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Research on the Impact of Standardization on Economic Growth

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Abstract: The relationship between standardization and economic growth has received increasing attention. This article first gives different classifications of standards, including classification based on economic purposes. The analysis shows that standards have economic effects in reducing information asymmetry, promoting economies of scale, expanding division of labor, and accelerating technology transfer and diffusion. The research literature of foreign standards on economic growth shows that standards are an important factor in promoting economic growth. Empirical results (mainly based on the Cobb-Douglas production function or VAR model) show that there is a significant positive correlation between standards and economic growth, and standards can effectively promote Economic growth. In addition, the Granger causality test between the standard and economic growth points out that economic growth is the Granger reason for the standard, indicating that the standard is not an exogenous variable independent of the economic system, and the standard level is affected by the economic level of a country. It is an endogenous variable determined by the economic system. At the end of the article, it also gives suggestions on possible future research directions, from the perspectives of the impact of splitting to standard sub-categories, management standards, economic growth quality, and institutional economics.

Keywords: Standardization, Technical Standard, Economic Growth, Cobb-Douglas Production Function

1. Introduction

The origin of standards has a long history, from primitive society's symbolic standards: Arabic numerals, agricultural society's weights and measures standards: feet, catties, etc., industrial society's function/performance standards: railroad tracks, Ford cars, to the interconnection standards of the information society: TCP /IP, 4G/5G. The industrial revolution originated in Europe pushed standard activities to human society and life. Standardization has rapidly expanded from enterprises to industries, countries and regions, and even globally. Countries around the world have established national standardization institutions and formed a number of international standardization organizations, the International Telecommunication Union (ITU), one of the three major international standards organizations today. Its predecessor, the International Telegraph Union, was established in 1865.

The study of standards and standardization from a social perspective includes the study of the best economic benefits that standardization brings to enterprises from a micro perspective, and the study of the economic effects of standardization on the entire industry and the entire country from a macro perspective. Taking into account that the "Thirteenth Five-Year Plan" outline clearly stated that "implementing the strategy of strengthening the country by quality", the report of the 19th National Congress of the Communist Party of China once again emphasized the construction of a strong country by quality. As an important part of "quality infrastructure" standards, there is undoubtedly a close relationship with economic growth. Therefore, this article will focus on analyzing the impact of standardization on economic growth from a macro perspective. The second part of the article gives the classification of standards and the economic purpose of standardization, and studies the effectiveness of standards in reducing information asymmetry, promoting economies of scale, expanding the division of labor, and accelerating technology transfer and diffusion; The third part sorts out the research results of the impact of standardization on economic growth from both domestic and international dimensions.

The domestic part focuses on the analysis of the research literature based on the Cobb-Douglas production function or VAR model. The fourth part gives the conclusions of this article and possible follow-up research direction.

2. Standard Classification and Economic Purpose Analysis

China national standard GB/T20000.1-2014 "Guidelines for Standardization Part 1: General Terminology for Standardization and Related Activities" defines "standards" as follows: "Documents that provide rules, guidelines or features for various activities or their results through standardized activities, in accordance with prescribed procedures, and through consensus, for common use and repeated use". At the same time, this standard also defines "standardization" as follows: "In order to obtain the best order within the established scope, promote common benefits, establish common use and repeated use clauses, and prepare, publish and apply documents for actual or potential problems." The standard also points out that standardization can have one or more specific purposes, including applicability, compatibility, interchangeability, variety control, health and safety, and environmental protection, etc.

There are different classifications of standards, such as Li Chuntian [1], according to the basic attributes of standardization objects, standards can be divided into technical standards, management standards and working standards; according to the scope of application of standards, they can be divided into international standards, regional standards, National standards, industry standards, local standards and corporate standards. Standard classification reflects different research perspectives on standards. Considering that this article mainly studies the impact of standardization on economic growth, this article will mainly discuss classification based on the economic purpose of standards.

David [2] divided the standards into compatibility (or interface) standards, quality (or safety) standards, and product category standards based on economic purposes. On this basis, Swann [3] divided the standards into four types: Compatibility/Interface Standards, Minimum Quality/Safety Standards, Variety Reduction/ Focussing Devices and Information/Measurement standards.

Minimum quality/safety and information/measurement standards can help reduce information asymmetry and thus promote economic growth. Without quality standards reflecting product attributes and related information/measurement standards, consumers cannot understand and evaluate product quality before the transaction. This information asymmetry may cause serious market failure: sellers with low product quality drove high-quality sellers out of the market, which is the so-called "lemon effect". Quality standards can help consumers correctly identify the level of product quality, thereby reducing information asymmetry between buyers and sellers, thereby reducing market failures caused by adverse selection. As Lin Yifu [4] pointed out: the asymmetry of quality information will not only lead to the shrinking of the final product market, but also reduce the pricing of knowledge products, reduce R&D investment, and thus hinder the growth of knowledge in a country. Since the growth rate of knowledge determines a country's long-term economic growth rate, the asymmetry of quality information hinders knowledge innovation will have a profound negative impact on a country's economy.

