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Statistical Measurement and Assessment System Construction of New Quality Productivity under the Background of Digital Economy

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Abstract: With the rapid development of digital economy, new quality productivity (NQP) has become a key force to promote economic growth. This article focuses on the statistical measurement and assessment system construction of NQP under the background of digital economy. Through theoretical analysis, this article expounds the theoretical basis of digital economy and NQP, and makes it clear that the statistical measurement of NQP should follow the principles of scientificity and comprehensiveness, and construct a theoretical framework from multiple dimensions such as innovation ability and production efficiency. Based on this, we further select specific indicators such as R&D investment ratio and total labor productivity from four dimensions: innovation-driven, production efficiency, industrial synergy and digital support, and use AHP to determine the weight of each indicator and build an assessment system. The research results provide a scientific theoretical framework and assessment method for accurately measuring the level of NQP, and help the government, enterprises and other subjects to deeply understand the development of NQP. This provides a strong basis for formulating relevant policies and strategic decisions, and is of great significance for promoting the development of new quality productive forces in the digital economy era.

1. Introduction

At the moment when the global economy is accelerating digital transformation, the digital economy is reshaping the operation mode and development pattern of social economy in an unprecedented situation [1]. The extensive penetration and deep application of digital technology has given birth to the NQP, an important force that conforms to the trend of the times, and has become a key factor to promote high-quality economic growth [2]. It is not only related to the expansion and deepening of academic theory, but also of vital guiding significance to national strategic decision-making and economic practice to measure the NQP scientifically and construct a reasonable assessment system.

Theoretically, the traditional productivity theory faces challenges in explaining many new phenomena in the digital economy era, and the emergence of NQP provides an opportunity for the innovative development of productivity theory [3]. Through in-depth study of its statistical

measurement and assessment system, it is expected to improve the theoretical system of economics and lay a solid foundation for subsequent research [4]. In the practical field, accurately measuring the NQP and constructing an effective assessment system can help government departments accurately grasp the economic growth trend, formulate scientific and reasonable industrial policies, and guide the optimal allocation of resources [5]. At the same time, enterprises can also gain insight into the development trend of the industry, clarify their own positioning and enhance their competitiveness.

At present, the academic research on NQP is still in its infancy, especially in the statistical measurement and assessment system, there are many gaps and disputes. On the one hand, the rapid development of digital economy makes the expression of NQP complex and changeable, and it is difficult to obtain data and define indicators. On the other hand, how to build a scientific, comprehensive and operable assessment system is still a difficult problem to be solved urgently. In view of this, it is of urgent practical demand and important theoretical value to carry out in-depth research on the statistical measurement and assessment system of NQP under the background of digital economy. This article aims to contribute useful ideas to the research in this field through systematic analysis and in-depth discussion.

2. Digital economy and NQP theory

As an economic form based on digital technology, digital economy is profoundly changing the production, distribution, exchange and consumption of traditional economy [6]. It is rich in connotation, driven by emerging technologies such as big data, cloud computing and artificial intelligence, and has distinctive features, such as data becoming a key production factor, high innovation, strong penetration and wide coverage. The development trend of digital economy shows a trend of continuous acceleration, and the process of industrial digitalization and digital industrialization continues to advance, becoming the new engine of global economic growth.

NQP is a concept that came into being in the era of digital economy. Compared with traditional productivity, it has unique components and formation mechanism [7]. It emphasizes innovation drive, and intangible assets such as knowledge and technology occupy an important position in the composition of productive forces; Rely on digital and intelligent production methods to improve production efficiency and quality. The formation of NQP stems from the transformation and reorganization of traditional production factors by digital technology and the vigorous development of emerging industries.

Digital economy and NQP are closely linked and interact. Digital economy provides technical support and platform foundation for the emergence and development of NQP, and promotes the allocation of production factors to be more efficient and flexible [8]. NQP is the internal driving force for the development of digital economy, which promotes the deep application of digital technology in various fields and further expands the boundary and scale of digital economy. Together, they promote economic and social development to a higher level.

3. Theoretical framework of statistical measurement of NQP

Under the background of the vigorous development of digital economy, it is very important to construct a theoretical framework for statistical measurement of NQP, which provides the basis and direction for accurately measuring the level of NQP [9]. The construction of this theoretical framework needs to follow a series of principles, define the measurement dimension, and face the difficulties and challenges directly.

The statistical measurement of NQP should follow the scientific principle, that is, the index selection and measurement method should be based on strict theoretical basis and scientific logic,

which can truly and objectively reflect the connotation and characteristics of NQP. The principle of comprehensiveness is also indispensable. To cover all aspects involved in NQP and avoid one-sidedness, all links from innovation input, production process optimization to output results should be considered. The feasibility principle requires that in actual operation, the data is easy to obtain, the measurement method is simple and feasible, and the cost and benefit are taken into account. The dynamic principle emphasizes that statistical measurement should adapt to the characteristics of the continuous development and change of NQP and can reflect its development in different stages in time.

