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A synthesis of research on education and economic growth in China

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Abstract

Economic growth is one of the major concerns of economics, and the research on economic growth theory has made breakthrough progress since the 20th century. The article summarizes the classical growth theory, neoclassical growth theory, and endogenous growth theory. Based on these theories, the article puts forward a proposal for the development of education and R&D expenditures and China's economic growth. The article is summarized as follows.

Keywords

Economic growth theory, neoclassical growth theory, endogenous economic framework, education and China's economic growth.

1. Introduction

1.1. A Review of Research on Economic Growth Theory

The issue of growth, as a core issue in economics, has always been of great concern to scholars, and its research history is profound and fruitful. Since the 20th century, with the acceleration of globalization and the rapid development of technology, breakthrough progress has been made in the research of economic growth theory, among which the new economic growth theory is particularly noteworthy.

Classical economic theory, as an early form of economics, mainly emphasizes analysis from a production perspective. Adam Smith, the founder of classical economics, delved into labor value theory, division of labor theory, and free trade theory in "The Wealth of Nations". Smith believed that labor is the source of all wealth, and the invisible hand of the market automatically regulates the economy, achieving effective allocation of resources and stable economic growth. Classical economic theory emphasizes the self-regulation function of market mechanisms and believes that government intervention should be minimized to avoid disrupting the natural order of the market.

However, with the deepening of the Industrial Revolution and the development of capitalist economy, the limitations of classical economic theory gradually became apparent. So, neoclassical theory emerged and developed on the basis of classical economics. The neoclassical theory emphasizes the role of individuals and market mechanisms, believing that the market is the optimal way of resource allocation. Compared with neoclassical theory, classical economic theory places more emphasis on the perfection of the market and the rational choices of individuals. Under the framework of neoclassical theory, economic growth mainly relies on the input of material capital and labor, and technological progress is regarded as an exogenous variable with limited impact on economic growth.

However, with the continuous progress of technology and the rise of the knowledge economy, neoclassical theory seems inadequate in explaining long-term economic growth drivers.

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Therefore, the new economic growth theory, also known as the endogenous economic growth theory, has emerged. This theory breaks through the limitations of neoclassical theory and introduces knowledge accumulation, technological progress, and human capital into the growth model, providing a new perspective for explaining economic growth. The core viewpoint of the new economic growth theory is that the sustained economic growth of a country or region is not mainly dependent on external factors, but mainly depends on the knowledge accumulation, technological progress, and human capital level of the country or region. This theory emphasizes the crucial role of knowledge and human capital in economic growth, believing that they are endogenous drivers of economic growth. Among them, education and research and development expenditure are two important aspects in the new economic growth theory. Firstly, education, as the main means of investing in human capital, is of great significance in improving the quality and skill level of the workforce. Through education, people can acquire more knowledge and skills, improve production efficiency and innovation ability, and thus drive economic growth. Therefore, the government and enterprises should increase investment in education, improve the quality and popularization of education, and provide strong talent support for economic growth. Secondly, research and development expenditure is a key factor driving technological progress and innovation. Through research and development activities, new technologies, products, and processes can be developed to improve production efficiency and quality, and promote industrial upgrading and transformation. Research and development expenditure not only helps to enhance the competitiveness of enterprises, but also injects new vitality into the entire economic system. Therefore, the government should increase its support for research and development activities, encourage enterprises to increase research and development investment, promote technological innovation and economic growth.

In summary, the new economic growth theory, as one of the important achievements in economic research since the 20th century, provides us with new perspectives and ideas for understanding economic growth. By combining education and research and development expenditures with new economic growth theories, we can gain a deeper understanding of the role of knowledge accumulation and human capital in economic growth, providing important references for formulating effective economic development strategies and policies. In the future, with the continuous progress of technology and the deepening development of globalization, the new economic growth theory will continue to play its important role, providing strong theoretical support for the sustained and healthy development of the economy.

1.2. A review of research on economic issues under the neoclassical growth framework

Due to the fact that economic growth is guaranteed by exogenous technological progress in this analytical framework, it leads to long-term economic growth being unrelated to the optimization of economic behavior allocation. Therefore, in this framework, external inputs in fields such as education and research and development only have distorted benefits on the economy. In the study of economic issues under the neoclassical growth framework, we can first focus on the relationship between economic growth and exogenous technological progress. As shown in the Solow Swan model, technological progress is the main driving force that determines economic growth, and this technological progress is often seen as an exogenous factor, independent of the optimal allocation and behavior within the economy.

