蒲勇健 著

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可持续发展经济增长方式的数量刻画与指数构造

国家自然科学基金资助项目

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内 容 简 介

本书是国家自然科学基金项目阶段成果之一。该书详细考察了可持续发展概念的起源、历史背景、理论发展及其哲学基础，并通过在新增长理论模型中置入可持续发展规范对可持续增长方式加以数量刻画，构造出了测度增长方式可持续程度的指数，该指数还将增长方式可持续程度与产业结构联系起来。本书在可持续发展指标、产业结构调整及增长方式转变研究方面都有所创新，理论分析深入、透彻，文献掌握丰富，在学科前沿上进行了大胆和有益的探索，成果具有较大的实用价值。

本书适合于广大经济工作者、经济管理类专业的博士、硕士研究生阅读，也可作为广大社会科学研究人员的科研参考资料及宏观经济、资源环境管理决策者的学术参考文献。

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ABSTRACT

A quantiative depiction and index construction of sustainable economic growth pattern

I

Since the industry revolution had begun, human's material civilization has made great progress. Though the growth pattern that had been formed since that time has created a great deal of material wealth, the conflict between economy development and environment has become more serious. "sustainable development" is a new developmental model in the next century. In sustainble development, economy development, environment development, society development and the interest of the people borned and unborned are harmonizing.

The crux of the concept of sustainable development is the definition of "sustainability". Ecologists place considerable stress on the sustainability of the aggregate ecosystem structure or life-support system. Economists definite sustainability as WS rule, which reguires that the overall stock of capital assets and some "critical" components of natural assets should remain constant over time. Other schools definite social sustainability, environmental sustainability, etc. There are debates between differents views. While ecologists put emphasis on the complementarity of resources in ecosystem structure and the importance of diversity in ecosystem resilience, the mainstream economists underline the substitution between different resources. So far there is no universal acceptable definition of sustainable development. Therefore, it is high time that various disciplines put aside their differences and joined hands under the banner of sustainable development to tackle the myriad of problems facing us today.

II

Essentially, "sustainability" is a kind of philosophy. The environmental ethics originated in the 1970s may develop as the philosophy of sustainability. Modern environmental ethics is the generalization of traditional ethics, including many system such as Biocentric Ethics, Ecology Ethics, the Land Ethics, Deep Ecology and Social Ecology and Ecofeminism, etc.

Among the theory frames of sustainability, the London School's theory plays a important role in the discussion of sustainable development. Their definition and policy recommendation is "constant natural capital". Another well-known sustainable development theory is the so-called "Steady-State Economy", which was initiated by Daly. This theory recommends a "minimal throughput" policy for sustainability.

London School suggested that discount rate has nothing to do with natural resources depletion. They also suggested that the modern specialized agriculture is depleting biological diversity.

Ⅲ

Classical economists, such as Adam Smith, David Recardo, and Thomas Malthus, and, much later, Frank Ramsey, Allyn Young, Frank Knight, and Joseph Schumpeter, provided many of the basic ingredients that appear in modern theories of economic growth. These ideas include the basic approaches of competitive behavior and equilibrium dynamics, the role of diminishing returns and its relation to the accumulation of physical and human capital, the interplay between per capita income and the growth rate of population, the effects of technological progress in the forms of increased specialization of labor and discoveries of new goods and methods of production, and the role of monopoly power as an incentive for technological advance.

Our main study begins with these building blocks already in place and focuses on the contributions in the neoclssical tradition since the late 1950s. We use the neoclassical methodology and language and rely on concepts such as aggregate capital stocks, aggregate production functions, and utility functions for representative consumers (who often have infinite horizons). We also use modern mathematical methods of dynamic optimization and differential equations.

From a chronological viewpoint, the starting point for modern growth theory is the classic article of Ramsey (1928), a work that was several decades ahead of its time. Ramsey's treatment of household optimization over time goes far beyond its application to growth theory; it is hard now to discuss consumption theory, asset price, or even business-cycle theory without invoking the optimality conditions that Ramsey introduced to economists. Ramsey's intertemporally separable utility function is as widely used today as the Cobb-Douglas production function. The economists profession did not, however, accept or widely use Ramsey's approach until the 1960s.

Between Ramsey and the late 1950s, Harrod and Domar attempted to integrate Keynesian analysis with elements of economic growth. They used prodution functions with little substitutability among the inputs to argue that the capitalist system is inherently unstable. Since they wrote during or immediately after the Great Depression, these arguments were received sympathetically by many economists. Although these contributions triggered a good deal of research at the time, very little of this analysis plays a role in today's thinking.

