

# Studies on the Establishment and Evaluation of Quality Development Efficiency Index

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## Abstract

China has made rapid progress in quality development since the implementation of the "Quality Development Outline (2011-2020)". To evaluate the efficiency of quality development, a Quality Development Efficiency Index (QDEI) was constructed based on the data of two international institutions, the World Economic Forum and the International Institute for Management Development. The index includes 4 target indicators, i.e., product quality, service quality, engineering quality, and environmental quality, and 12 process indicators with close relationships with "Quality Development Outline". Some conclusions can be summarized based on the index analysis. Firstly, in the last decade, China's quality development can be summarized within three phases, i.e., a stationary phase, a promotion phase, and an acceleration phase. Secondly, the engineering quality and the product quality have developed and attained a higher level in the world, but the overall development of the four kinds of quality is not balanced and has not achieved simultaneous improvement. Thirdly, there is much difference in the implementation performance of different policies on quality. Especially, it is significant to make effort in technological innovation and the construction of multiple remedies for quality safety. Based on the research results, some suggestions were proposed for future work on quality development in China.

## Keywords

Quality; Development Outline; Implementation Efficiency; Evaluating.

## 1. Introduction

The report of the 18th CPC National Congress proposed that "the foothold of promoting development should be shifted to improving quality and efficiency", and the report of the 19th CPC National Congress proposed that "China's economy has changed from a high-speed growth stage to a high-quality development stage", and the development quality is an important measure to achieve high-quality growth. The Outline of Quality Development (2011-2020) (hereinafter referred to as "Outline of Quality Development") issued by the State Council in 2012 is the second medium-and long-term plan for comprehensively strengthening quality work in China, which clearly puts forward the development strategy of "winning by quality" and puts forward specific requirements and work objectives for building a quality power. With the promulgation and implementation of important documents such as the Outline Action Plan for Quality Development (2012-2016) and the Guiding Opinions on Quality Improvement Action (2017), China's quality development has made significant progress. To meet the next challenge of quality development, it is necessary to summarize the laws and experiences of China's quality development in the last ten years after the implementation of the Outline of Quality Development. Analyze the shortcomings of China's quality development at present. Based on the Outline of Quality Development (2011-2020), this study quantitatively analyzes the implementation effect of the Outline of Quality Development in recent ten years by constructing the Quality Development Efficiency Index (QDEI) and using third-party data, to understand the macro-level of quality development in China at present, analyze the weak links

of quality development, and provide support for promoting the construction of a strong quality country.

## 2. Literature Review

### 2.1. The Concept of Quality

The cognition of quality is closely related to the characteristics of the times and the development of quality management theory. In the process of expanding the connotation of quality from narrow sense quality and broad sense quality to total quality, people's perspective on quality is constantly changing, from the perspective of production standards to the perspective of customer use and comprehensive performance. The definition of quality has also experienced an evolution from conformity quality, applicability quality, and satisfaction quality to excellent quality. Huang et al. (2018) believe that the cognition of the quality concept is closely related to the national economic development, and the core of the quality concept in today's era is a more social value judgment [1]. In the Outline of Quality Development, the object of quality development includes product quality, service quality, and engineering quality. Since the 19th National Congress, high-quality development has become the guiding ideology of China's economic development, and the concept of quality is closely related to national competitiveness on the macro level.

High-quality development expands the boundary of quality, the research object expands from the original product quality to the development quality [2]. From the economic point of view, the research group of the Economic Research Institute of the National Development and Reform Commission (2019) defines high-quality economic development as the economic development that provides high-quality output for the whole society sustainably and fairly with high efficiency and benefit. Its core performance is high quality, high efficiency, and high stability of the supply system [3]. Regarding the value cognition of high-quality development, Tian (2018) believes that the value orientation of high-quality development is quality and efficiency [4]. Zhao et al. (2019) believe that the value orientation of high-quality development should be people's livelihood and people's enjoyment, fairness, and justice [2]. From the connotation point of view, Zhang et al. (2019) believe that High-quality development aims at meeting the people's growing needs for a better life, and has three specific characteristics of high efficiency, fairness, and green [5]. Ren and Li (2018) pointed out that high-quality development pays attention to the coordination of economic "quantity" and "quality" by making a special contrast and distinction between high-quality development and high-speed development. It shows the harmonious symbiosis of economic benefits, social benefits, and ecological benefits [6]. Zhao et al. (2019) also pointed out that high-quality development abandons the economic development thinking characterized by rational "economic man" and advocates scientific rationality, high-quality safety, energy conservation, and environmental protection [2].

### 2.2. Quality Evaluation

In the Outline of Quality Development, product quality, service quality, and engineering quality are evaluated from product qualification rate, engineering acceptance qualification rate, customer satisfaction of service, and other indicators. These indicators are the result of quality. To achieve these goals, the Outline of Quality Development points out that efforts should be made in many processes, including strengthening the main role of enterprise quality. Strengthen quality supervision and management, innovate quality development mechanism, optimize quality development environment, lay a solid foundation for quality development, and implement quality improvement projects. Since 2005, the former General Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ) has continuously released the national manufacturing quality competitiveness index, based on the manufacturing industry, to

carry out an annual evaluation of China's manufacturing quality from two aspects of quality level and quality development. The quality competitiveness index includes two secondary indicators (quality level and development capability), six tertiary indicators (standard and technical level, quality management level, quality supervision and inspection level, R&D and technological transformation capability, core technical capability, and market adaptability), and 12 statistical indicators (product quality rate, proportion of engineers and technicians, and quality management system certification rate), industrial cost-profit rate, the qualified rate of product supervision and spot check, the qualified rate of export commodity inspection, the proportion of research and experimental development funds, the proportion of technical transformation funds, number of patents per 100 million yuan of output value, the proportion of new product sales, per capita product sales revenue and international market sales rate). The evaluation index of quality and its development involves not only the field of enterprise quality management but also the National Quality Infrastructure (NQI), which is closely related to the evaluation of concepts such as high-quality development and national competitiveness. Among them, in the evaluation system of national competitiveness. The influential evaluation systems are the World Economic Forum and International Institute for Management Development.

