Evaluation on Quality of China's Economic Growth: A New and Comprehensive Evaluation System and Application

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Abstract: The priority of China's economic growth has shifted from scale expansion to quality improvement, in which case scientific measurement of the growth quality is particularly important. However, existing research lacks due attention to quality assessment, still focusing on the scale and speed. The paper has built up a new and comprehensive evaluation system in 4 aspects of input factors quality, process control quality, products and services quality and environment quality. In order to realize the objective empowerment and timing, the efficacy coefficient of entropy method is used to determine weight. The findings indicated that China's economic growth quality kept going upward in a phase of 2000-2014. However, environment quality degradation, grim emission reduction, stern soil contamination, comparatively undeveloped Hicks neutral progress (the quality of R&D) in spite of the input factors quality rapid improvement. Moreover, labor, safety and health also need improving, the quality of products service is unstable as well as satisfaction degree need increasing.

1. Introduction

The Chinese economy has entered a stage of high-quality development, and the problem of insufficient imbalance in economic development has become increasingly prominent. In view of this, based on the clarification of the difference in quantity and quality, this paper constructs a new indicator system from the aspects of input factor quality, process control quality, product service quality and environmental quality, use the efficiency coefficient entropy method to measure the China's economic growth quality index from 2000 to 2014.

The marginal contribution of this paper is: focusing on "quality", while covering some important but not overlooked in previous research.(1)Embodies the importance of micro-product quality, quantifies the multi-dimensional attributes of product service quality, and adds customer satisfaction; (2)Process control, focusing on safe production; (3)Input factors, considering embossed technological progress and life expectancy; (4) In terms of environmental quality, considering soil pollution factors. From the method point of view, the power factor entropy method can be compared with the customer view weight and timing.

2. Theoretical Framework

At present, the research on the quality of economic growth is divided into narrow and broad. The narrow view equates the quality of economic growth with economic efficiency. Many scholars measure the quality of economic growth with total factor productivity (TFP). A review by Crafts (1998) [1] shows that the calculation of TFP in Singapore is controversial. For example, Young (1995) [2] measured the average annual growth rate of TFP in Singapore from 1966 to 1990 as 0.2, if the capital weight is adjusted from 0.49 to 0.35, the result is 1.0. In the 1970s, when Singapore built a large airport, capital investment was proportional to fixed assets, resulting in an overestimation of capital investment and an underestimation of TFP. Because TFP is based on

Solow's residual, on the one hand, it ignores the importance of capital accumulation, and does not consider the embossed technological progress contained therein.

The broad view of the quality of economic growth begins with the academic criticism of GDP worship. Obviously, GDP cannot reflect environmental pollution. In the 1990s, with the use of refined environmental data, a number of documents discussing the relationship between economy and pollution had been emerged. Panayiotou (1990) [3], Grossman and Krueger (1991) [4] and Siebert (1992) [5], drawing on Kuznets's (1955) hypothesis that income inequality and per capita income are inverted U-shaped, opened the research path of the "Environmental Kuznets Curve Hypothesis" (EKC).In the 21st century, the study of the quality of economic growth has evolved into a multi-dimensional. The Human Development Index (HDI) of the United Nations Development Programme (UNDP) (Anand and Sen, 2000) [6] includes three dimensions: life expectancy, education level, and quality of life. The definitions of Barro (2002) [7] and Thomas et al. (2000) [8] extend the quality of growth to political, social, and religious aspects. Charles and Klenow (2016) [9] included consumption, leisure, mortality, and inequality into the expected utility model to measure welfare levels and found that the difference in welfare levels between developed and developing countries is greater than per capita GDP.

Therefore, quality inspections (whether macro or micro) should focus on the process of transforming inputs into outputs, especially the health and safety of workers. The environment is an indispensable natural condition for the production of material data and the survival of mankind. It is damaged by the “unintended output” of economic growth and is an important aspect to measure the quality of economic growth. In summary, we believe that the quality of economic growth is relative to the quantity of economic growth, and refers to the quality of new economic activities and achievements of a country or region in a certain period of time. High-quality economic growth is not only reflected in the high quality of input factors and useful outputs, but also in the production process itself and the higher quality of the environment.

3. The Indicator System and Data Sources

The measurement of economic growth quality can be carried out in terms of input factors, process control, production services, and environmental quality. These four aspects cover twelve dimensions including material capital, human capital, research & development, Labor Safety & Hygiene, labor insurance, standards & certification, conformity, quality economic loss, satisfaction, competitiveness, pollution emission, and environmental governance(Table 1).The theoretical basis for indicator system is described below.