Compatibility/interface standards and reduced diversity standards can promote economies of scale, thereby promoting economic growth. Among them, compatibility/interface standards increase the scale of consumers and reduce average transaction costs through network externalities, while reducing diversity standards reduce product types by restricting technological diversity, imposing "order" on the production process, and achieving more efficient Economies of scale.

Compatibility/interface standards and information/measurement standards can effectively promote component labor, increase the variety of intermediate products, and promote economic growth. Standards can define the product structure and the relationship between modules. When module interface standards and standard design rules are determined, each module only needs to pay attention to its own production links. The design boundary is determined by this, and the design and production tasks have module boundaries, which reduce the time and complexity of the overall work, thereby greatly improving the production flexibility and category diversity of products, and can reduce the transaction cost between the division of labor.

As a public product, standards can effectively promote technology transfer and diffusion, thereby promoting economic growth. Compared with a single accumulation of work experience, the standard has more obvious technology spillover effects, which can shorten the time to learn and accept new technologies and promote the efficient development of technological innovation. Moreover, in order to maintain their own competitive advantages, companies that dominate technical standards often incorporate new technical knowledge into the standardization body, constantly re-innovate on the basis of their original technology, and through the wide range of standard use, spread and disseminate this new technical information.

3. Research and Analysis of Standardization on Economic Growth

Since Adam Smith's "The Wealth of Nations", the theory of economic growth has received widespread attention. The Harrod-Domar model, which is the basis of modern economic growth theory, was given by Harrod [5] and Domar [6]. This is the first revolution in economic growth theory, marking the application of mathematical methods in economic growth theory; Solow [7] And Swan [8] modified

the assumption of the fixed-coefficient production function in the Harrod-Domar model and established the Solow-Swan model, which is called the "neo-classical economic growth theory." Solow [9] believed that long-term sustained economic growth could only Rely on exogenous technological progress. Romer [10] and Lucas [11] established the endogenous economic growth theory, which is different from the exogenous technological progress assumed by the Solow-Swan model. The theory believes that technological progress is endogenously generated in a country's economic system and promotes economic growth. The accumulation of knowledge is the driving force for endogenous technological progress. The combination of the neoclassical economic growth theory and the endogenous economic growth theory's research on technological progress and the technical attributes of standards have promoted the research on the role and efficacy of standards in economic development. With the establishment of various databases mentioned by Pan Shiyuan [12], economists began to gradually get rid of the difficulties caused by the lack of data in economic growth research, which greatly promoted the empirical research on economic growth issues. The development of economics and computer technology has also provided a greater boost for empirical research.

3.1. International Studies

The German Association for Standardization (DIN) [13] evaluated the relationship between economic output and five factors (labor, capital, standards, patents, and licenses). Research shows that there is a significant positive correlation between standards and economic output. In addition, this relationship has also changed over time. The results show that after the unification of Germany, the number of standards has changed by 1%, and the economic growth has changed by 0.7% to 0.8%.

The French Association for Standardization (AFNOR) [14] studied the impact of standards on economic growth. Here, Total Factor Productivity (TFP) is used as a measure of economic growth. Research shows that since 1950, the impact of standards on economic growth is usually significant. Positive correlation, a 1% change in the number of standards can bring a 0.12% change in TFP.

The Conference Committee of Canada (CC) [15] studied the impact of standards and capital-labor ratios on labor productivity from 1981 to 2004. The study shows that there is a significant positive correlation between standards and labor productivity, and a 1% change in the number of standards can bring labor The productivity change was 0.356%.

The Australian Centre for International Economics (CIE) [16] studied the research of R&D and standards on total factor productivity (TFP). CIE's research is divided into two parts: The first part is to study the impact of R&D and standards on TFP respectively. The results show that the number of standards has changed. 1% can bring a 0.17% change in TFP; the second part is to create a knowledge stock index based on R&D and standards, and then study the relationship between this knowledge stock index and TPF, a 1% change in knowledge stock index can bring a TFP change 0.12%.

The Department of Trade and Industry (DTI) [17] studied the impact of standards and capital-labor ratios on labor productivity. Research shows that standards and capital-labor ratios are significantly positively correlated with labor productivity. A 1% change in the number of standards can bring about changes in labor productivity. 0.054%.