#### (1) Evaluation of high-quality development

As for the evaluation of high-quality development, there is no unified evaluation index system at home and abroad at present. The mainstream view in domestic academic circles points out that the content of development quality is rich and multidimensional [7]. Compared with high-speed development, the evaluation of high-quality development shows complexity, and it is difficult for a single factor such as total factor productivity to achieve comprehensive and effective evaluation. It needs to be judged through the construction of a multi-dimensional index system [8]. Early scholars focused on the consideration of the rationality of economic structure, such as the economic growth quality index system [9], which was evaluated by revising the current statistical indicators of economic growth. Zhao et al. (2006), from the perspective of economic efficiency, the index system is constructed from five aspects: output efficiency, output consumption, product quality, economic operation quality, and living environment quality [10]. Nie and Jian (2020) built the index system according to the measurement standard of "four highs and one good"[11], and some scholars built the index system with five development concepts as the starting point [12-13]. In addition, there are related institutions such as the International Monetary Fund (IMF), which evaluate high-quality development based on the two dimensions of economic fundamentals and social development by constructing the Quality of Growth Index (QGI) [14]. In recent related studies, scholars have shown great importance to the ecological environment under high-quality development [15-17]. Some scholars have conducted specific research on the impact of environmental pollution and economic development quality and its transmission mechanism [18]. There are also great differences among different scholars in the measurement methods. The commonly used methods include subjective weighting method, entropy weighting TOPSIS method, equal weighting method, entropy method, etc [11, 15, 19-23]. There are also relative differences in the levels of related research. For example, Ma et al. (2019) are based on the research of high-quality development of regional economy [22], and Xu et al. (2019) are all provincial cities in China [23].

#### (2) Evaluation of the World Economic Forum's Global Competitiveness Index

The World Economic Forum (WEF) has established the theoretical principles, research methods, evaluation systems, and data indicators of national and regional economic growth and international competitiveness. Based on the economic growth theory, by building a Global Competitiveness Index (GCI) WEF began to evaluate and rank the economies and international competitiveness of major countries and regions around the world in 1980. Its annual Global Competitiveness Report is one of the most influential international competitiveness research

reports in the world, which is widely favored by political leaders and business leaders from all over the world. The GCI consists of three major parts and 12 sub-items (known as the competitiveness pillar). It has a fairly mature global competitiveness index framework (as shown in Table 1), comprehensively integrates national data, and presents a comprehensive picture of the competitiveness of a country or economy. It has become a measure of the comprehensive development strength and potential of a country or economy with important global influence and recognition.

**Table 1.** Global Competitiveness Index (GCI) Framework

Basic requirements subindex	Efficiency enhancers subindex	Innovation and sophistication factors subindex
Pillar 1. Institutions Pillar 2. Infrastructure Pillar 3. Macroeconomic environment Pillar 4. Health and primary education	Pillar 5. Higher education and training Pillar 6. Goods market efficiency Pillar 7. Labor market efficiency Pillar 8. Financial market development Pillar 9. Technological readiness Pillar 10. Market size	Pillar 11. Business sophistication Pillar 12. Innovation

### (3) International competitiveness evaluation of International Institute for Management Development

The International Institute for Management Development has been publishing international competitiveness reports since 1996. The evaluation index system adopted by the World Competitiveness Yearbook (WCY) published by IMD includes four areas, 20 secondary indicators, and a total of 333 detailed indicators, which objectively and comprehensively analyze and forecast the competitiveness of core countries or regions in the world (as shown in Table 2). By contrast, IMD pays more attention to the statistical data of economic operation and conducts comprehensive analysis by combining the "soft data" obtained from the annual questionnaire survey. WEF mainly uses the results of a questionnaire survey and uses some macroeconomic data.

**Table 2.** IMD evaluation index system framework

Economic performance	Government efficiency	Business efficiency	Infrastructure
Domestic Economy International Trade International Investment Employment Prices	Public Finance Tax Policy Institutional Framework Business Legislation Societal Framework	Productivity & Efficiency Labor Market Finance Management Practices Attitudes and Values	Basic Infrastructure Technological Infrastructure Scientific Infrastructure Health and Environment Education

## 2.3. Review of Research

The concept of quality has developed from micro-level products, services, and engineering to macro-level high-quality development, and is closely related to concepts such as national competitiveness. The manufacturing quality competitiveness index released by the former General Administration of Quality Supervision, Inspection, and Quarantine is based on the concept of quality, including result index and process index, and it is the most widely used quality evaluation system in China at present. But it lies in the lack of comparability with other countries. Although the GCI and IMD have been widely concerned in many countries and have good international comparability, their purpose is national competitiveness, not quality competitiveness. In addition, the evaluation system of high-quality development proposed and

established by many scholars also failed to carry out relevant research from the quality itself. And the deficiency of the existing economic research framework on high-quality development is manifested by the general lack of quality elements [7].