Table 1. Indicator System of China's Economic Growth Quality

Aspects	Dimensions	Indicators	Unit	Attribute	Data Sources
Input Factors	Human Capital	Labor capital per capita	Thousand Yuan	Positive	Human Capital In China 2016
		Input Intensity on Education	%	Positive	China Statistical Yearbook (Over the years)
		life expectancy	Year (of Age)	Positive	https://www.undp.org
	Material Capital	Relative Price Index	——	Positive	China Price Statistical Yearbook (Over the years)
		energy consumption per	Ton of standard	Ne	China Statistical Yearbook (Over the

		unit	coal/10 000 Yuan	gative	years)
		Input Intensity on Technical Reformation	%	Positive	China Statistical Yearbook on Science and Technology (Over the years)
	Research & Development	Whole Society Intensity on Research and Development	%	Positive	China Statistical Yearbook (Over the years)
		Patent per 100 Million Yuan from GDP	Item	Positive	
		Intensity on Product Development	%	Positive	China Statistical Yearbook on Science and Technology (Over the years)
Process Control	Labor Safety & Hygiene	Deaths from Safety Accidents	People	Negative	China's work safety Yearbook (Over the years)
		Safety Accidents	Number	Negative	
		Deaths From Accident of Industrial, Mining and Commercial Enterprises	People	Negative	
		New Cases of Occupational Diseases	Case	Negative	
	Labor Insurance	Coverage of Unemployment Insurance	%	Positive	China Statistical Yearbook (Over the years)
		Coverage of Basic Medical Insurance	%	Positive	
		Coverage of Work Injury Insurance	%	Positive	
	Standards & Certification	Number of National Standards	Item	Positive	China Statistical Yearbook on Science and Technology (Over the years)
		Standard Score on Certification Rate of Quality Management System	——	Positive	Research and Application of Quality Competitiveness
Production Services	Conformity	Weighted Qualified Rate of Spot-Check	%	Positive	China Statistical Yearbook & China Statistical Yearbook on Science and Technology (Over the years)
		Qualified Rate of Entry-Exit Value Inspection	%	Positive	China Statistical Yearbook (Over the years)
		High-class Rate	%	Positive	

	Quality Economic Loss	Rate of Quality Loss	%	Negative	
		Financial loss of Consumers	10000 Yuan	Negative	http://www.cca.org.cn/
	Satisfaction	Complaints from Consumers	Number	Negative	
		CCSI	——	Positive	China's famous-brand customer satisfaction survey and CCSI survey results
	Competitiveness	New Product Sales Rate	%	Positive	China Statistical Yearbook (Over the years)
		Export Sales Rate of New Products	%	Positive	
		Export Rate of High-tech Products	%	Positive	
Environmental Quality	Pollution Emission	Industrial Emission	One Hundred Millio Standard Cubic Meters	Negative	China Statistical Yearbook on Environment (Over the years)
		Industrial SO2 Emission	10000 Tons	Negative	
		Industrial Smoke (Dust) Emission	10000 Tons	Negative	
		Industrial Wastewater Emission	10000 Tons	Negative	
		Industrial COD Emission	10000 Tons	Negative	
		Industrial Ammonia nitrogen Emission	10000 Tons	Negative	
		Industrial Solid Waste Emission	10000 Tons	Negative	
		Pesticide Usage per Unit Area	Kg/Ha	Negative	China Statistical Yearbook (Over the years)
		Chemical Fertilize Usage per Unit Area	Kg/Ha	Negative	
	Environmental	Treatment Facilities for Industrial Gaseous Waste per 10000 People	Set	Positive	China Statistical Yearbook (Over the years) and China Statistical Yearbook on Environment (Over the years)

	Governance	Treatment Facilities for Industrial wastewater per 10000 People	Set	Positive	
		Comprehensive Utilization Rate of Industrial Solid Waste	%	Positive	
		Investment Intensity on Industrial Gaseous Waste Treatment	%	Positive	
		Investment Intensity on Industrial Wastewater Treatment	%	Positive	
		Investment Intensity on Industrial Solid Waste Treatment	%	Positive	
		Non-Urban-infrastructural Investment Intensity on Pollution Treatment	%	Positive	

3.1 Quality of Input Factors

Since the neo-classical growth theory, the importance of human capital, R&D and technological progress has become increasingly prominent. (Hansen and Prescott, 2002) [10].The quality investigation on input factors has been carried out in three dimensions: material capital, human capital, and R&D. As an input factor, the improvement of material capital's quality is mainly manifested in the dynamic integration of technological progress with capital accumulation. The quality of human capital is measured by three indicators: the actual per capita human capital, the life expectancy of the population and the intensity of educational input.

