

Evolutionary Economics and Social Complexity Science

Volume 1

Editors in Chief

Takahiro Fujimoto, Tokyo, Japan

Yuji Aruka, Tokyo, Japan

Editorial Board

Satoshi Sechiyama, Kyoto, Japan

Yoshinori Shiozawa, Osaka, Japan

Kiichiro Yagi, Neyagawa, Japan

Kazuo Yoshida, Kyoto, Japan

Hideaki Aoyama, Kyoto, Japan

Hiroshi Deguchi, Yokohama, Japan

Makoto Nishibe, Sapporo, Japan

Takashi Hashimoto, Nomi, Japan

Masaaki Yoshida, Kawasaki, Japan

Tamotsu Onozaki, Tokyo, Japan

Shu-Heng Chen, Taipei, Taiwan

Dirk Helbing, Zurich, Switzerland

The Japanese Association for Evolutionary Economics (JAFEE) always has adhered to its original aim of taking an explicit “integrated” approach. This path has been followed steadfastly since the Association’s establishment in 1997 and, as well, since the inauguration of our international journal in 2004. We have deployed an agenda encompassing a contemporary array of subjects including but not limited to: foundations of institutional and evolutionary economics, criticism of mainstream views in the social sciences, knowledge and learning in socio-economic life, development and innovation of technologies, transformation of industrial organizations and economic systems, experimental studies in economics, agent-based modeling of socio-economic systems, evolution of the governance structure of firms and other organizations, comparison of dynamically changing institutions of the world, and policy proposals in the transformational process of economic life. In short, our starting point is an “integrative science” of evolutionary and institutional views. Furthermore, we always endeavor to stay abreast of newly established methods such as agent-based modeling, socio/econo-physics, and network analysis as part of our integrative links.

More fundamentally, “evolution” in social science is interpreted as an essential key word, i.e., an integrative and/or communicative link to understand and re-domain various preceding dichotomies in the sciences: ontological or epistemological, subjective or objective, homogeneous or heterogeneous, natural or artificial, selfish or altruistic, individualistic or collective, rational or irrational, axiomatic or psychological-based, causal nexus or cyclic networked, optimal or adaptive, micro- or macroscopic, deterministic or stochastic, historical or theoretical, mathematical or computational, experimental or empirical, agent-based or socio/econo-physical, institutional or evolutionary, regional or global, and so on. The conventional meanings adhering to various traditional dichotomies may be more or less obsolete, to be replaced with more current ones vis-à-vis contemporary academic trends. Thus we are strongly encouraged to integrate some of the conventional dichotomies.

These attempts are not limited to the field of economic sciences, including management sciences, but also include social science in general. In that way, understanding the social profiles of complex science may then be within our reach. In the meantime, contemporary society appears to be evolving into a newly emerging phase, chiefly characterized by an information and communication technology (ICT) mode of production and a service network system replacing the earlier established factory system with a new one that is suited to actual observations. In the face of these changes we are urgently compelled to explore a set of new properties for a new socio/economic system by implementing new ideas. We thus are keen to look for “integrated principles” common to the above-mentioned dichotomies throughout our serial compilation of publications. We are also encouraged to create a new, broader spectrum for establishing a specific method positively integrated in our own original way.

Yuji Aruka

Evolutionary Foundations of Economic Science

How Can Scientists Study Evolving
Economic Doctrines from the Last Centuries?

 Springer

Yuji Aruka
Faculty of Commerce
Chuo University
Hachioiji, Tokyo
Japan

ISSN 2198-4204 ISSN 2198-4212 (electronic)
ISBN 978-4-431-54843-0 ISBN 978-4-431-54844-7 (eBook)
DOI 10.1007/978-4-431-54844-7
Springer Tokyo Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014943513

© Springer Japan 2015

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

May the worlds be calm and peaceful in the future.

Mozi said: He who rules a large state does not attack small states: he who rules a large house does not molest small houses. The strong does not plunder the weak. The honoured does not demean the humble. The clever does not deceive the stupid. This is beneficial to Heaven above, beneficial to the spirits in the middle sphere, and beneficial to the people below. Being beneficial to these three it is beneficial to all.