This viewpoint leads to limited effectiveness of traditional economic policy intervention and optimization allocation strategies in promoting economic growth within the framework of neoclassical growth. For example, Fagerberg (2005) pointed out in his research that under the neoclassical growth theory, government investment in education and research and

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development may have distorted benefits, meaning that increased investment does not lead to corresponding economic growth, as technological progress is mainly exogenous

However, although exogenous technological progress is considered the main driving force of growth in the neoclassical growth framework, investment in areas such as education and research and development is still considered important. Although technological progress is exogenous, it still requires human resources and professional knowledge in practical application and promotion. Therefore, investment in education and research and development can still affect the absorption and application capacity of technology, thereby indirectly affecting economic growth.

Becker's (1964) theory of human capital proposes a new perspective that emphasizes the positive impact of education on individual productivity and overall economic growth. According to this theory, education is not only a personal investment, but also an investment in the entire economic system. Through education, individuals can acquire skills and knowledge, thereby improving their productivity and creativity.

Under the neoclassical growth framework, technological progress is seen as an exogenous factor, but education investment can play a crucial role in promoting technological progress. By receiving education, workers can better understand and apply new technologies because they have higher skill levels and adaptability. This makes the adoption and application of new technologies smoother and more efficient, thereby driving economic growth.

In addition, education can also cultivate talents with more innovative awareness and leadership abilities, who can become an important force in promoting economic development. Therefore, education is not only in the interest of individuals and families, but also in the interest of the entire society and country. By improving education levels, a country can cultivate more high-quality workers, laying a solid foundation for long-term economic growth.

In the field of research and development, Romer (1990) and Jones (1995) broke through the traditional neoclassical growth theory and proposed a theoretical framework for endogenous technological progress. They believe that through research and development activities, businesses and governments can create new knowledge and technology, thereby promoting economic growth. Although this technological advancement is endogenous, it still requires support from education and human resources.

However, it should be noted that the effectiveness of education and research and development investment may be influenced by factors such as institutional, market structure, and policy environment. For example, Aghion and Howitt's (1998) study suggests that market competition and institutional environment have a significant impact on the incentive effect of research and development activities and technological innovation.

Overall, under the neoclassical growth framework, although exogenous technological progress is the main driving force of economic growth, investment in education and research and development still has an important impact. Therefore, future research needs to delve deeper into how to optimize education and research and development policies to promote the absorption and application of technological progress, thereby achieving the goals of economic growth and social development.

1.3. Research on Relevant Issues under the Framework of Endogenous Economic Growth

Under the endogenous growth framework, steady-state economic growth rates greater than zero are caused by sector growth with externalities, and the decisive role of technological progress in economic growth and the importance of human capital accumulation are emphasized. From the model analysis of China's education, research and development expenditure, and economic growth, it can be seen that most domestic scholars often assume

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human capital or technological progress before conducting research on the optimal scale of education research and development expenditure.

In economics, when one of the two factors has a stable growth function, the assumption of stable growth in the economy can be used to reasonably optimize the function on the steady-state path, thereby obtaining the optimal expenditure scale for the other external factor. Based on this principle, Chinese scholars have conducted a series of related studies on the optimal scale of government R&D expenditure. In 2013, domestic scholar Yan Chengliang used Romer's (1990) analysis framework to subdivide the R&D departments and ultimately solved the explicit expressions for two different types of R&D expenditures. He provided the optimal R&D expenditure scale at the economic steady state level and the proportion relationship between the two types of R&D department expenditures. Zhang Xiaoyun et al. (2019) internalized the overall expenditure scale of the R&D department in the economy into their growth model, assuming the existence of human capital accumulation in the economy. Similar works include Lai Mingyong et al. (2005)'s study on the impact of basic R&D investment on China's long-term economic growth. Meanwhile, Yao Qiuge et al. (2020) also used a similar method to endogenously determine the scale of research and development expenditure. However, the work of Hao Shuobo and Ni Ni (2014), Zhao Xinyue (2014), Li Ya and Wang Xiyuan (2016) only considered changes in education expenditure, while exogenous technological progress (At) was considered; Some scholars, such as Guo Lu (2018), have integrated the analytical frameworks of Lucas (1990) and Barro (1990) to depict the long-term relationship between education expenditure and government expenditure on infrastructure (public capital) and economic growth. However, the above mechanism has not played a substantial role in improving the economic growth rate of developed countries. The results of Taiwan Airlines and Cui Xiaoyong's (2017) cross-border study on human capital structure and economic growth also indicate that there is a significant heterogeneity in the role of education investment in national economic growth. The research results show that as a country's economic development level gradually improves, the promoting effect of primary education investment on economic growth will gradually decrease, while the long-term impact of higher education investment on the economy will gradually increase.