3.2 Quality of Process Control

The process of economic activity is the production process of products and services, the combination process of labor and production goods, and the formation process of quality. This paper examines the quality of process control from three dimensions: labor safety and health, labor insurance, standards and certification system. Labor safety and health were measured by the number of accidents in production safety and the number of deaths caused by accidents, the number of deaths caused by accidents in enterprises for industrial, mining, commercial and trade industries, and the number of new occupational diseases.

3.3 Quality of Product and Service

The evolution of product quality concept presents three stages: conformity, applicability and satisfaction. The accepted product quality concept is "the ability of a set of inherent characteristics to meet needs". Good products and services should not only conform to objective standards, avoid causing losses to consumers and producers due to "non-conforming quality problems", but also meet the subjective needs of consumers and achieve the unity of subject and object. At the same time, the quality of products and services has increasingly become the source of competitiveness of countries and enterprises. Therefore, this paper examines the quality of products and services from four dimensions: conformity, quality economic loss, satisfaction and competitiveness.

3.4 Environmental Quality

Environmental pollution is an unavoidable problem in economic development. Environmental quality assessment is usually measured by pollution emissions which is the unsatisfactory output of economic growth.

In summary, the evaluation system of economic growth quality includes 4 first-level indicators (aspects), 12 second-level indicators (dimensions) and 44 observation indicators, as shown in Table 1. Except for special instructions, other indicators are from the China Statistical Yearbook. It should be pointed out that the damage caused by "non-conformity" is not mitigated by the expansion of economy or population, so these reverse indicators should be measured by aggregate indicators rather than unit output or per capita indicators. Of course, if we compare the quality of regional growth horizontally, it is necessary to eliminate the impact of scale differences.

4. Construction of China's Economic Growth Quality Index

In the literature on the comprehensive index of economic growth quality, principal component analysis is the most widely used, but the use of principal components for comprehensive evaluation is still controversial, such as selecting several principal components and how to weight to obtain a composite index. Taking the time series data as an example, whether the correlation matrix or the covariance matrix is used as the input, the comprehensive score only indicates the positional relationship with the average level (for example, the average score of the principal component of the correlation matrix is 0), and the timing is not comparable. More importantly, the more complete principal component analysis requires high data. For example, one dimension is generally no less than two indicators, and the first principal component variance contribution rate is not less than 85% (or 80%). In many cases, the optional indicators with economic implications are relatively scarce, and these indicators may still not meet the requirements of principal component analysis.

Relatively speaking, the entropy method, which is also based on objective weighting, has fewer restrictions and has been used more recently in related applications. For time series data, direct extremum processing necessarily results in a dimensionless index of 0 for some years; therefore, the weight is determined using the power factor entropy method, and the power factor is 0.95. Given the availability of data, the study interval was determined to be from 2000 to 2014. The specific formula and calculation steps are handled as follows.

The raw data dimensionless:

Positive indicator

$$\dot{x}_{ij} = \frac{x_{ij} - \mathrm{m}_j}{M_j - m_j} \times \alpha + (1-\alpha) \tag{1}$$

Negative indicators:

$$\dot{x}_{ij} = \frac{M_j - x_{ij}}{M_j - m_j} \times \alpha + (1-\alpha) \tag{2}$$

$m_j = \min_i \{x_{ij}\}$ $M_j = \max_i \{x_{ij}\}$ $\alpha = 0.95$

Determine the weight and index calculation:

$$p_{ij} = \dot{x}_{ij} \Big/ \sum_{i=1}^{n} \dot{x}_{ij} \tag{3}$$

$$e_j = -(1/\ln n) \sum_{i=1}^{n} p_{ij} \ln p_{ij} \tag{4}$$

$$g_j = 1 - e_j \tag{5}$$

$$w_j = g_j \Big/ \sum g_j \tag{6}$$

$$Q_i = \sum w_j \dot{x}_{ij} \tag{7}$$

α : For the efficiency factor, e_j : the entropy value

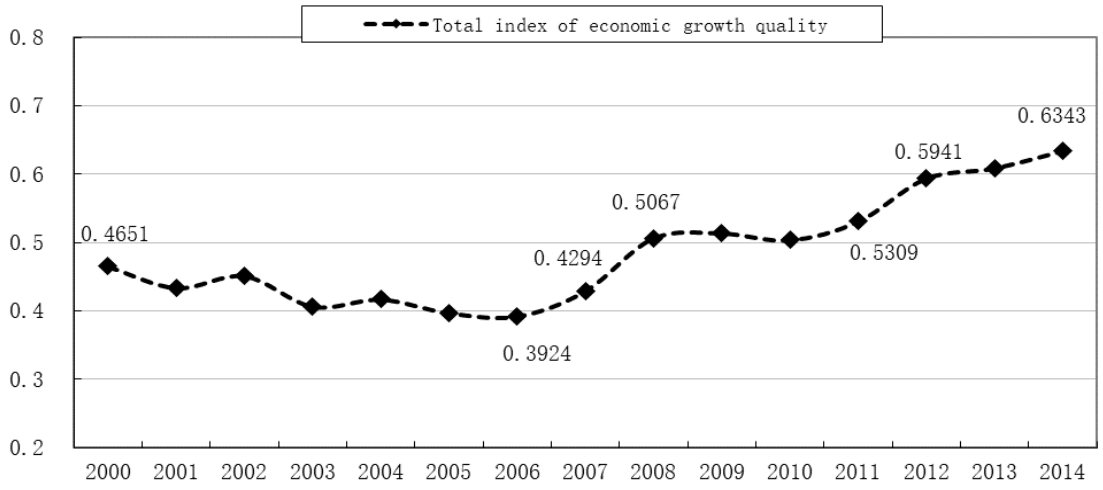
g_j : The difference coefficient, w_j : the weight