Mozi, Book 7: Will of Heaven I (<http://ctext.org/mozi>)

子墨子言曰。處大國不攻小國、處大家不小家、強者不劫弱、貴者不傲賤、多詐者不欺愚。此必上利於天、中利於鬼、下利於人、三利無所不利。(墨子、卷七、天志上)

Preface

This book aims to explain briefly the essential features of the founding theories of economics and compare them with later theories developed to address inconsistencies in outcomes. The earlier stages of this book are focused on the economic ideas and theories developed mainly between the 1930s and 1950s, because their emergence bred what were effectively new branches of economics. Over time, these economic theories have been gradually updated, but this updating has not necessarily addressed their theoretical difficulties. Roughly speaking, the updates converged towards behavioral science without eliminating the essential problems behind the theories. The idea of bounded rationality was a typical concern of these revisions. With universal rationality, then the core of the theory remained. The ideas of systems science were therefore increasingly less associated with this revisionist economic theory. However, even as these updates were being proposed, the world was dramatically changing. To use my favorite phrase, a car is no longer a car, but an adaptive cruising system, an air fighter is no longer an air fighter in the sense that stability is no longer part of its structural design. The control of modern vehicles is becoming further removed from human input. This also applies to the market. The revisionist approach therefore does not fully describe the essential transformations emerging in the world.

For these reasons, I have preferred in this book to describe an alternative analytical framework in the interdisciplinary field of socio-econophysics and socio-dynamics. It targets a set of branching or critical points separating the previous framework from the new one. Arthur (2009) used the term “re-domaining” when he referred to technological innovations. Here, we are trying to re-domain economic theories to fit a new social system. Major technological innovations not only accompany economic and market changes but also alter their meaning. In particular, the evolution of trading technology has changed the meaning of the phrase “invisible hand”. At the end of the last century, the advent of socio-econophysics was decisive in the emergence of a new economic science. This coincided with a change in the economy and the market, which begged a re-domaining of economic science. For

the future, many scientists outside traditional economics are now joining together to develop new ideas such as power law distribution and network analysis. However, the more diverse the backgrounds of economic scientists, the fewer common views they will share, potentially expanding economic terminologies. This book may help to mitigate any conflicts.

To achieve this, I believed that it was important to position and select the classical and essential topics in economic science. The behavioral interpretations in the standard approach rather twisted the economic view to fit a very limited range of interests. In any retrospection of classical doctrines, even a short one, the ideas of production, consumption, distribution, and the market must be included. Without these, no discussion of economic theory is possible. Unfortunately, in the 1980s, such a synthesis suddenly disappeared from standard economics teaching, so I am attempting here to resurrect this view. I am convinced that economic science needs the theory of production and consumption as its first stage.

Incidentally, at this point it may be appropriate to explain my personal views on “economics”. In Japanese, the word “economics” retains an explicit meaning of a core of morality. In ancient China, there was some metaphysical thought that underestimated personal business activities because of morality. According to Yao and Shun, for instance: “If a sage were content simply with eating plain food and drinking water, then it would make no sense to perform acts of charity for the people”. In Japan, however, the meaning of economics and business activities was connected to the *Analects of Confucius* for many years, which eventually led to a very specific construction of business morality. The most influential mover in this was Miura Baien, a doctor of Chinese medicine, who systematically represented his economic doctrine in his book *Kagen* at the end of the eighteenth century. Interestingly, he not only argued his norm of economic morality but also was well known as a scholar who successfully formulated the idea of excess demand to establish price equilibrium.¹ In his view, economic policy measures should be concentrated on the theory of enlightened rule and succor of the people. Profits must not be monopolized, but should be socially distributed among the people by the earners themselves, not by either central or local government. Here the accumulation of monetary wealth became simply a tool to achieve public welfare. This idea was then applied to capitalism by Viscount Eiichi Shibusawa (1840–1931) during Japan’s industrial revolution, also known as the Meiji Restoration. Shibusawa examined an inquiry by Zigong, a disciple of Confucius, who asked “Providing charity for people widely and thereby relieving them—should that be considered an act of benevolence?” The master replied that “acts of charity and relief for others are the works of all ages, or at least should be undertaken by a ruler who governs a country with justice and benevolence”. In his conscious comparison with Adam

¹*Miura Baien KAGEN: Vlm Ursprung des Wertes. Faksimile der zwischen 1773 und 1789 entstandenen Handschrift*, cited by Bertram Schefold et al. and translated by Masamichi Komuro, Hidetomi Tanaka, and Kiichiro Yagi, Verlag Wirtschaft und Finanzen, Verlagsgruppe Handelsblatt GmbH, Düsseldorf, 2001.