To solve the above problems, based on the quality development outline, the programmatic document of China's quality development, this study constructs the quality development efficiency index (QDEI) system and evaluates China's quality development in recent ten years by using the World Economic Forum (WEF), the International Institute for Management Development and other international general database resources.

### 3. The Construction and Calculation of QDEI

#### 3.1. Data Source and Composition

To ensure the validity of the construction and measurement of the quality development efficiency index, this study screened the data sources from two aspects: open source and international recognition. The data used in this study consists of four parts, which are from the World Economic Forum, Lausanne International School of Management, the World Bank, and the State Administration of Market Supervision. Considering the comprehensiveness of the index system and its consistency with China's basic national conditions, aiming at the measurement of domestic product supply quality and the effectiveness of promoting the improvement of certification and accreditation system in China, this study selects the pass rate index of product quality spot check published by the State Administration of Market Supervision every year and the Global Innovation Index (GII) published by the World Bank. Under the ISO9001 certification pass rate index to carry out evaluation research.

#### 3.2. The Selection of Quality Indicators and the Construction of QDEI

**Table 3.** Index data source of development efficiency index

NO.	Indicator name	NO.	Indicator name
W1	Intellectual property protection	I1*	Export concentration by partner
W2	Quality of overall infrastructure	I2	Legal and regulatory framework
W3	Quality of the education system	I3	Competition legislation
W4	Quality of management schools	I4	Apprenticeships
W5	The intensity of local competition	I5	Employee training
W6	The extent of market dominance	I6	Skilled labor
W7	Effectiveness of anti-monopoly policy	I7	Competent senior management
W8	Degree of customer orientation	I8	Credibility of managers
W9	Buyer sophistication	I9	Customer satisfaction
W10	Local supplier quality	I10	Social responsibility
W11	Nature of competitive advantage	I11	Image abroad or branding
W12	Value chain breadth	I12	Distribution infrastructure
W13	Production process sophistication	I13	Qualified engineers
W14	Capacity for innovation	I14	High-tech exports (%)
W15	Quality of scientific research institutions	I15	Total expenditure on R&D (%)
W16	Company spending on R&D	I16	Total expenditure on R&D (%)
I21	Sustainable development	I17	Number of patents in force
I22	Pollution problems	I18	Intellectual property rights
I23	Environmental laws	I19*	Energy intensity
I24	Quality of life	I20*	CO2 emissions intensity
O1	Rate of Product Qualified	O2	ISO 9001 quality certificates

Indicators marked with \* are cost indicators, and other unmarked indicators are benefit indicators, the same below.

As for the indexes of WEF and IMD, this study takes Quality Development Outline as the key link and finally determines 16 quality-related indexes from the 114 indexes of WEF and 24 quality-related indexes from the 333 indexes of IMD by investigating the coincidence degree between the indexes and Quality Development Outline. The sources of the 42 selected indicators are shown in Table 3. In which *w* represents the index from WEF data, *I* represents indicators from IMD data, and *O* represents other third-party databases. Based on the selection of the above indicators, this study classifies the indicators with overlapping or similar meanings among the 42 indicators that have been determined, corresponding to the entry outline of the Outline of Quality Development, thus forming the evaluation index system of quality development efficiency index, specifically including achievement rate index and measure index.

#### (1) Achievement rate index.

From the development goal point of view, Quality Development Outline covers three kinds of quality, namely product quality, service quality, and engineering quality. Because the qualified rate index of product quality spot check selected in this study focuses on the evaluation of product quality in China, trade quality is selected to measure international product quality. In addition, considering the increasingly prominent contradiction between environment and development and the need for sustainable development, this study listed the evaluation of environmental quality. Therefore, this study has identified four kinds of quality, covering all the quality development goals of the Quality Development Outline, and together formed a major category of achievement rate indicators, and measured and evaluated the quality development in China in the past decade (as shown in Table 4).

**Table 4.** Corresponding relation of achievement rate index

NO.	Index category	Index data source	Corresponding to the content of Quality Development Outline
N1	quality of product	Domestic trade: O1	II. (III) Development Goals
		Foreign trade: I1, I14	
N2	quality of service	W3, W4, W10, W15, I24	II. (III) Development Goals
N3	quality of construction	W2, I12	II. (III) Development Goals
N4	quality of environment	I19, I20	II. (III) Development Goals

#### (2) Measures and indicators.

In terms of concrete measures, the Outline of Quality Development covers six areas: strengthening the main role of enterprise quality, strengthening quality supervision and management, innovating quality development mechanism, optimizing quality development environment, laying a solid foundation for quality development, and implementing quality improvement projects. Considering the integrity and accuracy of data, this study comprehensively selected different indicators to measure specific measures in various fields, effectively covering 12 measures elements in the Outline of Quality Development (covering all first-class categories, as shown in Table 5). According to categories, measure indicators can be classified into three categories: market environment, quality and culture, and R&D and innovation.