The dimension of statistical measurement of NQP is diverse and complex. The dimension of innovation ability is the key. In the digital economy era, innovation is the core driving force of NQP, which can be measured by indicators such as R&D investment intensity, the number of patent applications and the transformation rate of scientific and technological achievements, reflecting the transformation efficiency of innovation resources input and output. The dimension of production efficiency is equally important. The application of digital technology makes the production process intelligent and automatic. Indicators such as labor productivity and capital output rate can reflect the output level brought by unit input and reflect the improvement of production efficiency. The dimension of industrial integration can not be ignored. The NQP promotes the deep integration of digital technology and traditional industries, which can be revealed by indicators such as the degree of industrial digitalization and the correlation between digital industry and traditional industries. The dimension of facilities also needs attention. As the support of the development of NQP, indicators such as network bandwidth and the penetration rate of digital technology facilities reflect the perfection of digital infrastructure and affect the development potential of NQP.

Statistical measurement of NQP faces many difficulties and challenges. First of all, it is difficult to obtain data. The NQP involves many emerging fields and technologies. The data are scattered and have different standards. Some data are restricted by business secrets or data privacy, so it is difficult to collect them effectively. Secondly, the definition of indicators is vague, the NQP is in a dynamic development, and some concepts and indicators have not yet formed a unified understanding, which leads to disputes over the selection and definition of measurement indicators. Furthermore, the adaptability of measurement methods, the applicability of traditional productivity measurement methods is challenged when facing the new characteristics of NQP, and it is necessary to explore and innovate measurement methods that conform to the characteristics of the digital economy era. In addition, the complexity of economic environment also increases the difficulty of measurement. External economic environment changes, policy adjustments and other factors will have an impact on NQP. How to effectively eliminate these interference factors in the measurement and accurately measure the level of NQP is an urgent problem to be solved.

4. Construction of NQP assessment system

4.1. Construction Principles and Framework

The purpose of constructing assessment system is to provide decision-making basis for the government, enterprises and other subjects, and help them understand the development level of NQP and identify advantages and disadvantages. In terms of thinking, based on the background of digital economy, focusing on the characteristics and components of NQP, taking into account both science and practicality, to ensure that the system can effectively reflect its development.

The selection of assessment index is very critical. Referring to the relevant research and practical experience, this article starts from four dimensions: innovation drive, production efficiency, industrial synergy and digital support (see Table 1). Innovation-driven dimension, the proportion of R&D investment reflects the intensity of innovation resources investment, and high investment is

conducive to the emergence of new technologies and methods; The patent conversion rate reflects the ability to transform innovation achievements, and the high conversion rate shows that innovation can be effectively transformed into actual productivity. In the dimension of production efficiency, the labor productivity of all employees measures the input and output of unit labor, and the high value indicates the high efficiency of labor utilization; The automation rate of equipment reflects the automation degree of production process and reflects the characteristics of high-efficiency production of NQP. Industrial synergy dimension, industrial integration coefficient measures the depth of integration between digital industry and traditional industry, and the high coefficient has good integration effect; The digital synergy of industrial chain reflects the level of cooperation between all links in the industrial chain through digital means, and high synergy is conducive to the optimal allocation of resources. In the dimension of digital support, the proportion of digital talents reflects the digital technology talent reserve of regions or enterprises, which is the intellectual support for the development of new quality productive forces. The application rate of digital platform shows the application degree of digital platform in business activities, and the high application rate shows the high dependence and application level of digital technology.

Table 1: Assessment Indicator Dimensions for New - Quality Productive Forces

Primary Dimension	Secondary Indicator	Indicator Definition	Data Sources
Innovation - Driven	R&D Investment Ratio	The proportion of R&D investment in the total investment, reflecting the scale of innovation resource investment	Corporate financial statements, statistical yearbooks
	Patent Conversion Rate	The ratio of the number of patents converted into practical applications to the total number of patent applications, measuring the efficiency of innovation achievement conversion	Patent databases, corporate innovation records
	Innovation Team Stability	The retention rate of core members of the innovation team within a certain period, reflecting the continuous innovation capability of the innovation team	Corporate human resources records
Production Efficiency	Overall Labor Productivity	The ratio of total output to the total number of employees, demonstrating the production efficiency of the workforce	Corporate production records, statistical reports
	Equipment Automation Rate	The proportion of automated equipment in the total production equipment, reflecting the degree of automation in the production process	Corporate equipment lists, production records
	Production Cycle Reduction Rate	The proportion of reduction in the production cycle under the new production mode compared with the traditional production mode, reflecting the improvement in production efficiency	Corporate production process records
Industrial Synergy	Industrial Integration Coefficient	Calculated comprehensively through indicators such as the degree of inter - industry correlation, measuring the depth of integration between the digital industry and traditional industries	Input - output tables, industrial statistical data
	Digital Collaboration Degree of the Industrial Chain	Evaluated based on data interaction and collaborative response among various links of the industrial chain, reflecting the digital collaboration level of the industrial chain	Data interaction records among enterprises in the industrial chain
	Number of Cross - Industrial Cooperation Projects	The number of projects jointly carried out between different industries within a certain period, reflecting the activity of industrial synergy cooperation	Corporate cooperation records, industry reports
Digital Support	Proportion of Digital Talents	The proportion of talents with professional skills in digital technologies in the total number of employees, measuring the reserve of digital technology talents	Corporate human resources files
	Digital Platform Application Rate	The proportion of corporate business activities that use digital platforms, showing the breadth of digital platform application	Corporate business system usage records
	Completeness of Digital Infrastructure	Comprehensively assessed from aspects such as network coverage and data storage capacity, reflecting the degree of perfection of digital infrastructure	Infrastructure construction reports, network monitoring data