Blind [18] used panel co-integration technology to study the impact of standards and patents on economic growth in 15 EU countries from 1981 to 2014. Research shows that standards have a significant impact on long-term economic growth. A 1% change in the number of standards can bring about changes in GDP between 0.02% and 0.15%.

The above-mentioned literature on the impact of standards on economic growth (research shows that there is a significant positive correlation between standards and economic growth. Standards are one of the factors that promote economic growth. The economic growth indicators used in the literature include GDP, total factor productivity, and Labor productivity.

3.2. Research in China

A considerable part of Chinese research is based on the Cobb-Douglas production function (Abbreviated as CD function) to establish models and uses a variety of economic standards to study the relationship between economic growth. For standards, the commonly used indicators are national standards stock data, while economic growth mostly uses GDP as the indicator, and a small amount of labor productivity. Xin Chunhua [19] introduced standards into the CD function and established a model of productivity, standards, and capital-labor ratios. Using data from 1978 to 2007, the results showed that a 1% change in the number of standards resulted in a 0.0549% change in labor productivity. Cheng Jianbing [20] introduced standards, patents, foreign technology authorization and patent licensing, volume research and development into the CD function, and studied The relationship between labor production and standards, the results prove that technical standards contribute significantly to production practice, and the impacts of different time periods are different; this article also studies the potential endogeneity of standards and finds that production standards have a significant positive impact. Wei Fulei [21] introduced standards and patents into the CD function and studied the relationship between China's standardization (ISO standards and national standard stocks cited at the end of the year) and economic growth (GDP). The research shows that the elasticity is positive, and the standard stock changes by 1%, GDP Change 0.523%. Zhang Tianyu [22] uses the research method given by Jungmittag [23] to introduce the standard into the CD function, and establishes a model of productivity, standard, and capital-labor ratio. Based on the data from 1978 to 2002, the research results show that the elastic coefficient of the standard to productivity is 0.107; Hou Junjun [24] included standards and patents into the CD

function, where the standards were characterized by the sum of national standards and industry standards, and based on China's inter-provincial data, the panel analysis method was used to study the impact of standards on economic growth (GDP). The results show that a 1% change in the standard will cause a 0.1425% change in economic growth. In addition, this document establishes a scientific and technological innovation capability index, and based on this, China's provinces and cities are divided into three categories according to the level of innovation. The contribution of standards to economic growth shows that the contribution of technical standards to economic growth is quite different at different levels of the market. At the national level, the contribution of technical standardization to economic growth is higher than that of the regional level. The higher the regional technological innovation capability, the more significant the promotion of regional economic growth by standardization. Wang Lijun [25] introduced standards and patents into the CD function, and established a model between economic growth and capital, labor, standards, and patents. Capital, patents, and standards all use the perpetual disk method to measure effective stock. The research results show that standards are in place. Before 1992, economic growth was significantly restricted. After 2000, the impact of standards on economic growth was positive. On the basis of previous research, Wang Lijun [26] used panel analysis to study the relationship between standardization and economic growth in China's central and eastern regions. The standards here are characterized by effective national standards and the stock of industrial standards. The research proves that the elasticity coefficient is positive and the contribution rate of standardization to economic growth shows regional differences. Fan Zhouping [27] introduced patents and standards into the CD function and established two models. In the first model, in addition to capital, labor, standards, and patents, the influencing factors also added time variables, thus introducing the economy of the previous year. The second model takes into account the high collinearity of capital and labor and removes labor from the influencing factors. The research results show that there is a positive correlation between the standard and economic growth, and the elasticity coefficient of the second model higher.