**Table 5.** Corresponding relation of measures

NO.	Index category	Indicator name	Index data source	Corresponding to the content of Quality Development Outline
N5	market environment	Create a good market environment	W5, W6, W7, I2, I3	(B) Optimize the quality development environment-create a good market environment.
N6		Create brand cultivation incentive mechanism	I11	(E) Innovative quality development mechanism-creating an incentive mechanism for brand cultivation
N7		Promote the improvement of certification and accreditation system	O2	(IV) Consolidate the foundation of quality development-promote the improvement of certification and accreditation system.
N8		Establish a multi-relief mechanism for quality and safety	W1, I17, I18	(VI) Innovate the quality development mechanism-establish a multi-relief mechanism for quality and safety.
N9	Quality and culture	Strengthen the construction of quality culture	W9, W11	(1) Optimize the quality development environment-strengthen the quality culture construction.
N10		Quality improvement project	I4, I5, I6, I7, I13	Eight (a) the implementation of quality improvement project-quality improvement project.
N11		Service quality satisfaction improvement project	W8, I9	(III) Implementing quality improvement project-service quality satisfaction improvement project
N12		Promote enterprises to fulfill their social responsibilities	I10	(E) Strengthening the main role of enterprise quality-promoting enterprises to fulfill their social responsibilities
N13		Promote the construction of a quality credit system	I8	(V) Strengthening quality supervision and management-promoting the construction of a quality credit system
N14	R&D and innovation	Accelerate enterprise quality and technological innovation	W16, I15, I16	(C) Strengthening the main role of enterprise quality-accelerating enterprise quality and technological innovation
N15		Promote the construction of quality innovation ability	W12, W13, W14	(I) Consolidate the foundation of quality development and the construction of quality innovation ability.
N16		Cleaner production promotion project	I21, I22, I23	(V) Implementing the Quality Improvement Project-Cleaner Production Promotion Project

### 3.3. Calculation Method

Because the index system and evaluation method of the GCI index changed fundamentally before 2006 and after 2017, this study selected the data of the World Economic Forum from 2006 to 2017. For the data from 2017 to 2019, the moving average method is used to simulate and forecast the weights of the adjacent years from far to near 50%, 30%, and 20% respectively. With IMD data and other data, then the data from 2011 to 2019 will be used directly. The missing data in the database are supplemented by the mean interpolation method and moving average method.

Because there is no clear definition of the importance of all kinds of quality and measures in the Outline of Quality Development, equal weighting is carried out in the weight design. For the achievement rate index, the weight of the four qualities is the same, each accounting for 25%. For measure indicators, the calculation of 12 measure elements and their three categories of indicators also adopts the average weight. In the case that some single elements in the index system are measured by multiple indexes, the average value of each index is taken for the calcToureToer to ensure the unity of measurement, this study takes the data from all over the

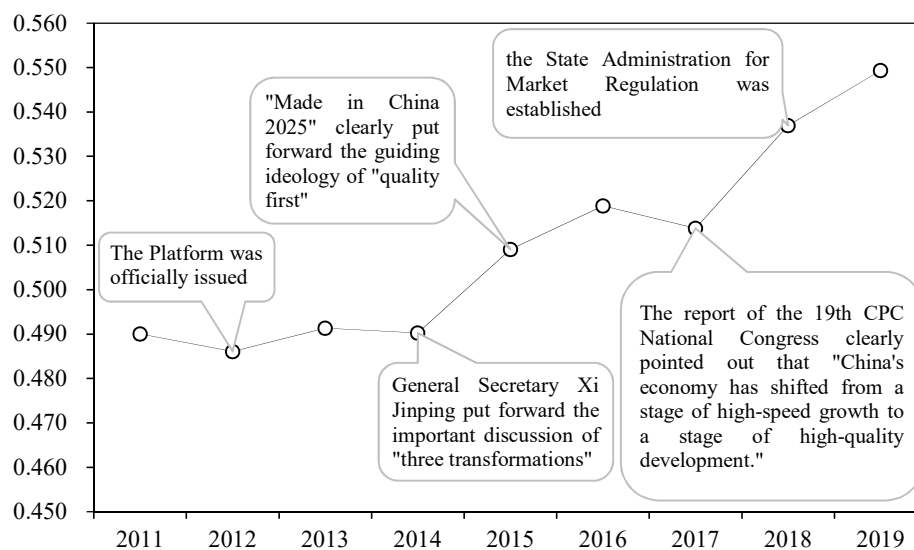
world as the sampling rate. For benefit index, formula (1) is directly used for processing, while for cost index, the original value is converted backwards first, then processed according to formula (1), and all data are standardized to a measurement scale of 0.01-1 for calculation. Where  $y$  is the original value before standardization,  $norY$  is the normalized dimensionless value,  $a=0.01$ ,  $b=1$ . Because the value range of WEF data is 1-7, the max and min values are 1 and 7, respectively. IMD's index types are divided into the hard index and soft index. The value of the hard index is the original data of related indexes (such as CO2 emissions). Therefore, in standardization, the max and min values are the maximum and minimum values of all countries or economies and all years in the database; The value range of the soft index is 0-10, so the max and min values are 0 and 10 respectively in standardization.

$$norY = a + \frac{(b-a) \times (Y - \min)}{\max - \min} \quad (1)$$

## 4. Result in the Analysis of QDEI

### 4.1. The Overall Change Trend of China's QDEI in Recent Ten Years

Through the weighted calculation of standardized data, the trend chart of QDEI score in China in the recent ten years is obtained. As can be seen from Figure 1, in the past ten years, China's QDEI score has shown a stepwise rising feature, namely, three stages of 2011-2013, 2014-2016, and 2017-2019.



