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Strategic Performance Comparison of Provinces in China

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***Abstract*—A framework of strategic performance comparison is designed based upon the well-known theory of generic strategic analysis in business and is used to carry out a competence analysis of provinces in China. An introduction of Porter's generic strategic analysis is introduced first to provide background information. Then, a summary of multiple criteria decision analysis and a few decision analysis tools are sequently presented. Next, a two-dimension framework is proposed for the strategic performance comparison and its application to the competence analysis of provinces in China is discussed in detail, including the analysis procedures and findings.**

***Index Terms*—Strategic performance comparison, multiple criteria decision analysis, Data envelopment analysis, Analytic hierarchy process**

I. Introduction

The world economy has changed dramatically over the past fifty years. The United States (US) dominated the global economy for a long time after the end of World War II. As result of rapid recovery from the devastation from the war and accompanying fast economic growth, European Union (EU) countries and Japan became strong economic competitors of the US. The Group of Seven (G7) countries consisting of Canada, France, Germany, Italy, Japan, the United Kingdom (UK), and the US accounts for about two-thirds of the world's economic output and is regarded as an unofficial "world economic government". Now, new players are challenging the world economic order. The leading investment banking firm, Goldman Sachs Group, Inc., predicts that in less than forty years, the BRICs economies (Brazil, Russia, India and China) combined, could be larger than the Group of Six (G6) which includes the US, Japan, Germany, UK, France, and Italy in US dollar terms [14].

Recently, projected BRICs-related economic performance has been studied from different perspectives. The British Broadcasting Corporation (BBC) hosted the program, "Who runs your world", to introduce BRICs and their potential new powers in the global economy [2]. Authors of global economic papers published within the Goldman Sachs Group [8], [14] examined the economical potential of BRICs by employing a long-term growth model. The study of BRICSAM countries, which extends BRICs by including South Africa, ASEAN (Association of South-East Asian Nations), and Mexico, is one of the major research topics of the Centre for International Governance Innovation (CIGI), located in Waterloo, Ontario, Canada [4].

Utilizing multiple criteria decision analysis (MCDA) tools, a strategic-performance comparison model based upon the theory of generic strategic analysis proposed by Porter [9], [10], is presented in this paper to carry out a competence analysis of provinces in China.

II. Porter's Generic Strategic Analysis

Porter's generic strategic framework constitutes a major contribution to the development in the strategic management literature. Generic strategies were first presented in two books by Dr. Michael Porter of the Harvard Business School in the US [9], [10]. Porter suggested that some of the most basic strategies faced by companies are essentially the scope of the markets that the company would serve and how the company would compete in the selected markets.

Companies can achieve competitive advantages by differentiating their products and services from those of competitors and through low costs. Firms can target their products using a broad target, thereby covering most of the marketplace, or they can focus on a narrow target in the market. Porter maintains that there are three generic strategies that a company can undertake to attain competitive advantage: cost leadership, differentiation, and focus.

- *Cost leadership*: The companies that attempt to become the lowest-cost producers in an industry can be referred to as those following a cost leadership strategy. The company with the lowest costs would earn the highest profits when the competing products are undifferentiated, and selling at a standard market price. Companies following this strategy focus on cost reduction in every activity in the value chain. It is important to note that a company might be a cost leader but that does not necessarily imply that the company's products would have a low price.
- *Differentiation*: When a company differentiates its products, it is often able to charge a premium price for its products or services in the market. Some general examples of differentiation include better service levels to customers and better product performance in comparison with the existing competitors. Porter [9] has argued that for a company employing a differentiation strategy, there

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would be extra costs that the company would have to incur. Such extra costs may include high advertising spending to promote a differentiated brand image for the product, which in fact can be considered as a cost and an investment.
- *Focus*: Companies employ this strategy by concentrating on the areas in a market where there is the least amount of competition. Organizations can make use of the focus strategy by focusing on a specific niche in the market and offering specialized products for that niche. Competitive advantage can be achieved only in the company's target segments by employing the focus strategy. The company can make use of the cost leadership or differentiation approach with regard to the focus strategy. In this way, a company using the cost focus approach would aim for a cost advantage in its target segment only.

III. Multiple Criteria Decision Analysis Tools

Multiple criteria decision analysis (MCDA) constitutes an increasingly popular set of techniques used to evaluate and compare different alternative solutions according to diverse environmental, economic, social, and political criteria. For example, in 1998 the Department of the Environment, Transport, and the Regions in the United Kingdom developed MCDA methods to appraise transport projects instead of using traditional cost-benefit analyses. This approach improved project appraisal by incorporating both monetised and non-monetised impacts of transport projects into the management planning process [5].