The original data is de-dimensional zed and forwarded by the formula (1) or (2), and the index system weights can be obtained from the formulas (3)-(6), and the corresponding index sets are calculated by the formula (7).

In Table 1, the temporal variation of the four aspect indices and the total index are depicted. First, overall, from 2000 to 2006, the quality of China's economic growth is on the rise, the quality of economic growth fluctuated at a lower level; after 2007, the quality of growth increased at a higher level. As far as the four aspects of the index are concerned, it is obvious that the quality of input factors have the largest smoothly rising, and the quality of product service has the largest fluctuated. Second, the changes in China's economic growth quality between 2000 and 2014 are mainly reflected in the environmental quality, and the changes in environmental pollution emissions are reflected in the soil. Third, from the inflection point of the subdivision period, the first jump in the quality of economic growth in 2007 and 2008 (the total index increased by 9.41%, 18%), on the one hand stems from the input factors, process control, and good quality of product service, that mainly due to the slowdown in the deterioration of environmental quality. After 2010, the year-on-year improvement in the quality of economic growth is mainly due to the improvement of environmental quality. The second jump in the 2012 index was due to a significant increase in input factors and product service quality.

5. Conclusion and Policy Suggestion

Focusing on four aspects of input factors, process control, product service and environmental quality, this paper reconstructs an index system which is more in line with the connotation of quality. In order to give consideration to objective empowerment and time-comparable, efficiency coefficient entropy method is used to determine the weight, and to calculate the quality index of China's economic growth.



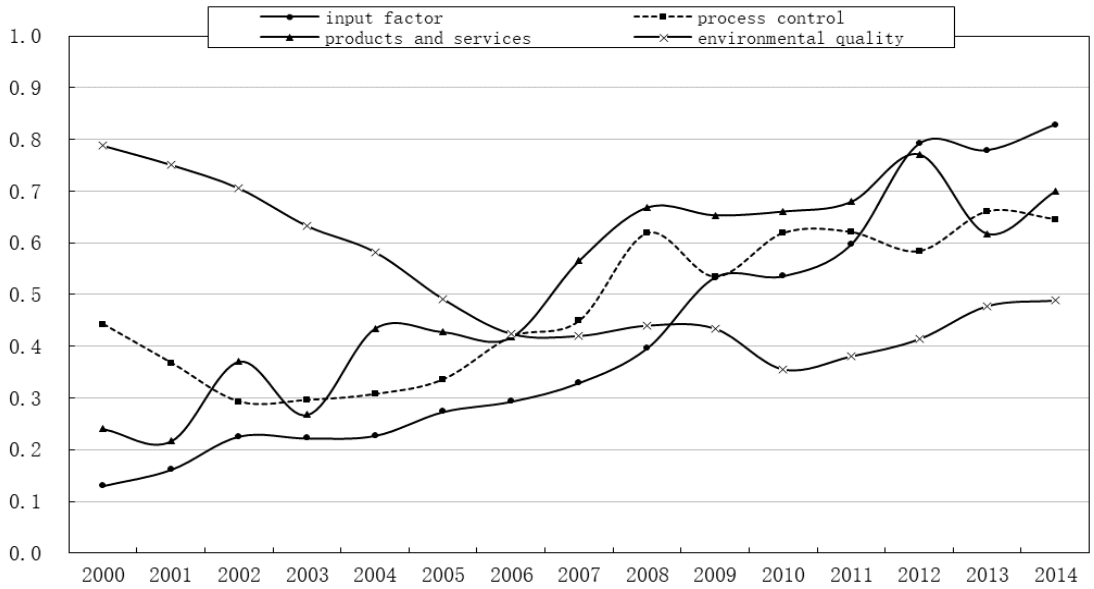


Figure 1. The Total Index of China's Economic Growth Quality and Four Aspects Indies

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