The next and more important contributions were those of Solow (1956) and Swan (1956). The key aspect of the Solow-Swan model is the neoclassical form of the production function, a specification that assumes constant returns to scale, diminishing returns to each input, and some positive and smooth elasticity of substitution between the inputs. This production function is combined with a constant-saving-rate rule to generate an extremely simple general-equilibrium model of the economy.

One prediction from these models, which has been exploited seriously as an empirical hypothese only in recent years, is conditional convergence. The lower the starting level of real per capita GDP, relative to the long-run or steady-state position, the faster is the growth rate. This property derives from the assump-

tion of diminishing returns to capital; economies that have less capital per worker(relative to their long-run capital per worker) tend to have higher rates of return and higher growth rates. The convergence is conditional because the steady-state levels of capital and output per worker depend, in the Solow-Swan model, on the saving rate, the growth rate of population, and the position of the production function-characteristic that might vary across economies. Recent empirical studies indicate that we should include additional sources of cross-country variation, especially differences in government policies and in initial stocks of human capital. The key point, however, is that the concept of conditional convergence——a basic property of the Solow-Swan model——has considerable explanatory power for economic growth across countries and regions.

Another prediction of the Solow-Swan model is that, in the absence of continuing improvements in technology, per capita growth must eventually cease. This prediction, which resembles those of Malthus and Ricardo, also comes from the assumption of diminishing returns to capital. We have already observe, however, that positive rates of per capita growth can persist over a century or more and that these growth rates have no clear tendency to decline.

The neoclassical growth theorists of the late 1950s and 1960s recognized this modeling deficiency and usually patched it up by assuming that technological progress occurred in an exogenous manner. This device can reconcile the theory with a positive, possibly constant per capita growth rate in the long run, while retaining the prediction of conditional convergence. The obvious shortcoming, however, is that the long-run per capita growth rate is determined entirely by an element—— the rate of technological progress——that is outside of the model. (The long-run growth rate of the level of output also depends on the growth rate of population, another element that is exogenous in the standard theory.) Thus, We end up with a model of growth that explains everything but long-run growth, an obviously unsatisfactory situation.

Cass(1965) and Koopmans(1965) brought Ramsey's analysis of comsumer optimization back into the neoclassical growth model and thereby provided for an endogenous determination of the saving rate. This extension allows for richer transitional dynamics but tends to preserve the hypothesis of conditional convergence. The endogeneity of saving also does not eliminate the dependence of the long-run per capita growth rate on exogenous technological proress. The equilibrium of the Cass-Koopmans version of the neoclassical growth model can be supported by a decentralized, competitive framework in which the productive factors, labor and capital, are paid their marginal products. Total income then exhausts the total product because of the assumption that the production function features constant returns to scale. Moreover, the decentralized outcomes are Pareto optimal.

The inclusion of a theory of technological change in the neoclassical framework is difficult, because the standard competitive assumptions cannot be maintained. Technological advance involves the creation of new ideals, which are partially nonrival and therefore have aspects of public goods. For a given technology——that is, for a given state of knowledge——it is reasonable to assume constant returns to scale in the standard, rival factors of production, such as labor, capital, and land. In other words, given the level of knowledge on how to produce, one would think that it is possible to replicate a firm with the same amount of labor, capital, and land and obtain twice as much output. But then, the returns to scale tend to be increasing if the nonrival ideas are included as factors of production. These increasing returns conflict with

perfect competition. In particular, the compensation of nonrival old ideas in accordance with their current marginal cost of production-zero-will not provide the appropriate reward for the research effort that underlies the creation of new ideas.

Arrow (1962) and Sheshinski (1967) constructed models in which ideas were unintened by-products of production or investment, a mechanism described as learning-by- doing. In these models, each person's discoveries immediately spill over to the entire economy, an instantaneous diffusion process that might be technically feasible because knowledge is nonrival. Romer (1986) showed later that the competitive framework can be retained in this case to determine an equilibrium rate of technological advance, but the resulting growth rate would typically not be Pareto optimal. More generally, the competitive framework breaks down if discoveries depend in part on purposive R&D effort and if an individual's innovations spread only gradually to other producers. In this realistic setting, decentralized theory of technological proress requires basic changes in the neoclassical growth model to incorporate models of imperfect competitive. These additions to the theory did not come until Romer's (1987, 1990) research in the late 1980s.