An MCDA problem can be summarized using the three steps: (1) Problem construction, which involves defining objectives, arranging them into criteria and identifying all possible alternatives. (2) Data collection, to obtain an information matrix, in which each column represents an alternative and each row provides evaluations of the performance of the alternatives over that criterion; (3) Decision analysis and outcomes, in which decision protocols define how analyses are carried out to obtain ranking, sorting or choice results for the alternatives as an aid to decision making. During the last thirty years, many methods have been proposed for MCDA. Next, three well-known approaches are briefly introduced.

A. Linear Additive Value Function (LAVF)

The linear additive value function (LAVF) is widely used in many practical applications because it is easily understood and implemented. The basic LAVF can be generalized as follows:

$$V(A^i) = \sum_{j=1}^{q} w_j v_j(A^i), \tag{1}$$

where $V(A^i)$ is the overall evaluation of alternative $A^i \in \mathbf{A}$, w_j is the weight of criterion $j \in \mathbf{Q}$ and $v_j(A^i)$ is the value of A^i over criterion j. Note that usually $0 < w_j < 1$, $\sum_{j=1}^{q} w_j = 1$ and $0 \leq v_j(A^i) \leq 1$.

B. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a mathematical decision technique that allows consideration of both qualitative and quantitative aspects of decisions. It reduces complex decisions to a series of one-on-one comparisons, and then synthesizes the results. Compared to other techniques like ranking or rating techniques, AHP uses a human's ability to compare single properties of alternatives. It not only helps decision makers choose the best alternative, but also provides a clear rationale for the choice. The process was developed in the 1980s by Thomas Saaty [12]. AHP is based on the following principles:

- The overall objective of the decision problem is decomposed into sub-objective levels in a hierarchy. Elements of approximately equal importance are arranged at the same level. For example, in a decision problem the overall objective is represented by a few criteria at the criteria level. Then for each criterion, sub-criteria that represent it are located at the sub-criteria level.
- Once a hierarchical structure is established, pairwise comparisons of the elements at each level of the hierarchy must be carried out. Local priorities can then be generated by an eigenvalue technique.
- Based on linear additive aggregation, the global priority of each element to the overall objective is determined.

C. Data Envelopment Analysis (DEA)

DEA is an increasingly popular management decision tool initially proposed by Charnes et al.[3]. The basic idea of DEA is to measure the relative efficiency of different product units or decision making units (DMUs) which have multiple possibly incommensurate inputs and outputs using a weighted linear-additive equation.

$$\text{Efficiency} = \frac{\text{Weighted sum of outputs}}{\text{Weighted sum of inputs}} \tag{2}$$

Charnes et al. [3] recognized the difficulty in seeking a common set of weights (relative importance) of inputs and outputs to determine the relative efficiency of DMUs, and that a DMU might value inputs and outputs differently and therefore adopt different weights. Hence, they proposed an optimization model so that each DMU was allowed to adopt a set of weights which shows it in the most favorable light in comparison to the other DMUs. The detailed mathematical model construction is skipped here and can be found in the paper by Charnes et al. [3]. Overall, the final results of the relative efficiency of DMUs are normalized and measured by real-value numbers between 0 and 1. Large values indicate high relative efficiency and if a DMU can obtain the value of 1, it is efficient, otherwise it is non-efficient. The advantages of DEA is that it requires much less subjective information from DMs, such as various types of preference information, and is easy to implement.

IV. Strategic Performance Comparison

A. The Analysis Framework

Following Porter's generic strategic analysis, a framework to carry out strategic performance comparisons for regions' competence analysis is designed and shown in Figure 1. The two dimensions in the figure measure the competence efficiency and potentiality. It is easy to see that any region with high competence efficiency and potentiality is in the best position. If a region falls into low scores for both directions, the decision makers should improve the region's performance through the arrows I or II, as indicated in Figure 1. Similarly, more effort needs to be conducted for regions with high performance on one side and low performance on the other to get improvements through arrow III or IV in Figure 1.

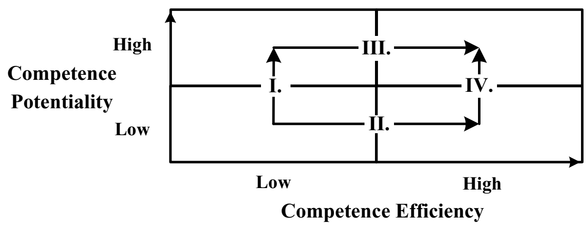

Fig. 1. Generic strategic policy analysis

To quantify the study, the aforementioned MCDA decision tools are used to carry out the measure of the competence efficiency and potentiality. Specifically, the DEA model is used for the analysis of competence efficiency and the LAVF along with the AHP approaches are utilized to solve the analysis of competence potentiality.