**Figure 1.** Trend chart of China's quality development efficiency index in recent ten years

The first stage, that is, the initial stage of the promulgation and implementation of the Outline of Quality Development is a stable period of China's quality development. At this time, China's GDP has just surpassed Japan and become the second-largest economy in the world. The promotion of quality and efficiency to the economy is gradually becoming prominent, and the focus of economic development is beginning to shift. The guiding ideology of "shifting the foothold of promoting development to improving quality and efficiency" was put forward, which accelerated the process of this shift. At this stage, due to being in the early stage of the transition period, China's QDEI score did not show an obvious growth trend. However, from the perspective of historical development, the positive effects of this stage on China's economic development, First, the transformation of medium-and long-term planning and national strategy enlarges the weight proportion of quality factors in economic growth; second, specific



policies and measures such as the selection and promulgation of China Quality Awards further enlarge the radiation effect of quality factors in the whole society ideologically. Both of them have laid the fundamental tone with quality elements as the core in the new model of China's economic development.

In the second stage, we can see from the trend chart that the growth characteristics of QDEI scores in China are remarkable, and the efficiency of quality improvement has been significantly improved compared with the first stage. This is due to the urgency of improving China's quality level at this stage. Due to the structural slowdown, China's economic growth rate continued to drop below 7% at this stage. The economic fundamentals have undergone historic and substantial changes [24]. Specifically, first of all, at this stage, the proportion of China's tertiary industry in GDP has increased from 44.2% in 2010 to 51.8% in 2016, and service quality has become an important part of the overall quality level. Second, by the end of 2014, China's aging rate had reached about 15%. About 5 percentage points higher than the average level of developing countries. The rise of the aging rate leads to the increase of labor cost and other collateral effects, which further force the labor productivity [25] and the growth of enterprise innovation ability [26]. Third, at this stage, China's industrialization began to enter a deepening period, the value orientation factors of post-materialism, For example, the sustainability of environmental quality and development is emerging [24]. These factors have changed the whole society's cognition of the concept of quality, and the introduction of relevant reform measures represented by supply-side structural reform has contributed to the increase of quality improvement efficiency.

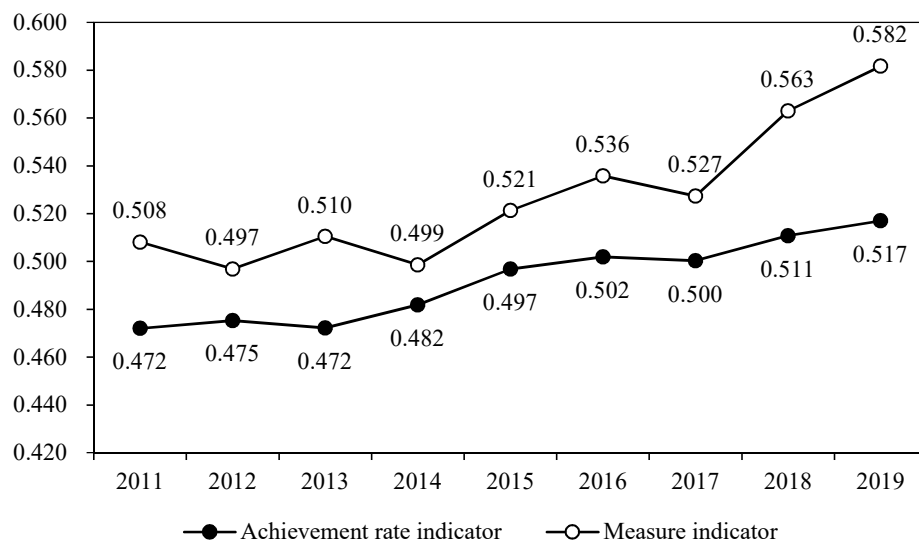
In the third stage, the growth rate of QDEI score in China has further increased, and the quality development has entered an accelerated period. At the same time, however, we can see that the efficiency of quality improvement is constrained to some extent, and many factors lead to the instability of growth. First of all, with the wave of "de-globalization", the "re-industrialization" strategy of developed countries such as the United States has further formed growth barriers for China's quality development. Compared with Obama, the "re-industrialization" strategy of the Trump era version 2.0 emphasizes protectionism, which increases the strategic blow to the transformation and upgrading of "Made in China 2025" to high-end manufacturing. Not only that, the quantity inhibition effect and price inhibition effect of technical barriers to trade in friction have dynamic time extension, which will limit the development of international trade of commodities [27]. Second, China's factor cost comparative advantage in labor cost and environmental cost is gradually losing and turning into a market advantage [28]. The substitutability of markets in Southeast Asia and other countries has increased the uncertainty of foreign direct investment (FDI), which further hurts the domestic supply chain and technology introduction. Third, with the per capita GDP exceeding the \$10,000 mark, China has entered the deepwater area of the "middle-income trap". However, at present, the lack of quality soft power such as intellectual property protection and technological innovation magnifies the uncertainty of the risk of falling into the "middle-income trap" during the transition from "high speed" to "high quality".