The work of Cass (1965) and Koopmans (1965) completed the basic neoclassical growth model. Thereafter, growth theory became excessively technical and steadily lost contact with empirical applications. In contrast, development economists, who are required to give advice to sick countries, retained an applied perspective and tended to use models that were technically unsophisticated but empirically useful. The fields of economic development and economic growth drifted apart, and the two areas became almost completely separated.

Probably because of its lack of empirical relevance, growth theory effectively died as an active research field by the early 1970s, on the eve of the rational-expectations revolution and the oil shocks. For about 15 years, macroeconomic resesarch focused on shout-term fluctuations. Major contributions included the incorporation of rational expectations into business-cycle models, improved approaches to policy evaluation, and the application of general-equilibrium methods to real business-cycle theory.

Since the mid-1980s, research on economic growth has experienced a new boom, beginning with the work of Romer (1986) and Lucas (1988). The motivation for this research was the observation (or recollection) that the determinants of long-run economic growth are crucial issues, far more important than the mechanics of business-cycles or the countercyclical effects of monetary and fiscal policies. But a recognition of the significance of long-run growth is only a first step; to go further, one has to escape the straitjacket of the neoclassical growth model, in which the long-term per capita growth rate is pegged by the rate of exogenous technological proress. Thus, in one way or another, the recent contributions determine the long-run growth rate within the model; hence, the designation endogenous-growth models.

The initial wave of the new research——Romer (1986), Lucas (1988), Rebelo (1991)——built on the work of Arrow (1962), Sheshinski (1967), and Uzawa (1965) and did not really introduce a theory of technological change. In these models, growth may go on indefinitely because the returns to investment in a broad class of capital goods——which includes human capital-do not necessarily diminish as economies develop. Spillovers of knowledge across producers and externel benefits from human capital are parts of this process, but only because they help avoid the tendency for diminishing returns to the accumulation of capital.

The incorporation of R&D theories and imperfect competition into the growth framework began with Romer (1987, 1990) and includes significant contributions by Aghion and Howitt(1992) and Grossman and Helpman (1991, Chapter 3 and 4). In these models, technological advance results from purposive R&D activity, and this activity is rewarded by some form of ex-post monopoly power. If there is no tendency for the economy to run out of ideas, then the growth rate can remain positive in the long run. The rate of growth and the underlying amount of inventive activity tend, however, not to be Pareto optimal because of distortions related to the creation of the new goods and methods of production. In this frameworks, the long term growth rate depends on governmental actions, such as taxation, maintenance of law and order, provision of infrastructure services, protection of intellectual property rights, and regulations of international trade, financial markets, and other aspects of the economy. The government therefore has great potential for good or ill through its influence on the long-term rate of growth.

The new research also includes models of the diffusion of technology. Whereas the analysis of discovery relates to the rate of technological progress in leadingedge economies, the study of diffusion pertains to the manner in which follower economies share by imitation in these advances. Since imitation tends to be cheaper than innovation, the diffusion models predict a form of conditional convergence that resembles the predictions of the neoclassical growth model.

Another key exogenous parameter in the neoclassical growth model is the growth rate of population. A higher rate of population growth lowers the steady-state level of capital and output per worker and tends thereby to reduce the per capita growth rate for a given initial level of per capita output. The standard model does not, however, consider the effects of per capita income and wage rates on population growth——the kinds of effects stressed by Malthus——and also does not take account of the resources used up in the process of child rearing. Another line of recent research makes population growth endogenous by incorporating an analysis of fertility choice in the neoclassical model. The results are consistant, for example, with the empirical regularity that fertility rates tend to fall with per capita income over the main range of the experience, but may rise with per capita income for the poorest countries. Additional work related to the endogeneity of labor supply in a growth context concerns migration and labor/leisure choice.

The clearest distinction between the growth theory of the 1960s and that of the 1980s and 1990s is that the recent research pays close attention to empirical implications and to the relation between theory and data. Some of this applied perspective involves amplification of the empirical implications of the older theory, notably the neoclassical growth model's prediction of conditional convergence. Other analyses apply more directly to the recent theories of endogenous growth, including the roles of increasing returns, R&D activity, human capital, and the diffusion of technology.

The recent growth research has attracted interest from economists in a wide variety of fields. Conferences on growth have participation from specialists in macroeconomics, development, international economics, theory, history, econometrics, and industrial organization. We think that the effective combination of theory and empirical work will sustain this broad appeal and will allow growth theory to survive this time as a vibrant field. We do not expected the growth theory of the 1990s to suffer the same fate as the growth theory of the 1960s.