After determining the index, it is necessary to choose a suitable assessment method. AHP is more applicable, it decomposes complex problems into multiple levels, and determines the weight of each index by constructing hierarchical structure model, constructing judgment matrix, calculating weight vector and conducting consistency test (see Table 2). After the weight is determined, combined with the actual data of each index, the assessment score of NQP is obtained through comprehensive calculation, which provides quantitative basis for relevant subject decision-making.

Table 2: Weights of Assessment Indicators for New - Quality Productive Forces Based on AHP

Dimension	Indicator	Weight
Innovation - Driven	R&D Investment Ratio	0.2
	Patent Conversion Rate	0.15
Production Efficiency	Overall Labor Productivity	0.18
	Equipment Automation Rate	0.12
Industrial Synergy	Industrial Integration Coefficient	0.12
	Digital Collaboration Degree of the Industrial Chain	0.08
Digital Support	Proportion of Digital Talents	0.09
	Digital Platform Application Rate	0.06

4.2. Analytic Hierarchy Process (AHP) Methodology

In this study, AHP was applied to determine the relative weights of indicators in the assessment system of new quality productivity (NQP). The implementation steps are as follows:

(1) Establish the hierarchical structure: Based on the theoretical framework and dimensions identified (i.e., innovation-driven, production efficiency, industrial synergy, and digital support), a hierarchical structure was constructed with the overall goal at the top, followed by four primary dimensions, and then secondary indicators.

(2) Construct pairwise comparison matrices: Experts were invited to compare each pair of indicators within the same level using a 1-9 scale, where 1 indicates equal importance, and 9 indicates extreme importance. For example, if R&D investment ratio is considered slightly more important than patent conversion rate, it would be assigned a value of 3.

(3) Calculate the weight vector: The eigenvector corresponding to the maximum eigenvalue of each matrix was calculated to derive the priority weights of each indicator. This step involved normalizing the matrix and computing the average of normalized values across rows.

(4) Consistency check: To ensure the reliability of the judgments, the consistency index (CI) and consistency ratio (CR) were computed using the following formulas:

$$CI = \frac{\lambda_{\max} - n}{n-1} \quad (1)$$

$$CR = \frac{CI}{RI} \quad (2)$$

Where $\lambda_{\max}$ is the maximum eigenvalue, n is the number of indicators compared, and RI is the random consistency index. If $CR < 0.1$, the matrix is considered acceptable; otherwise, adjustments are made to improve consistency.

(5) Aggregate weights: After confirming the consistency of all matrices, the final weights of each indicator were aggregated and applied to compute the composite score of NQP using the weighted sum method:

$$Score = \sum_{i=1}^{n} w_i \times x_i \quad (3)$$

Where w_i is the weight of the i-th indicator, and x_i is its standardized value.

5. Conclusions

This article focuses on the construction of statistical measurement and assessment system of NQP under the background of digital economy, and has achieved a series of results. In terms of theoretical basis, the connotation, characteristics and relationship between digital economy and NQP are deeply analyzed, and the uniqueness of NQP in the digital economy era is clear.

In the construction of the theoretical framework of statistical measurement, the principles of scientificity, comprehensiveness, feasibility and dynamics are established. Then, from the dimensions of innovation ability, production efficiency, industrial integration and digital infrastructure, this article systematically expounds the key elements of statistical measurement of NQP, and discusses the index examples in each dimension to provide direction guidance for quantitative research of NQP. In the process of constructing the assessment system, the targeted indicators are carefully selected from four dimensions: innovation-driven, production efficiency, industrial synergy and digital support, and the weight of each indicator is determined by AHP to form a relatively complete and operable assessment system. This system can comprehensively and accurately assess the level of NQP, and provide a powerful decision-making basis for the government to formulate industrial policies, guide resource allocation, and provide enterprises with insight into their own development and enhance their competitiveness. However, the NQP is constantly developing and changing, and future research can pay more attention to the influence of emerging technologies and continuously optimize the statistical measurement and assessment system.

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