Smith, therefore, Shibusawa derived from this Confucian answer that the leadership of a country cannot afford to overlook the importance of industry and profit-making. Summing up, he called his synthesis “harmony between ethics and economy”.² In this book, I suggest interpreting Shibusawa’s idea as a coordination between *Homo socialis* and *Homo economicus*, according to Dirk Helbing.³ This is an advanced insight, and the reason why Shibusawa is called “a father of Japanese capitalism”. From the beginning of Japanese capitalism, then, an effort was made to integrate *Homo socialis* and *Homo economicus* side by side to manage capitalism. This is the reason why this book does not adopt a one-sided view on *Homo economicus* alone.

I should also refer to the direct motivation behind this book. The idea of it was born when I was staying at ETH Zürich, i.e., Eidgenössische Technische Hochschule Zürich, recently. I was invited to the institute SOMS, i.e., Sociology, in particular of Modeling and Simulation, by Dirk Helbing in February 2010, August 2011, and March 2012, and also visited the department D-MTEC, i.e., Department of Management, Technology, and Economics, at the instigation of Frank Schweitzer in February to March 2012. Without useful discussions with Dirk and Frank, I would never have written this book, so I am grateful to them both for their hospitality. Needless to say, I am also indebted to many other colleagues, too many to name here, but who will be thanked in specific chapters.

I spent much space on dedications to my professors and colleagues in my previous book (Aruka 2011). Here I would also like to express my gratitude to two other organizations. First, the Japan Association for Evolutionary Economics (JAFEE), where I am currently vice president, and where I continue to be encouraged to study and develop my ideas. Second, and equally, I continue to be enlightened by the Society for Economic Science with Heterogeneous Interacting Agents (ESHIA), where I am a directorial board member. I would like to express my gratitude to all my colleagues at both organizations.

At Springer, I am much indebted to my editors, specifically, Editorial director in charge of Business, Economics, and Statistics, New York, and Editors of Springer Japan. They were kind enough to arrange not only my own book but also the monograph series titled *Evolutionary Economics and Social Complexity Science*. Without their assistance, this book would not have been published. In particular, Editorial director, New York, decided on the book title: *Evolutionary Foundation of Economic Science*. His decision is a genuine honor for me.

At my Hakoneyama-Hermitage,
Kanagawa Prefecture, Japan
August 2013⁴

Yuji Aruka, PhD in economics

²From Shibusawa’s speech at the Imperial Institute of Invention and Innovation, June 13, 1923, available in the Shibusawa Memorial Museum (ed) (2009, p. 56): *Guide to the Exhibits*.

³See Chap. 1 of this book.

⁴This book was almost written up within 2013. But the book then underwent necessary revisions after 2013. Thus a part of the book is supported by JSPS Grant-in-Aid for Scientific Research (B) no. 26282089, which started since April 2014.

Contents

1	Historical Reviews Around Evolving Ideas of the Invisible Hand	1
1.1	Modern Technology and the Rise of the Service Economy	1
1.1.1	The Classical Production Scheme	2
1.1.2	A New Production Scheme in View of the Dominance of the Service Economy	4
1.2	The Doctrines of Political Economy in the Anglo-Saxon Tradition.....	7
1.3	The Constant Measure of Value and a Nave Reasoning of Technology	9
1.4	Removal of Ordinary Life from the ‘Invisible Hand’ of Lionel Robbins.....	10
1.5	The ‘Invisible Hand’ in the Game Theoretic Approach and the Limit of Computability	12
1.6	The Invisible Hand in the Self-Organization of the Market	13
1.7	Invisible Hands and Market Failures	14
1.7.1	The Trade-Off Between the Real Economy and the Financial Economy, and the Differential Effects on Each.....	15
1.8	Some Myths of Modern Economies	16
1.8.1	Is More Liquidity Better?.....	17
1.8.2	Are Financial Markets Efficient?.....	18
1.8.3	Is Economics an Equilibrium System?.....	20
1.9	Harmony Between <i>Homo Economicus</i> and <i>Homo Socialis</i>	21
1.9.1	Dirk Helbing’s View on Harmony in Society.....	23
1.10	The Mozi School: Impartial and Heterogeneous Interacting Agents	25
1.11	Human Interactions: A Macroscopic Microeconomic Feedback Loop.....	27
1.11.1	Economics of a Master Equation and Fluctuations.....	30
	References	31