#### 4.2. Index Analysis of China's QDEI

From the above overall trend analysis, China's quality improvement efficiency has achieved a step-by-step growth in the past decade, but the uncertain factors at this stage have formed the threshold of quality improvement efficiency. It can be seen that the overall score of QDEI in China is still in the range of 0.486-0.549. Theoretically, the full score is 1, but no country can get full scores on all indicators at the same time. There is still a big gap between China and a strong country in quality. Further analysis of QDEI's sub-index can help us understand the advantages and disadvantages of China's quality development at this stage.

(1) Policy investment is gradually increasing, and the conversion rate has room for improvement.

From the first-level indicators, China's scores on achievement rate indicators and measures indicators keep the same frequency-changing (as shown in Figure 2). It is worth noting that China's achievement rate index score has just exceeded 0.5, and there is still much room for development. At the same time, in the third stage, China's measure index score has achieved rapid growth, and China's investment in quality is rapidly increasing. By 2019, the score has reached 0.582, which is close to the average passing score of countries around the world in the same period. How to further increase short-term investment and improve the efficiency of policy measures transformation in the future will have a positive impact on the improvement of China's achievement rate index, that is, the quality level.

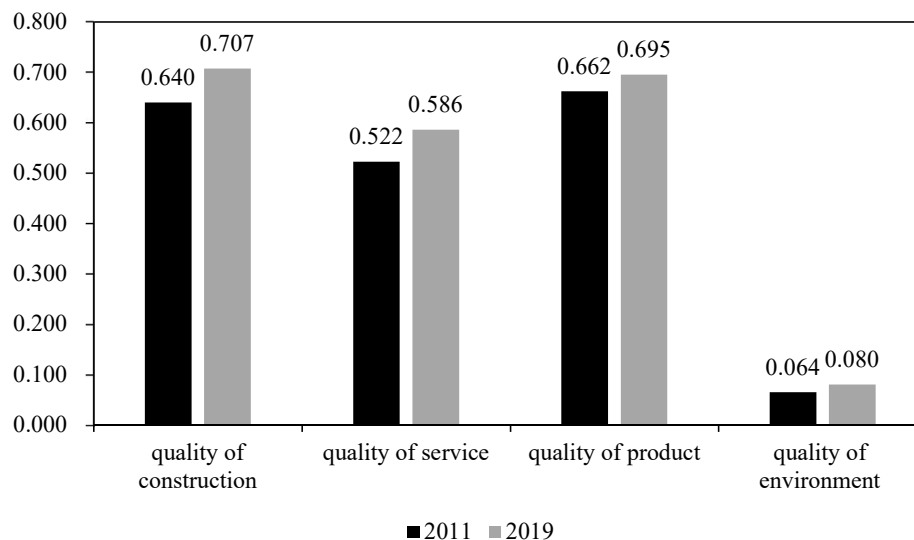


**Figure 2.** The change trend chart of achievement rate index and measure index score in China in recent ten years

(2) The development of four kinds of quality is not balanced, and the promotion is not synchronized.

Comparing the four qualities of product quality, service quality, engineering quality, and environmental quality, China's quality development shows unbalanced characteristics, that is, the engineering quality level is the best, and the environmental quality obviously lags behind the development of the other three qualities (as shown in Figure 3). According to the score data of QDEI in 2019, China's engineering quality score has exceeded 0.7, and the product quality has reached the upper-middle level. The service quality is close to the medium level, with a score of 0.586. However, the score of environmental quality is less than 0.1. Comparing the scores of QDEI in 2011 and 2019, the improvement of four kinds of quality is not synchronous. The engineering quality (0.067 points) and service quality (0.063 points) improved the most, product quality is second (0.033 points), and the improvement of environmental quality is the smallest, with an increase of only 0.016 points. High-quality economic development is accompanied by the improvement of the environment and the improvement of the government's governance capacity [18]. Environmental quality has become the key index that restricts the improvement of China's overall quality score. Therefore, China's score on environmental quality is low. From the single index data, in 2016 alone, China's total energy consumption per 1,000 US dollars of GDP reached 175.98 MTOE (million tons of oil equivalent), while Japan's energy utilization efficiency was only 59.68 MTOE, which was 2.9 times that of

China. At the same time, in 2016, China's carbon dioxide emissions per million dollars of gross domestic product (GDP) consumed by fuel combustion reached 809.29 metric tons, while Germany's was 209.32 metric tons in the same period, only a quarter of China's. Accelerating the transformation of development mode from high consumption, high emission, and high pollution development to high-quality development, improving the environmental friendliness and sustainability of the development model is another key point for China to build a quality power in the next stage.