Specifically, Yan Chengliang (2009) introduced government fiscal expenditure in the field of technology research and development into the analytical framework of Aghion and Howitt (1992) and Grossman and Helpman (1991), and then analyzed its long-term impact on economic growth. Empirical research shows that there is a long-term equilibrium relationship between China's economic growth rate and government R&D investment, and the economic growth rate increases with the expansion of government R&D scale investment. In addition, Yan Chengliang and Gong Liutang (2009) further analyzed the impact of different tax mechanisms on R&D on long-term economic growth, and the results showed that subsidies to the R&D sector help improve the level of long-term economic growth and overall economic welfare.

In 2013, Yan Chengliang and Hu Zhiguo examined the distortion effects of capital income tax and labor income tax in Romer's (1990) analysis framework. Their research results showed that in an economy driven mainly by innovation, labor investment in the R&D sector will directly determine the steady-state growth level of the economy. Therefore, in this environment, increasing taxation on labor income has a more direct impact on economic growth and social welfare improvement. Wang Jun and Zhang Yifei (2016) further considered the impact of differentiated government R&D subsidy strategies on corporate R&D performance. The study found that the higher the government R&D subsidy in any situation, the more significant its promoting effect on economic growth. Moreover, when the government R&D subsidy is freely controlled by enterprises, the efficiency of its use is the highest. Hu Zhiguo et al. (2013) introduced government R&D investment within the horizontal innovation

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framework of Rivera Batiz and Romer (1991), and further compared the effects of government R&D investment and R&D subsidies on economic growth and overall welfare levels.

In the theoretical model analysis of human capital investment and its impact on economic growth, Yang Liyan and Pan Huifeng (2003) extended Jones (1995)'s technology research and development department to depict the impact of human capital and different types of technological progress on long-term economic growth in China. Yan Chengliang and Hu Zhiguo (2013) extended Lucas's (1988) human capital growth function and introduced education expenditure into the human capital supply function, ultimately generating the optimal government education expenditure. In addition, it was found that the government can achieve stable saddle point equilibrium economic growth by investing fiscal revenue in human capital, which is significantly different from the conclusion in Lucas (1990). Hao Shuobo and Ni Ni (2014) incorporated heterogeneous R&D departments into an endogenous growth model with public education investment, and further examined the impact of a country's differentiated R&D strategies on different educational investment demands under different levels of technological differences. Zhao Xinyue (2014) specifically analyzed the optimal allocation structure of human capital and material capital in the long-term economic growth process, but did not consider the optimal structure of human capital investment.

From the perspective of China's economic development stage, before 2007, the Chinese economy showed a significant capital biased development model. Jiang Sanliang and Li Pan (2016) also showed in their research on the relationship between technological progress, capital output ratio, and China's economic growth that there was a significant change in the growth rate of China's capital output ratio before and after 2007. As a result, since 2008, the impact of China's economic growth will be more dependent on technological progress, and the promoting effect of education and research and development expenditure on economic growth is also different from before. From the specific stage division, when empirical research data is mainly selected from the pre 2008 stage data, the research results often show that the promoting effect of education and R&D expenditure on China's economic growth is not significant. Liu Xintong's (2010) study on the impact mechanism of China's R&D investment on economic growth at different stages also showed that before 2008, although there was a long-term cointegration relationship between R&D expenditure and China's economic scale, R&D expenditure did not promote China's economic growth in this stage; In the panel data analysis results of Yan Chengliang and Gong Liutang (2013) on the relationship between R&D expenditure scale and economic growth in 31 provinces of China from 1998 to 2013, it was found that there was a negative correlation between R&D expenditure scale and actual economic growth in China during this period. Yuan Yijun et al. (2015) also showed similar conclusions in the analysis of provincial-level panel VARs in China at this stage. However, when selecting the period after 2008 as the main stage, empirical results will show that education and research and development expenditures have a significant promoting effect on economic growth in this stage.

