

# Economic Complexity and Equilibrium Illusion

The Principle of Large Numbers indicates that macro fluctuations have weak microfoundations; persistent business cycles and interrupted technologies can be better characterized by macro vitality and meso foundations. Economic growth is limited by market extent and ecological constraints. The trade-off between stability and complexity is the foundation of cultural diversity and mixed economies. The new science of complexity sheds light on the sources of economic instability and complexity.

This book consists of the major work of Professor Ping Chen, a pioneer in studying economic chaos and economic complexity. The chapters are selected from works completed since 1987, including original research on the evolutionary dynamics of the division of labor, empirical and theoretical studies of economic chaos, and stochastic models of collective behavior. Offering a new perspective on market instability and the changing world order, the basic pillars in equilibrium economics are challenged by solid evidence of economic complexity and time asymmetry, including Friedman's theory of exogenous money and efficient market, the Frisch model of noise-driven cycles, the Lucas model of microfoundations and rational expectations, the Black–Scholes model of option pricing, and the Coase theory of transaction costs.

Throughout, a general framework based on complex evolutionary economics is developed, which integrates different insights from Smith, Malthus, Marx, Hayek, Schumpeter, and Keynes and offers a new understanding of the evolutionary history of division of labor. This book will be of interest to postgraduates and researchers in Economics, including macroeconomics, financial economics, advanced econometrics and economic methodology.

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# **Economic Complexity and Equilibrium Illusion**

Essays on market instability and macro  
vitality

**Ping Chen**

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# Preface

We are in the midst of the Grand Crisis (this is a term in parallel with the Great Depression in the 1930s). In Chinese, crisis (*wei-ji*) means danger (*wei*) and opportunity (*ji*). This is the main idea of order out of chaos introduced by the late Belgian physicist Ilya Prigogine (Prigogine and Stengers 1984). In economic literature, instability is mainly used as a negative term. But the physics concepts of nonequilibrium, complexity, and chaos imply not only the destruction of an old order, but also the emergence of a new structure. From this perspective, the current Grand Crisis may bring about a new world of economic order and a new era of economic thinking.

“The whole intellectual edifice collapsed in the summer of last year,” the perplexed former Federal Reserve Chairman Alan Greenspan confessed in congressional testimony on October 23, 2008 (Greenspan 2008). Changing historical currents demand changes in economic paradigm. Media commentaries and prominent economists soon identified two failed theories in mainstream economics: the efficient market hypothesis in finance and the microfoundations theory in macroeconomics, which is the core of the counter Keynesian revolution in last three decades. Among critics of market fundamentalism, only some weak voices of information asymmetry and behavioral finance have been heard. Justin Fox, an economics columnist for *Time* magazine, documented a series of intellectual failures in a recent book on the myth of rational markets (Fox 2009). He laments the lack of any alternative “grand new theory” and finds that the debate has resulted in a “muddle.”

However, Fox’s complaint is not quite true. His bounded knowledge is a good example of incomplete information or even distorted information in the mainstream media. This book of collected essays demonstrates that there are better alternatives in understanding market instability and economic crisis, and a new paradigm has been developing for the last three decades. Only the exclusive attitude of mainstream economics has marginalized new ideas and new approaches in economic literature and university textbooks.

This Grand Crisis revives old philosophical debates between Keynes and classical economists, between Hayek and Friedman, between Schumpeter and Frisch, between Minsky and Lucas, on the nature of business cycles and financial crisis. Moreover, it revitalizes new methodological contests among econometricians,

mathematicians, and physicists in analyzing economic time series. Generally speaking, there are at least three, not just two competing schools of thoughts.

The first is the equilibrium economics or neo-classical school. Its core belief is the so-called efficient market with rational expectations, which is self-stabilizing without need of government intervention. Any disturbance in the market is external and temporary in nature. Brownian motion or random shocks are their mathematic formulation of laissez-faire policy. There is a long cast of prominent names associated with this school: Ragnar Frisch, Milton Friedman, Eugene Fama, Robert Lucas, etc. Their arguments are based on methodological individualism, often in the form of a representative agent. Their main instrument in creating an equilibrium illusion is the first differencing (FD) filter in econometric practice, which wrongly targets the short-term fluctuations outside the business cycle frequency. Its deficiency is parallel to the geocentric system of the Ptolemy model in astronomy.