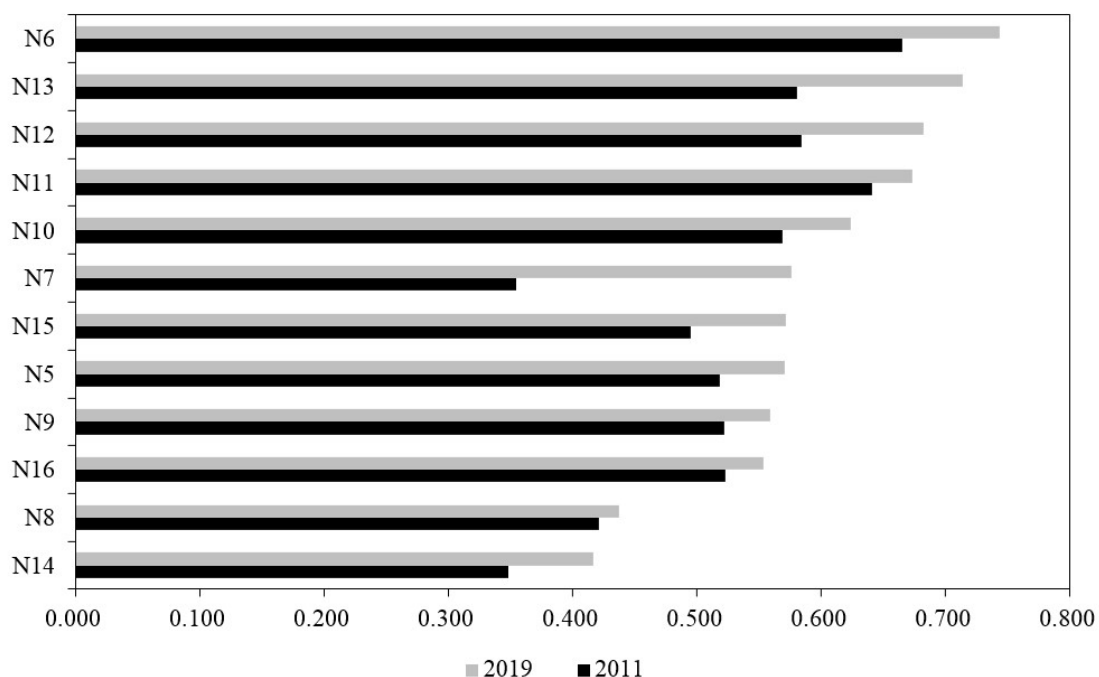


**Figure 3.** Comparison of QDEI's four quality scores in 2011 and 2019

(3) The quality of soft power has been effectively improved, but the technological innovation and multi-relief ability are insufficient.

The measurement results of 12 measures indicators of QDEI show that, on the overall trend, the efficiency of China's measures indicators is gradually increasing with the evolution of three stages, which has increased from 0.508 in 2011 to 0.582 in 2019, especially during the acceleration period. Specifically, the quality soft power represented by brand cultivation incentive mechanism and quality credit system construction has been significantly improved, and the score has exceeded 0.7; The project of promoting enterprises to fulfill their social responsibilities, improving service quality satisfaction, and improving quality also achieved initial results, with the score rising to 0.6-0.7; The scores of promoting the improvement of certification and accreditation system, promoting the quality innovation capacity building, creating a good market environment, strengthening the quality culture building and cleaner production promotion project ranged from 0.5 to 0.6, while the scores of establishing the multi-relief mechanism of quality and safety and accelerating the quality and technological innovation of enterprises just exceeded 0.4, which did not reach the average level of all countries in the world in the same period. Comparing the scores of 2011 and 2019, from the perspective of the improvement range, the measures of promoting the improvement of certification and accreditation system (0.221 points), promoting the construction of quality credit system (0.133 points), and promoting enterprises to fulfill their social responsibilities (0.098 points) have the best transformation effect. Create incentive mechanism for brand cultivation (0.078 points), promote quality innovation capacity building (0.076 points), speed up enterprise quality and technology innovation (0.068 points), and quality improvement project (0.05 points), creating a good market environment (0.052 points); The measures of strengthening quality culture construction (0.037 points), improving service quality satisfaction (0.033 points), promoting

cleaner production (0.030 points) and establishing multiple relief mechanisms for quality and safety (0.016 points) have lower conversion rates. From two angles, China has achieved the best results in terms of quality soft power training, such as creating brand cultivation incentive mechanisms, promoting the construction of quality credit systems, and promoting enterprises to fulfill their social responsibilities. There are still some shortcomings in establishing the multi-relief mechanism of quality and safety and accelerating technological innovation of enterprises. From the data point of view, the R&D expenditure of Chinese enterprises as a percentage of GDP was 1.65% in 2017, while Israel had reached 3.91% in the same period, which was 2.4 times China's expenditure. In 2017, the average number of R&D personnel in each enterprise in China was 2.24, less than half of that in Germany and Japan in the same period and less than one-third of that in South Korea. The number of valid patents per 100,000 residents in China increased rapidly from 27 in 2011 to 109 in 2017, however, there is still an order of magnitude gap between China and the United States, Germany, South Korea, and Japan, with 726, 806, 1,921 and 2,224 valid patents per 100,000 residents in 2017. At the same time, China's intellectual property protection is only equal to India's. The investment in these elements determines the height that China's quality development can achieve in the future, and new incentives are urgently needed.



**Figure 4.** Comparison of the scores of 12 measures in QDEI between 2011 and 2019

## 5. Conclusion

The year 2020 will be the final year of the Outline of Quality Development (2011-2020). Summarizing the laws and experiences of China's quality development in the past decade and analyzing the shortcomings of China's quality development at the present stage is of great significance to the strategic planning and formulation of quality power in the next stage. Based on the literature research and the "Outline of Quality Development", this study constructs the quality development efficiency index (QDEI). The quantitative analysis of China's quality development in the past ten years after the implementation of the Quality Development Outline from the perspective of a third party effectively fills the shortcomings of the existing research and provides strong support for understanding the macro level of China's current quality

development, analyzing the weak links of quality development and promoting the construction of quality power.