Ⅳ

In recent years, China's center government has advanced two developmental strategies and two transformations. The "sustainable development strategy" is one of the two strategies and the "economic growth pattern transformation" is also one of the two transformations. There are many papers and works contributing to economic growth transformation. These papers and works usually discuss the meanings of the concepts of "intensive growth pattern" and "extensive growth pattern". Some researchers definite the concept of "intensive growth pattern" as that the technology progress's comtribution to growth exceeds 50%. This definition has not any supporting theory and there is no any theory that can explain the differences between the growth pattern which's contribution to growth exceeds 50% and that which's contribution to growth not exceeding 50%.

We (and some other authors) suggest that the transformation target growth model would be the "sustainable development growth pattern" or "sustainable growth pattern".

since the 1970s, many papers in English have contributed to the researching of sustainable growth. The authors of those papers usually employed the neoclassical growth model to investigate the probability or conditions of balance between sustainable growth and environmental conservation. This book's contribution is that we attempt to employ the new growth theory (endogenous growth theory) model to investigate this problem again.

Through constructing the endogenous growth model involving natural resources, we obtained the conditions of sustainable growth and accordingly construct the sustainable growth measureing indexes.

In this book, we employ two methodes to depict the sustainable growth pattern. They are exogenous depiction and endogenous depiction methodes. From the exogenous depiction model, we obtained a minimal technology progress rate which assures sustainable growth. In endogenous depiction model, another index has been deducted. This index depicts the intensive (or extensive) degree of economy growth or industrial structure. This theory also suggested when and only when that endogenous index exceeds some level the growth is sustainable. This theory proved that the endogenous index exceeding unity is the necessary conditions of sustainable growth. If the endogenous index is below unity, sustainable growth cannot realize in any cases. In this situation, the sustainable development policy would be developing the more "intensive" industries which involving more knowledges or more technology contents and cost less natural resources, such as high-new technique industries.

Finally, we employed the datum of China to calculate the indexes and assess the sustainability of China's growth pattern. The measure results indicated that China's existing economy growth pattern is far away from sustainability.

Ⅴ

This book consists of three parts. In the first part, which includes four chapters (chapter 2, 3, 4 and 5), environmental problems and sustainable development theories are presented and assessed. Chapter 2

investigated the historical background of "sustanable development" thoughts. Chapter 3 analysed the understandings of various schools or subjects in the world of "sustanable development" and gave some comments for these views. We also investigated the origin, evolution and theoretical debates from various school of sustainable development. Chapter 4 analysed the evolution of modern environmental ethics, the main views of various environmental ethics school and the relationship between them systematically. In chapter 5, we systematically introducted the most influential sustainable development theories and their policy recommends, including the London School's theory and Daly's theory, etc.

The second part consists of three chapters (chapter 6, 7 and 8). Chapter 6 reviewed modern growth theories with exogenous saving rates (the Solow-Swan model and AK model). Chapter 7 reviewed modern growth models with endogenous saving rates (with Ramsey frame). Chapter 8 studied one-sector models of endogenous growth systematially.

Part Ⅲ is the core of this book, it includes four chapters (chapter 9-chapter 12). In chapter 9, we reviewed the results of sustainability studies from scholars abroad since the 1970s, including studies with neoclassical (Solow or Ramsey frame) and new growth theory model, but mainly with the former.

The contents of chapter 10 gave our own independent contribution to sustainable growth pattern research. In this chapter, we advanced exogenous and endogenous sustainable growth pattern quantiative depiction models and index construction principles.

In chapter 11, the index construction methodes have been investigated systematically. First, we reviewed existing methodes advanced by other authors (including abroad and domestic). Then, according to the construction principles obtained in chapter 10, we put forward our own results. Compare with existing indicator, our results have some advantages, such as easy for calculating, not involving natural resources price value stock, etc.

In chapter 12, we investigated China's sustainable development problems and related policy evolution. We also analysed the sources of China's environmental problems, the formation processes of environment conservation policy and management institution, and the implement principles of sustainable development strategy in the future, etc.

Finally, this chapter measured the exogenous and endogenous index employing China's statistics datum respectively. The measure results suggested that China should development more intensive industries and high-new technique industries, accelerate the transformation processes from existing growth pattern to sustainable growth pattern, which is the crux of the implementing of sustainable development strategy.

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