A review of the Convergence Mechanismin the theory of Economic Growth

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Abstract. By combing the theory of economic growth, this paper discusses the internal logic relationship between the theory of late development advantage, the theory of neoclassical growth and the theory of endogenous growth and convergence, excavates the main points of convergence hypothesis of different economic growth theories, and compares and analyzes the differences of convergence mechanism in different theoretical models. This not only enriches the theoretical connotation, but also provides a theoretical basis for the study of economic growth convergence. Finally, the application of related theories is prospected.

1.   Introduction

In the study of economic growth theory, convergence is one of the most attractive fields. According to the neoclassical growth theory, due to the law of diminishing marginal return of capital, the per capita income and economic growth rate of different economies have strong convergence, and the existence of absolute convergence and conditional convergence is expected [1-2].However, a large number of empirical results show that there is no so-called neoclassical convergence. Facing the double dilemma of theory and reality, scholars reexamined the convergence of economic growth. Some scholars strengthened the explanatory power of the convergence mechanism to the real world by introducing human capital elements in the neoclassical framework[3]; others reexamined the convergence based on the existence of endogenous growth theory and the theory of late development advantage. The theory of backwardness advantage studies the problem of backward countries catching up with advanced countries. It holds that the later a country starts industrialization, the faster it will catch up. The convergence hypothesis provides a footnote for the proposition of backwardness advantage[4]. Based on this, from the perspective of convergence hypothesis, this paper explores the mechanism of economic convergence, clarifies the internal logical relationship between convergence and economic growth theory, and provides a theoretical basis for the analysis of regional economic growth convergence.

The next arrangement of this paper is as follows: the second part is to analyze the backwardness advantage theory and convergence, the third part is to analyze the new classical growth theory and convergence, the fourth part is to analyze the endogenous growth theory and convergence, and the last part is the conclusion and prospect.

2.   Backwardness Advantage Theory and Convergence

Gerschenkron (1962)[5] put forward "the theory of late development advantage" in "the re exploration of European industrialization". He believes that in the process of industrialization, those countries with lower initial industrialization have some unique advantages over those with higher industrialization. These advantages are not created by the late developing countries through their own efforts, but are symbiotic due to the relative backwardness of their economies compared with the first developing countries, mainly including three levels: (1)The will advantage. The relatively backward status makes the late developing countries discriminated and excluded by the first developing countries in the national activities, and stimulates the strong will of national industrialization, which causes social pressure, urges people to put pressure on the government to stimulate their own institutional innovation, and encourages the people to make full use of the industrialization experience of the advanced countries to promote their own industrialization

process.(2)Alternative advantages. The so-called "substitutability" refers to the fact that the development model of each country is not unified and standardized on the road of industrialization. On the basis of absorbing the successful experience and failure lessons of the advanced countries, the backward countries can seek many corresponding substitutes to achieve some conditions and overcome obstacles in the process of industrialization [6]. (3)Introduce advantages. As advanced countries have accumulated certain advanced technologies and equipment in the process of industrialization, late developing countries can directly introduce technologies and equipment without their own R&D and manufacturing, which reduces their own research time and cost, reduces the risk of cost development and improves management level. This makes the late developing countries stand at a higher starting point and develop faster in the industrial revolution. Levy (1966)[7]has concreted the advantages of the late developing countries from the perspective of modernization, including five aspects: (1) Recognize the advantages. Due to the continuous development of information technology, the late developing countries are not limited to the original first developing countries' understanding of industrialization, but more extensive in scope and degree.(2) Selection advantages. With the continuous accumulation of technology and equipment in the first developing countries, the later developing countries can choose to use and learn from the mature technology and equipment. (3) Jumping advantage. Late developing countries do not need to go through every stage of industrialization in the process of modernization. They can jump some stages of development according to their own characteristics. (4) Target advantages. With the experience of developing modernization in the first developing country, the later developing country has a clear goal and forecast for its own development and modernization process. It can realize its development goal step by step according to the plan in advance.(5) Other advantages. Under the open international conditions, the less advanced countries can get the technical and capital help from the first developing countries. Abramovitz (1986)[8]then put forward the "catch-up hypothesis", that is, the initial level of a country's economic development has a reverse relationship with its economic growth rate, which holds for both labor productivity variables and unit capital income variables. So, is the growth rate of the more backward countries certain to be higher, and all the backward countries are bound to catch up with the advanced countries? Abramovitz (1986) pointed out that the key to catch-up hypothesis is to grasp the difference between "potential" and "reality". It is necessary to meet certain restrictions in order to turn the "potential" catch-up into the "reality" catch-up. The first is the technology gap. By introducing and drawing on the technology of developed countries, the backward countries have raised their productivity level, so as to catch up with the developed countries. Technology gap is the key external factor to realize "catch-up hypothesis". The second factor is social ability, which is the internal factor of economic catch-up, that is, the adaptability and technical ability formed through education and training, as well as different laws, cultures, environments and systems, etc. through the effective play of these factors, the economy of backward countries can grow rapidly, so as to catch up with developed countries.