The construction of QDEI is carried out from two perspectives: objective and process. The achievement rate index of objective construction includes the main objectives of the Quality Development Outline, namely product quality, service quality, and engineering quality. In addition, considering the importance of environmental factors to high-quality development and sustainable development, environmental quality should be taken into account. The measured index of process layer construction is closely related to 12 specific measures in the Outline of Quality Development. In the measurement and calculation of QDEI, the data used in the research are mainly public databases, including WEF and IMD databases. Considering the coincidence of the index system with China's national conditions and the accurate measurement of specific indicators, the research also cited the data of the State Administration of Market Supervision and the World Bank. Through the equal weighting calculation of the standardized indicators, the QDEI score of China in the recent ten years is finally obtained. The results show that:

(1) China's quality level has achieved step-by-step growth, but there is still much room for development. On the whole, China's quality improvement process experienced three stages: steady period (2011-2013), advancing period (2014-2016), and accelerating period (2017-2019). On the stage, the stationary period is characterized by a fixed tone, it has laid the fundamental tone with quality elements as the core in the new model of China's economic development. The acceleration period is characterized by raising awareness, which accelerates the transformation of the quality perception of the whole society. The acceleration period is characterized by promoting efficiency, which greatly promotes the efficiency of quality improvement. In the three stages, the QDEI score increased from 0.490 to 0.549, exceeding the average level of all countries in the world in the same period. But there is still much room for development.

(2) High-level leaders' attention and supporting formulation of strategic policies are of great significance to achieving the objectives of the Quality Development Outline. From the historical transformation of the three stages of China's quality development, we can see that the guiding ideology of the 18th National Congress of the Communist Party of China "shifting the foothold of promoting development to improving quality and efficiency" and the specific policies and measures such as the selection and promulgation of China Quality Awards. By amplifying the weight proportion of quality factors in national economic growth and the radiation effect of quality factors in the whole society ideologically, it has promoted the transition of China's quality development from the advancing period to the accelerating period. Subsequently, the important thought of "Three Changes" and the guiding ideology of "Quality First" in Made in China 2025 was put forward. Actively respond to the collateral effects such as the increase of the proportion of the tertiary industry in GDP, the increase of labor costs caused by the aging of the population and the emergence of value-oriented factors represented by the environmental quality and sustainable development, and improve the overall social cognition of "high quality". And forced the growth of labor productivity and enterprise innovation ability, leading China's quality development into an accelerated period. After entering the accelerated period, China is faced with the transformation of a new stage of quality development, the guiding ideology of the 19th National Congress of the Communist Party of China that "China's economy has changed from a high-speed growth stage to a high-quality development stage", and major measures such as institutional reform of the State Council, from the ideological and institutional aspects, it promoted the quality improvement and the efficiency growth, and grasped the general direction of the times for China to build a quality power. The above historical experience shows that the attention of senior leaders and the formulation and implementation of quality strategies and policies play a decisive role in achieving the objectives

of the Quality Development Outline, and it is necessary to continue the plan of strengthening the country by quality.

(3) The development of the four kinds of quality is not balanced and the promotion is not synchronized. The measurement results of the QDEI achievement rate index show that the achievement rate index score in China has been increasing, from 0.472 in 2011 to 0.517 in 2019, which exceeds the average level of all countries in the world in the same period. Among the four kinds of quality, the engineering quality level is the best, from 0.640 in 2011 to 0.707 in 2019. Has reached the middle and upper level of all countries in the world in the same period. Although the improvement range of product quality (0.033 points) is not big, it also reaches 0.695 points. Although the service quality has just reached 0.586 points, the improvement rate is second only to the engineering quality, and it is approaching the medium level. The environmental quality is seriously not up to standard, not only has the smallest increase in scores (0.016 points) in the past decade but also the score is only 0.08 points by 2019. It has become the key to restricting the improvement of QDEI scores in China. Based on the above results, it is suggested that among the development goals of quality power, first, we should increase the environmental quality goals. The second is to set export product quality and overseas project quality targets. In addition, for environmental quality, it is necessary to form an environmental co-governance system with enterprises as the main body.

(4) The transformation effect of measures input is quite different, and the shortcomings of multiple relief of quality and safety and promotion of technological innovation of enterprises are prominent. The measurement results of 12 measures indicators of QDEI show that, on the overall trend, the efficiency of China's measures indicators is gradually increasing with the evolution of three stages, which has increased from 0.508 in 2011 to 0.582 in 2019, especially during the acceleration period. According to the scores of various measures and indicators in 2019 and their growth rate, China has made a big increase in creating the incentive mechanism of brand cultivation, promoting the construction of quality and credit system and promoting enterprises to fulfill their social responsibilities, and the scores have approached or exceeded 0.7 points. Specific measures such as setting up and awarding China Quality Award and holding China Quality Conference for the stable period and promotion period have effectively stimulated society and enterprises. The national image has effectively promoted the overseas influence of corporate brands and the global development of business, and the main role of enterprises in quality is becoming prominent. There are still some shortcomings in the establishment of a multi-relief mechanism for quality and safety, accelerating technological innovation of enterprises, etc., which shows that the scores are not only low (less than 0.45), but also the growth efficiency in the past decade is not high, and new incentives are urgently needed. First, we should pay attention to the improvement of R&D and innovation ability in the development mode; Second, in the way of developing a quality power, it is necessary to fill up the shortcomings of the construction of a multi-relief mechanism for quality and safety.

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