The second is the disequilibrium economics or Keynesian school. Its central theme is a fragile market, which frequently collapses under irrational panic or historical events. Known scholars in this camp include John Maynard Keynes, Hyman Minsky, Benoît Mandelbrot and behavioral economists. Their main effort is introducing social psychology into economic behavior (Akerlof and Shiller 2009). However, they have not yet developed a consistent theoretical framework. They experiment with various mathematical models, ranging from Levy distribution, fractal Brownian motion, unit roots, co-integration, sunspot, sand-pile, to power law in econophysics. Monetary and fiscal policies are the main tools for restoring market confidence from time to time. Their weakness is a lack of structural analysis and historical perspective. They often shared the problem of the whitening device (FD) in analyzing economic time series.

The third school is the self-organization economics or evolutionary school. Its perception of market economy and division of labor can be characterized as a viable market. Schumpeter's ideas of creative destruction, economic organism, and biological clock, and Hayek's concept of spontaneous order, are remarkably similar to Prigogine's idea of self-organization and dissipative structure in complexity science. Their characteristic is a biological view in an historical perspective for understanding human society. The term "viable market" was inspired by the observation of a firm's "viability" by Justin Lin, a former colleague at Peking University and now the Chief Economist at the World Bank (Lin 2009). Before the late 1970s, this school was overlooked by the new wave of econometrics and mathematic economics since the evolutionary perspective is difficult to be formulated by a linear stochastic model and optimization algorithm. Since the late 1970s, the new science of nonlinear dynamics and complex systems provided new tools in modeling biological and economic behavior. Our discovery is that a proper separation of trend and cycles is critical in studying an endogenous mechanism in business cycles. Our contribution is introducing nonlinear population dynamics with resource constraints as a unified framework in modeling micro, macro, finance, and historical evolution. Market movements do not like random walk with stable mean value but short correlations. The linear stochastic model in macro and finance economics implies no internal structure and historical con-

straints in industrial economy. The equilibrium illusion of self-stabilizing market is created by a white looking glass, the first differencing (FD) filter, which distorts any colorful picture into a white image. In the history of science, the telescope helped Galileo to prove the Copernicus heliocentric theory of planet motion. In economic analysis, our discovery of economic color chaos (color means a narrow frequency band against a noisy background) reveals a new world of macro vitality. The movements of stock market and macro indexes can be better understood by a mix of nonlinear trend, persistent cycles, plus minor noise. The market trend is mainly driven by technological wavelets and changing economic structure. Persistent cycles in the US economy are endogenous and nonlinear in nature, which fall within the stable range of NBER business cycles from two to ten years. The sources of business cycles are not microfoundations, but meso foundation in financial intermediate and industrial organization. Financial market is inherently unstable because of collective behavior, financial leveraging, nonlinear pricing, and power concentration. For a viable market with resilient frequency but erratic fluctuations, the government's role in managing and regulating economy should be more like a family doctor treating his patients rather than a school teacher dealing with pupils. He should care more about the system's health and structural malfunction than day to day instructions to pupils. It was Paul Samuelson, who predicted as early as 1995 in an evaluation letter of our work that new innovative paradigms might have a chance to stand an historic test in mainstream economics (Samuelson 1995).<sup>1</sup>

Unlike dramatic events of the Great Depression and the Grand Crisis, our adventure quietly started from two fundamental issues: the first is the so-called Joseph Needham's question of why science and capitalism emerged in Western Europe, not in China or other civilizations. The second is studying the nature of business fluctuations. Should we characterize them by random noise or deterministic chaos? The first issue shifted my interest from the heights of the culture revolution in China to Ilya Prigogine's new thermodynamics of evolution in 1973. I ended up studying and working with Prigogine from 1981 until his death in 2003. My studies of evolutionary dynamics were inspired by Peter Allen (a member of the Brussels school led by Prigogine), while my research of economic chaos was initiated by Ilya Prigogine. Without the intellectual culture at the Ilya Prigogine Center for Statistical Mechanics and Complex Systems at University of Texas at Austin, our endeavor cannot survive under the monotone atmosphere dominated by neo-classic economics. When I started teaching at Peking University in 1997, my focus moved from technical algorithms to fundamental principles behind policy issues. The striking difference between China and EEFSU (East Europe and former Soviet Union) during the economic transition induced me to examine basic assumptions in equilibrium economics, which turned out to be mathematic toy models rather than scientific theories.

With a basic knowledge in calculus and science, college students, economic teachers, and general readers alike should easily follow our journey to explore economic complexity and test competing economic theories. Here, complexity means nonlinear interaction, nonequilibrium diversity, many-body problem,

nonstationary dynamics, and path dependence, while simplicity implies linearity, equilibrium convergence, stationary model, and one-body problem (of representative agent). Nonlinear modeling of economic complexity provides new tools in understanding economic structure, history, and evolution. You may realize that an economy is more like a living system. Its vitality is characterized by life rhythms. Thoughtful economists may be surprised that the dominant belief in self-stabilizing market, promoted by Frisch, Friedman, Fama Lucas, and Coase, are purely an equilibrium illusion, made up by the FD filter, the representative agent, the bilateral exchange, and even a perpetual motion machine in economic theory. Economic complexity, with emerging property and resilient dynamics will completely reshape our framework of economic thinking.