2 The Historic Design of the Demand Law and Its Reconstruction 35

2.1 Some Criticisms of a Utility Function for the Design of Household Demand..... 35

2.1.1 Consumption As a Compromise Between Self-regarding and Other-Regarding Interests 35

2.1.2 The Discrete Choice Model of Different Modes 37

2.1.3 Some Generalizations on Random Terms, Heterogeneities, and Social Interaction 40

2.1.4 Some Essential Differences Between Frames 43

2.2 Analytical Examination of the Demand Law..... 45

2.2.1 A Makeshift Idea of Compensated Demand and Income .. 45

2.2.2 Design of the Demand Law and a New Form 46

2.2.3 A Numerical Derivation of a Demand Function..... 48

2.2.4 The Demand Law as Solved by Hildenbrand (1994)..... 49

2.3 Reconstructing Demand Theory 51

2.3.1 Self-organizing Patterns of Consumption 52

2.3.2 An Empirical Analysis of Patterns of Consumption 55

2.4 The Results of Statistical Verification 57

2.4.1 The Obtained Distributions of Eigenvalues 57

2.4.2 Comparison Between Alternative Seasonal Adjustments .. 58

2.5 Some Implications Derived from Statistical Tests 61

2.5.1 Main Findings 61

2.5.2 Further Findings 62

References 63

3 Network Analysis of Production and Its Renewal..... 65

3.1 Changes in the Concept of Price over the Last Century 65

3.1.1 Shift in Trading Methods and the Environmental Niche 66

3.1.2 Classical Steps Towards Equilibrium 66

3.1.3 Application of a Genetic Algorithm to the Economic System 67

3.1.4 Significance of the Standard Commodity, in the Context of the Genetic Algorithm 68

3.2 The Historical Background to Network Thinking in Economic Theory 74

3.2.1 The Recycling of Production 75

3.2.2 The von Neumann Economy 77

3.2.3 Von Neumann’s Original Formulation 77

3.2.4 Classical Truncation Rules of Choice of Techniques 78

3.2.5 Adaptive Plans in the von Neumann Economy 78

3.2.6 The Market Mechanism as a Genetic Algorithm 79

3.2.7 A System’s Eigenvector to Measure the Profitability of the Fictitious Processes/Commodities 80

3.2.8 Minimum Spanning Trees of the Industrial Network 80

- 3.3 An Essential Characteristic of the Joint-Production System..... 81
 - 3.3.1 An Acyclic Network of Production 81
 - 3.3.2 Criticism of the Traditional Approach 85
- 3.4 An Empirical Study Using Input–Output Tables 88
 - 3.4.1 The First Step Towards Empirical Input–Output Analysis 88
 - 3.4.2 A Further Consideration for Empirical Studies of the Inter-Industrial Network 95
- References 98
- 4 Matching Mechanism Differences Between Classical and Financial Markets 101**
 - 4.1 Reconsidering the Law of Supply and Demand in the Free Market 102
 - 4.1.1 The Classical Auction with Complete Ignorance of Others’ Preferences 102
 - 4.1.2 Auctions in the Financial Market 105
 - 4.2 The U-Mart System and Historical Background 111
 - 4.2.1 The U-Mart System Approach to the Futures Stock Market 111
 - 4.2.2 Historical Background to the Tokyo Stock Market..... 112
 - 4.3 The Matching Mechanisms in the U-Mart Experiment 114
 - 4.3.1 The Shapes and Performances of the Market Mechanism 114
 - 4.3.2 Zero-Intelligence Tests in the U-Mart System..... 116
 - 4.4 Similarities of Trading Strategies Between SF Spread and Random Strategy 120
 - 4.4.1 Arbitrage: Equalization Between Markets 120
 - 4.4.2 The Performance of the Random Agents in U-Mart ver. 4’s Simulation 125
 - References 130
- 5 The Evolution of the Market and Its Growing Complexity 131**
 - 5.1 Practical and Logical Time in High-Frequency Trading (HFT): A Re-domaining of the Trading System 131
 - 5.1.1 Caveats on HFT from the European Securities and Markets Authority 132
 - 5.1.2 The Re-domaining of the Market Caused by the HTF System 135
 - 5.1.3 A Historical Example: A Flash Crash..... 135
 - 5.1.4 How a Flash Crash Happened 140
 - 5.2 A Stealth Market 142
 - 5.2.1 The Invisible Organization of Finance 142