1.4. An Empirical Study on the Relationship between Education, R&D Expenditure, and Economic Growth in China.

An Empirical Study on the Impact Mechanism of Education Expenditure on R&D Innovation in 31 Provinces of China from 2006 to 2015 by Shang Haiyan and Liu Qingyuan (2019) on the impact mechanism of education expenditure on R&D innovation in 31 provinces of China from 2006 to 2015 shows that the expansion of education expenditure after 2008 has a significant promoting effect on China's technological progress (measured by patents in the article) and economic growth. The promotion of education expenditure on technological progress needs to be mediated by human capital. The vast majority of scholars have shown a positive correlation between research and development expenditure and economic growth; Some scholars have

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found that educational research and development have not played a significant role in economic growth; Some scholars have shown that there is a negative correlation between education expenditure and economic growth in China.

One is that research and development expenditure contributes to economic growth. Shang Haiyan and Liu Qingyuan (2019) jointly studied the accumulation of human capital and regional technological innovation, providing rich experience on how to guide educational consumption, use education to lead technological innovation, and promote economic transformation. Luo Yingxue (2023) conducted an empirical analysis based on fixed effects and quantile models, taking Guizhou as an example, and proposed a structural framework for the U-shaped relationship between government education expenditure and economic growth. The second is that the correlation between research and development expenditure and economic growth is not significant. Gao Yan and Yang Bowen (2019) drew on the random effects model (RE) and found that public education expenditure has brought about economic growth in the central and eastern regions, while its utility is relatively small in the western regions. The author believes that there is a certain lag in the development of education in the western region. Thirdly, education research and development expenditure will suppress economic growth. Zhu Shujin and Guo Juan (2008) found that R&D expenditure hinders economic development by analyzing cross-sectional data on R&D expenditure and economic growth across provinces. Its analysis suggests that the human capital, R&D investment, and trade openness levels in the central and western regions with a relatively high proportion of education expenditure are far lower than those in the developed eastern regions, further affecting the interaction of education spillover effects.

Looking at previous literature, there are two prominent points: firstly, there is a lot of existing research content by domestic scholars on the relationship between education research and development expenditure and economic growth, but most of the research has not gone beyond the macro research paradigm, mostly starting from a top-level design perspective to study the relationship between China's overall education expenditure and economic growth, and the most in-depth research is only conducted at the provincial level. This model can propose a more paradigmatic thinking path from a macro or meso level. But neglecting the combination of micro and macro, it is difficult to solve the many practical problems faced by education fiscal expenditure and economic growth from a specific type of perspective. When people are enthusiastic about starting from the total amount and seeking governance ideas, they overlook how to make the institutional construction and practical actions more "good fit" in concrete practice. Scholars have attempted to select specific aspects for research from a total perspective, but case studies and data support are somewhat weak, and the combination of macro systems and micro practices is still not close enough. The linear thinking logic clearly does not match the complex development situation of various regions in China, and a single corresponding measure is also difficult to adapt to the development situation of each specific region. Secondly, existing research has mostly focused on the relationship between the external manifestation of education fiscal expenditure and economic growth, directly focusing on the correlation between education and economy. However, according to Romer's new growth model, human capital has a mediating effect, and factors such as the internal hierarchical structure design of education research and development and education spillover effects need to be taken into account.

We believe that in response to the current research gaps in the field, further exploration in the following two areas will yield significant findings. One is to address the diversity and complexity of regional development in China. The second is to optimize the structure of China's tertiary education expenditure, taking into account the structural effects brought by the optimization of education investment.

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1.5. Conclusion

This article comprehensively reviews the development process of economic growth theory, from classical economic growth theory to neoclassical growth theory, and then to endogenous economic growth theory. These theories reveal the diverse driving forces and complex mechanisms of economic growth for us. Specifically, the article delves into the impact of education and research and development expenditures on China's economic growth, highlighting the core role of education in improving labor quality, promoting technological innovation, and promoting economic growth.

During the critical period of China's economic transformation, the article proposes suggestions such as increasing education investment, optimizing education resource allocation, and strengthening research and development innovation, which not only help to enhance the endogenous growth momentum of the Chinese economy, but also an important way to achieve sustainable development. These suggestions are not only based on profound theoretical support, but also closely combined with China's actual national conditions, providing strong theoretical support and practical guidance for us to formulate scientific and reasonable economic policies. This enriches our understanding of economic growth theory and provides us with new perspectives and ideas for in-depth exploration of the relationship between education and economic growth, which is of great significance for promoting high-quality development of the Chinese economy.

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