Like biology and physiology, structure matters immensely in understanding economic dynamics as a whole system. Adam Smith realized that division of labor is limited by market extent (1786, 1981), while Thomas Malthus pointed out the biological constraint to human activity (1798). Therefore, market-share competition is more fundamental than price competition, which serves a business strategy in market-share competition. Competition policy and structural reform are more essential than fiscal and monetary policy for developing a sustainable economy. The conventional micro–macro analysis ignores the middle layer of meso economics, i.e., financial intermediate and industrial organization, which are the foundations of creative destruction and business cycles. The irrational fads and panics in behavioral finance can be understood by interactions among individual actors. A consistent framework of ecology-socio-economic dynamics in continuous time is developing for micro, meso, macro, and Clio economics. Readers could judge if there is a better alternative to equilibrium economics based on individual rationality in discrete time.

Policy makers and the general public would find fresh ideas for understanding historical puzzles and contemporary events, such as the cultural diversification between East and West in the Middle Ages, the rise of China, the decline of EFSU, and policy effectiveness in dealing with an economic crisis.

We are witnessing ongoing events of the Grand Crisis which originated in the core of a capitalist economy and turned into a global crisis. It is an historical moment to advance our economic knowledge. Economics in the twenty-first century will stand on the shoulders of giants. We have learned from visionary thinkers like Schumpeter, Keynes and Prigogine, as well as failed attempts by Frisch and Lucas. Economics as an empirical science will reach a new height and go beyond the scope of physics and biology in the future.

Finally, I should point out that all the papers here are kept in the original form as much as possible. I made some corrections in symbols and English for clarity and consistency. I also updated the references. If readers find mistakes in my book, please email: pchen@cceer.pku.edu.cn. I appreciate your critique and comments.

Ping Chen

July 27, 2009 at Austin, Texas

The 20th birthday of my younger daughter Vivian, a vibrant and critical student

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Looking back, we are surprised how far we have gone when our research has been led by a visionary perspective. This volume is a humble memory for my late teachers, Ilya Prigogine, Walt Rostow, and Robert Herman. I am also indebted to my teachers and colleagues in Austin and Brussels, especially Peter Allen, Linda Reichl, William Schieve, Jack Turner, Werner Horsthemke, Gregoire Nicolis, and Luis Deneubourg.

I was trained as a physicist but turned into a self-educated economist. My knowledge of modern economics is mainly from dialogues with distinguished economists, including William Barnett, David Kendrick, John Stermann, Eric Mosekilde, Paul Samuelson, Robert Solow, Richard Day, Michael Woodford, William Brock, Victor Zarnowicz, Finn Kydland, James Galbraith, Edward Prescott, Douglas North, Steven Cheung, Robert Heckman, Gregory Chow, Duncan Foley, Willi Semmler, Jeffrey Sachs, Ulrich Witt, Kurt Dopfer, George Soros, Joseph Stiglitz, Edmund Phelps, Robert Mundell, Gary Becker, Vernon Smith, Kenneth Arrow, Robert Fogel, Giancarlo Gandolfo, Charles Goodhart, Barkley Rosser, Paul Davidson, August Maddison, Immanuel Wallerstein, Elizabeth Perry, Philip Huang, Richard Baum, Shuji Cao, Stewart Schwab, William Black, Raoul Weiler, Pierre Calame, Grzegorz Kolodko, Yagi Kiichiro, Yuji Aruka, Luiz Carlos Bresser-Pereira, Dalin Tong, Mingyu Wu, Chang-neng Xuan, Haizhou Huang, Ligang Song, Justin Lin, Deming Huo, Zhengfu Shi, Ziyuan Cui, Chang Liu, and Weiwei Zhang. I also benefited from discussion with fellow scientists Shi Qian, Dapang Chen, Weimou Zheng, Bailin Hao, Zuoxiu He, Yuankai Wen, and Benoît Mandelbrot. Many contributions are made by my students and co-workers at University of Texas at Austin and Peking University, including Kehong Wen, Zili Zhang, Huajun Li, Wei Zeng, Gao Xu, Yinan Tang, and Jicheng Jia.

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Finally, this volume is dedicated to my wife, Song Guohe Chen, for her endless love and constant inspiration in the risky journey of developing complex evolutionary economics.