- 5.3 Some Instances of Technological Innovations in the Complex Market Economy 145
 - 5.3.1 Redundancies and the Depth of Logic Contained in a Complex System 145
 - 5.3.2 Innovation and Techno-Culture 146
 - 5.3.3 A Creative Coincidence Connected with Hayabusa’s Return and JAXA’s Evolution..... 146
 - 5.3.4 An Assessment of the Hayabusa Mission..... 149
- 5.4 Key Ideas for the New Economics 153
 - 5.4.1 The Economics of the Master Equation and Fluctuations.. 153
 - 5.4.2 A General Urn Process 155
 - 5.4.3 Pitman’s Chinese Restaurant Process 158
- References 159
- 6 The Complexities Generated by the Movement of the Market Economy 161**
 - 6.1 A Brief Summary of the Efficient Market Hypothesis 161
 - 6.1.1 Disengagements from the Efficient Market Hypothesis.... 161
 - 6.2 Moving Away from the Social Philosophy Around the Gaussian Distribution 165
 - 6.2.1 The Historical Penetration of the Gaussian Distribution and Galton’s Ideas 165
 - 6.3 Heavy Tail Distributions with Heavier Randomness..... 170
 - 6.3.1 Hazard Rates 172
 - 6.3.2 An Alternative Derivation in View of Memoryless Processes 176
 - 6.3.3 Some Empirical Findings in the Market 177
 - 6.4 Alternative Interpretation: Trader Dynamics to Generate Financial Complexity 178
 - 6.4.1 Rules to Be Specified 181
 - 6.4.2 Complexities in a Dealing Model of an Iterated Finite Automaton 190
 - References 194
- A Avatamsaka Stochastic Process 195**
 - A.1 Interactions in Traditional Game Theory and Their Problems 195
 - A.1.1 A Two-Person Game of Heterogeneous Interaction: Avatamsaka Game 196
 - A.1.2 Dilemmas Geometrically Depicted: Tanimoto’s Diagram 197
 - A.2 Avatamsaka Stochastic Process Under a Given Payoff Matrix 199
 - A.2.1 Avatamsaka Stochastic Process Under Various Payoff Matrices 200

- B The JAVA Program of URandom Strategy** 203

- C An Elementary Derivation of the One-Dimensional Central
Limit Theorem from the Random Walk**..... 207
 - C.1 The Derivation of the Density Function of the Normal
Distribution 209
 - C.2 A Heuristic Finding in the Random Walk 213
 - References 213

- Name Index** 215

- Subject Index** 217

Acronyms

AI	Artificial Intelligence
AR	AutoRegressive
ARIMA	AutoRegressive Integrated Moving Average
CDF	Cumulative Distribution Function
CLT	Central Limit Theorem
DFR	Decreasing Failure Rate
DNA	DeoxyriboNucleic Acid
EMH	Efficient Market Hypothesis
GA	Genetic Algorithm
GCLT	Generalized Central Limit Theorem
HFT	High Frequency Trade
ICT	Information and communication Technology
i.i.d.	independent, identically distributed
IIA	Independence from Irrelevant Alternatives
JAXA	Japan Aerospace Exploration Agency
LP	Linear Programming
LTCM	Long-Term Capital Management
MA	Moving Average
MNL	Multinomial Logit
MST	Minimum Spanning Tree
NFA	Net Foreign Assets
OR	Operations Research
PDF	Probability Density Function
RMT	Random Matrix Theory
SBS	Shadow Banking System
TSE	Tokyo Stock Exchange