The theory of backwardness advantage studies the interactive mode of economic development between developed and backward countries under the open economy. Because knowledge and technology have the characteristics of public products, that is, the cost of research and development is very high, but the cost of communication and diffusion is almost zero, thus forming the advantage of technology late development [9].The backward countries gradually narrow the technological gap with the developed countries by taking advantage of the advantages of late development of technology. This process is characterized by stages, i.e. the stage of technology introduction, the stage of technology imitation and the stage of independent innovation. Through the technology spillover effect, the gap between the economic growth of the backward countries and the developed countries is narrowed, and the trend of economic convergence appears. This constructs the late development advantage of technology diffusion, which can realize the catch-up of economic growth.

3. Neoclassical Growth Theory and Convergence

In the standard neoclassical growth model, due to the law of diminishing marginal return of capital, capital flows into the economy with lower income. That is to say, countries with lower capital labor ratio have higher marginal return of capital, per capita growth rate of capital and per capita growth rate of output, so they can enjoy faster growth opportunities, which enables low-income countries to catch up with high-income countries or regions. When economies have the same structural characteristics, all countries will converge to the same steady state with the same per capita output. The process of economic stability is called absolute convergence. For example, each state of the United States and OECD countries are relatively homogeneous economies, that is, they have the same or similar economic structure, with little difference in development level, so the steady-state position is very close, and these economies are more likely to show absolute convergence. However, if the economies have different structural characteristics, such as a sample that includes both developed and developing countries, each economy will have different steady-state, and the steady-state position is very different, which leads to conditional convergence. Conditional convergence holds that due to the complexity and diversity of the real world, many exogenous variables have different effects on different economic experiences, so the economic characteristics of different economies are not likely to be absolutely consistent, and the growth path and steady state will be different. When the initial exogenous variables are controlled, the initial per capita output variables will show a negative correlation with their growth rate, so the cross-border samples with different structural characteristics support the conditional convergence hypothesis. The conditional convergence of the neoclassical growth model means that different economies converge to their own steady state, but the steady state position is not the same, and the convergence speed is inversely proportional to the distance between the steady state and the new economy. In the law of diminishing marginal return of capital, capital includes material capital and human capital, "capital deepening" will make the backward economy grow faster. Even if investment has certain externalities, such as "learning by doing" and human capital spillover, as long as the law of diminishing marginal return of capital is not damaged, we can get the conclusion of convergence [10].

4. Endogenous Growth Theory and Convergence

First Generation Endogenous Growth Model and Convergence. Romer (1990) [11] and Lucas (1988) [12] emphasized the importance of material capital and human capital as a medium of technology diffusion. In their model, there is no law of diminishing returns to scale, which is due to the externality of investment (the social gains from investment are greater than the private benefits).For example, workers with higher education will make every worker around them more productive, because other workers have the opportunity to learn from skilled workers. Romer (1990) is one of the earliest models of endogenous growth theory, which assumes that there are three sectors in the whole economy. The first is the R&D department, which uses human capital and existing knowledge to produce new knowledge (design scheme). The second is the intermediate production department, which uses the new knowledge of the first department to produce durable goods (intermediate products) together with other product inputs. The third is the final product department, which uses labor, human capital and the products produced by the second intermediate production department to produce the final products. The model concludes that the growth rate of output in an economy directly depends on the level of human capital.

Lucas (1988) [12] explains how human capital influences the current productivity or the current time distribution affects the accumulation of human capital. The model shows that the growth rate of labor output is directly proportional to the growth of human capital. Therefore, if an economy can maintain a high growth rate of human capital, then economic growth can maintain a high level. This model is consistent with the persistence of the per capita income gap of any scale. Therefore, the model is more inclined to think that there is no convergence between countries. The growth rate of capital and consumption is the same as that of human capital, that is, countries with higher

growth rate of capital and consumption have higher cumulative growth rate of human capital. On the contrary, countries with lower growth rate of capital and consumption tend to have lower cumulative growth rate of human capital, so the result of economic growth is divergence rather than convergence. At the same time, the model foresees the existence of multiple equilibria. Countries with initial poverty will continue to be poor in some relevant indicators, although their growth rate may be the same as that of rich countries.

In the first generation of endogenous growth model, capital as a factor of production has been given a new explanation, which overcomes the critical assumption of the central conclusion of Solow model that the marginal return of capital is decreasing, and then the long-term per capita economic growth can be achieved endogenous. Because the return of human capital does not decline, some endogenous growth models (Lucas, 1988) think that the externality of technology or knowledge can break the law of diminishing marginal return of capital, resulting in increasing marginal return of capital, so that economic growth is no longer convergent, but tends to diverge.