Other Chinese empirical studies are usually based on economic theory and analysis to find out the factors that affect each other, and then use VAR models or linear regression equations to conduct research. Zeng Zheng [28] believes that the market mechanism is an intermediate channel connecting technical standards and the final economic operation results. Standards play a role in the final economic operation results through the market mechanism. The impact of market institutions and rules, and then use VAR and VEC models to study standards (annual national standard stock) and market entities (consumer income, production scale (GDP)), market objects (capital use = capital stock/GDP), market systems Research shows that there is a long-term relationship between China's technical standards and market entities, market objects, and market systems and rules. However, the correlation is relatively low. The impact of standards on market entities and market systems and rules is greater than the impact on market objects. In addition, the correlation between China's technology and the market has a relatively significant one-way nature, that is, technical standards have a certain impact on market elements, while the reverse impact is not significant. Zhao Shukuan [29], based on the VAR model, studied the long-term equilibrium and causality among technical standards, technological innovation and economic growth from an empirical point of view. Every 1% increase in technological innovation and technological standards will cause economic growth of 0.616% and 0.229%, respectively., technological innovation promotes economic growth more significantly than technological standards, and economic growth and technological standards have Granger causality with each other. In the lagging period 1 and 2, economic growth and technological innovation are the causes of technical standards, and the relationship is one-way causality; in the lagging period 3 and 4, economic growth and technical standards are Granger causality with each other, and technological innovation is economic growth The Granger reason for technical standards, technological innovation is the source of economic growth. Lag 4 periods behind, technical standards are the Granger reason for technological innovation, and the impact of technical standards on technological innovation is lagging. Ren Kunxiu [30] first pointed out that standards and quality are both the driving force of economic growth, and the three interact and correlate with each other. Then, using co-integration test and causality test methods, they studied the relationship between fluctuations in standards and product quality levels and national economic growth. Research shows that for every 1% increase in the national standard, my country's GDP will increase by 2.16% to 6%. In addition, every 1% increase in the national standard will increase the product quality level by 0.37%. Gao Xiaobo [31] used measurement methods (cointegration test and Granger causality test) to examine the relationship between economic growth (GDP) and standardization level (national standard stock). Research shows that there is a cointegration relationship between economic growth and standards. In the short term (lagging 1st and 2nd period) economic growth is the Granger reason of the national standard. In the subsequent medium term (lagging 3rd period), the influence and effect of the national standard on economic growth began to appear, and in a longer period of time (Lag 4, 5, 6), the mutual influence between national standards and economic growth gradually disappeared. Wang Lijun [32] used the PVAR model to study the dynamic relationship and the mechanism of action among patents, standards, and the economic growth level (GDP) of each province in my country. The research shows that the interaction between standardization and economic growth is generally positive, but economic growth inhibited standardization in the initial stage.

In addition, Xin Chunhua [33] draws on the ideas of endogenous economic growth theory and uses Romer

research and development model as the framework to give the production function and product production function for research and development. Both production functions are based on the CD function. Research and develop the influence of each parameter in the production function, analyze the mechanism of the standard promoting economic growth, and give the conclusion that the standard promotes economic growth. Feng Xue [34] first pointed out the five decisive factors affecting economic growth: the accumulation of production factors, total factor productivity, international trade, the difference in per capita economic income, institutions and politics, and then analyzed the technical standards and the five decisive factors one by one. There is a positive correlation between the factors, and it is concluded that standardization can promote economic growth.

Although Paarlburg [35] and Shapiro [36] pointed out through theoretical analysis that technical standards may lead to market monopoly and thus damage economic growth, the relevant empirical literature only provided partial support by Wang Lijun [30]. In contrast, most scholars at home and abroad start from different empirical models. Their research results show that standards are the key factor in promoting economic growth. In addition, Granger causality tests between many standards and economic growth point out that economic growth is the standard. The Granger reason for this shows that the standard is not an exogenous variable independent of the economic system. The level of the standard is affected by the economic level of a country and is an endogenous variable determined by the economic system.

4. Conclusions and Research Prospects

Based on the above research and analysis, it can be seen that standards have economic effects such as reducing information asymmetry, promoting economies of scale, expanding division of labor, and accelerating technology transfer and diffusion. They are key factors in promoting economic growth. A large number of empirical analysis also illustrates this point, but current research is limited to the impact of technical standards on economic growth. In addition, economic growth mainly emphasizes quantity, and less consideration is given to high-quality economic development. For follow-up research, there are the following possible directions.

First, as the analysis in the second part, different standards have different economic effects. Today's research generally blurs the distinction between different types of standards. The impact of general research standards on economic growth as a whole can be studied in different categories in the future. Describe the impact of standards on economic growth with a finer granularity, and provide suggestions for the design of subsequent standards systems.

Secondly, although the impact of technical standards on economic growth is obvious, the contribution of management standards to promoting economic growth should also not be underestimated, because management standards involve knowledge of management technology and enterprise organization, and the use of management standards may better reduce labor costs and increase labor productivity, thereby promoting economic growth. Research on the impact of management standards on labor productivity and economic aggregates will also be a possible direction.

Thirdly, high-quality economic development is the main theme today. As a component of the "national quality infrastructure", standards play an important role in improving product quality and promoting the upgrading of industrial structure. Research on standards and the quality of economic growth may bring useful enlightenment for people to better understand long-term economic growth issues.

Finally, although the current research standards have many perspectives on the role of economic growth, they ignore the exploration from the perspective of the system. Therefore, the theory of the endogenous system (such as the patent system, the regulation of special industries, etc.) in the endogenous economic growth model and empirical research is undoubtedly worth trying.

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