subdivided into economists with expertise in philosophical perspective research and economists with expertise in mathematical perspective research. Knowledge of the categories of economist can enable us to better understand and evaluate the roles and types of those economists.

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# Object, Content and Meaning of Systems Economics\*

Systems economics is a study which research the relationship between human and nature, and interpersonal relationship in the process of economic system: resources → production → distribution → exchange → consumption → environment → resources, using the thoughts and methods of modern systems science, and absorbing the quintessence of classical philosophy of China, for instance of Sheng-ke theory. Come to be a bit more precise, systems economics refers to utilizing the thoughts and methods of modern systems science and Chinese classical quintessence of philosophic theory to study the formation and evolvement of economic system.

## I. Research Object of Systems Economics

The research object of systems economics is economic systems. The economic system is the reflection of the systematic scientific thoughts in economics. It is the crystallization that economics absorbs the modern science thought in other words. Though the noun of economic system has been used extensively, and even the International Input & Output Association specially established an international magazine named 《Economic Systems Research》, we have not got an generally acknowledged definition of economic system yet up till now. In systems economics, I define economic system as a whole composed of economic elements and the economic relation between them. Usually we call the assembly of economic elements the hardware of an economic system and call the economic relation between them the software. So, an economic system can be expressed formally: Economic System = ({Economic elements}, {the economic relation between economic elements}).

Economic element refers to the economic entity on all organizational levels with certain function here, which may represent individual, family, enterprise, region, country and even mankind utilizing and competing for resources in different cases. For example, power plants and local citizens, etc, are all economic elements participating in

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\* First published in chinese in the *Journal of Economic Perspectives*, 1996.10.