Second Generation Endogenous Growth Model and Convergence. In the first generation of endogenous growth model, the ratio of productivity growth to the number of R&D personnel is set without basis, so they are replaced by the second generation of endogenous growth model, which is called Schumpeter growth model or semi endogenous growth model. In the Schumpeter growth model of Howitt (2000) [13] and Peretto and Smulders(2002) [14],R&D grows over time to ensure that the economy grows at a steady rate. With the expansion of economy, the growth of products reduces the productivity effect brought by R&D activities. Schumpeter's treatment of scale effect is to assume that innovation occurs in a single enterprise rather than in the whole economic field. In other words, the shift in Schumpeter's theory is to shift the focus from the economy as a whole to every company with a product line. In some semi endogenous growth models, scale effect is avoided and the return of knowledge stock is assumed to decrease. Although R&D department can determine technological progress, the balanced growth rate of technological progress is significantly related to the growth rate of exogenous population. For example, Kortum (1997) [15] established a pareto distribution search theoretical model, that is, the technology frontier presents a state of rapid expansion, in this process, technological innovation will not be so easy to achieve, and the cost is also high. Segerstrom (1998) [16] also found that with the development of technological innovation, the more difficulties faced by later innovation, the slower the growth of technological innovation. All of the above models belong to the semi endogenous Schumpeter growth model. Its central idea is that technology is endogenous, and the equilibrium rate of economic growth is determined by the exogenous population growth rate. However, the more knowledge is produced in the process of production, the more difficult it is to bring innovation by knowledge. That is to say, technological innovation has the marginal decreasing effect, that is, with the increase of knowledge stock, the marginal productivity brought by knowledge and technology will be lower and lower, and the equal amount of technological input cannot bring the equal amount of economic growth. In order to achieve sustained economic growth, R&D investment must continue to increase. Because the semi endogenous growth model has the same steady-state characteristics as the Solow model, the conditional convergence is predicted.

The technology diffusion model of Barro and Sala (1997) [17] holds that technology has the same characteristics as public products, that is, once new inventions and innovations are spread, people can use them free of charge. Usually, technology is spread from developed countries to backward countries, mainly through free trade and foreign direct investment. When the backward countries have certain "social capacity", they use the advantages of backwardness to introduce advanced technology, capital and equipment from the developed countries, learn from the successful experience, and reduce the cost and risk of research and development. Because the cost of technological innovation through R&D is much higher than that through imitation or other technology introduction, the backward countries can catch up with the developed countries through technology spillover effect.The convergence mechanism based on technology diffusion can be summarized as follows: As the circulation and penetration of technology and knowledge from advanced economies to backward economies are realized through exchange, the backward countries

of economic development import products with technological advantages from countries with technological frontier, and imitate the leading technology at a cost far lower than the input of advanced countries, so the technology and knowledge flow from advanced countries to backward countries through free trade, foreign direct investment and other means. Through the technology spillover effect, we can share the benefits of technology diffusion and promote the rapid growth of technology and economy. This "late development advantage" makes the economic growth of backward countries faster. With the technology gap between the developed countries and the backward countries becoming smaller and smaller, the space of technology imitation is constantly compressed, the cost of imitation will be higher and higher, and the economic growth brought by imitation technology will be slower. In other words, this trend of convergence among countries is caused by factors such as technological imitation, technological diffusion and technological catch-up [18].

5.　Summary and Prospect

The advantage of backwardness has a strong and powerful influence on the development of different economies. Based on the hypothesis of diminishing marginal return of capital, the neoclassical growth theory predicts the existence of absolute convergence and conditional convergence among different economies. Convergence indicates the existence of "late development advantage", while conditional convergence, which controls investment, education and economic openness, means that the existence of "late development advantage" has certain conditionality, that is, "the more backward the economy, the faster the growth rate" is not unconditional, but a potential advantage. The transformation of "late development advantage" into "practical advantage" needs certain conditions to be completed. Endogenous growth theory is the supplement of neoclassical growth theory, which can explain the determinants of long-term economic growth in the model. The main difference lies in whether the convergence hypothesis is recognized. The first generation of endogenous growth theory believes that because of externalities, knowledge spillovers, specialized division of labor and other factors, the marginal income of the elements can be increased, and then the sustainable growth can be achieved, so the convergence is questioned. With the development of endogenous growth theory, the second generation of endogenous growth theory links innovation, R&D and endogenous economic growth. The model has the same steady-state characteristics as Solow model, so it predicts the conditional convergence. The neoclassical growth theory attributes convergence to the law of diminishing marginal return of capital, while the endogenous growth theory attributes it to the convergence of backward countries and developed countries by sharing the benefits of technology diffusion through technology spillover effect. Endogenous growth theory explains the way of "economic catch-up", that is, developing countries use knowledge spillover and technology leaping to realize the "late development advantage" of economic catch-up.

Theoretical research has shown the existence of convergence, which not only helps to understand the current situation of regional economic development gap, but also provides a solid theoretical basis for empirical research. With the global reduction of labor barriers and knowledge barriers, labor mobility and technology transfer are greatly realized, and economic convergence among different economies will become easier. In the future research, we can explore the convergence mechanism from other micro aspects besides capital, such as labor productivity and technology, and explore the factors that affect the convergence of regional economy, such as education, the degree of international trade, which are important factors to maintain productivity growth, and further provide a new research perspective for the study of convergence of economic growth.

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