B. Competence Analysis of Provinces in China

The above analysis framework is utilized in the competence analysis of provinces in China. The details are explained below.

1) Competence Efficiency Analysis: Three criteria are selected as inputs into the DEA model, which are:

- *Investment in Fixed Assets* (IFA). Fixed assets, also known as property, plant and equipment, are a term used in accountancy for assets and property which cannot easily be converted into cash. Fixed assets normally include items such as land and buildings, motor vehicles, furniture, office equipment, computers, fixtures and fittings, and plant and machinery. IFA is the essential means for social reproduction of fixed assets and is a comprehensive indicator which shows the size, pace, proportional relations and use orientation of the investment [13]. IFA is measured in units of hundred million RMB, where RMB is the Chinese monetary unit.
- *The Number of Industrial Employees* (NIE). The number of employee for all industry sectors is an indictor to reflect the actual utilization of the labor force during a certain period of time. NIE is measured in units of ten thousand people.
- *Area of Industrial Property* (AIP). The area of industrial property estimates the land used for industrial purposes and is measured in square kilometers (km^2).

Two criteria are utilized as outputs of the model:

- *Gross Domestic Product* (GDP). GDP is defined as the market value of all final goods and services produced within a region, usually a country, in a given period of time. Here, the GDP of a province is estimated in hundred million RMBs.
- *Tax Revenue* (TR). TR is the income that is gained by governments because of taxation of the person or business. It is measured in units of hundred million RMBs.

Table I shows the information of the inputs and outputs for all province level administrative divisions in mainland China which includes 22 provinces as well as 5 autonomous regions and 4 direct-controlled municipalities. The data are collected from [13]. The final results of DEA efficiency for provinces in China are obtained by a DEA software, Frontier Analyst [1], and listed in the last column of Table I.

TABLE I
DEA EFFICIENCY OF PROVINCES IN CHINA

Provinces	Inputs			Outputs		Efficiency
	IFA	NIE	AIP	GDP	TR	
1. Anhui	1418.69	3416	1044.2	3972.38	220.7	0.7716
2. Beijing	2169.26	858.6	1180.1	3663.1	592.5	0.7703
3. Chongqing	1161.51	1659.5	523.7	2250.56	161.6	0.5847
4. Fujian	1496.37	1756.7	598.4	5232.17	304.7	1.000
5. Gansu	619.82	1304	478.3	1304.6	87.7	0.6038
6. Guangdong	4813.2	4199.5	2546.9	13625.87	1315.5	0.9361
7. Guangxi	921.3	2601.4	685.4	2735.13	203.7	0.8805
8. Guizhou	748.12	2118.4	348.1	1356.11	124.6	0.5924
9. Hainan	280.02	353.8	176.7	670.93	51.3	0.7243
10. Hebei	2477.98	3389.5	1171	7098.56	335.8	0.8126
11. Heilongjiang	1166.18	1622.4	1362.5	4430.00	248.9	1.0000
12. Henan	2262.97	5535.7	1345.9	7048.59	338.1	0.8717
13. Hubei	1809.45	2537.3	1415.6	5401.71	259.8	0.8186
14. Hunan	1590.32	3515.9	959.4	4638.73	268.6	0.8164
15. Inner Mongolia	1174.66	1005.2	679.3	2150.41	138.7	0.5815
16. Jiangsu	5233	3610.3	2119.5	12460.83	798.1	0.8079
17. Jiangxi	1303.22	1972.3	598.5	2830.46	168.2	0.6208
18. Jilin	969.03	1044.6	850.5	2522.62	154.0	0.7607
19. Liaoning	2076.36	1861.3	1694.6	6002.54	447.0	0.9018
20. Ningxia	317.99	290.6	206.1	385.34	30	0.3764
21. Qinghai	255.62	254.3	101.8	390.21	24	0.4636
22. Shaanxi	1200.68	1911.3	508.3	2398.58	177.3	0.6099
23. Shandong	5315.14	4850.6	2195.4	12435.93	713.8	0.7310
24. Shanghai	2499.14	771.5	549.6	6250.81	886.2	1.0000
25. Shanxi	1100.86	1469.5	678.7	2456.59	186.1	0.6736
26. Sichuan	2336.34	4449.6	1357.4	5456.32	336.6	0.6662
27. Sinkiang	973.36	721.3	564.8	1877.61	128.2	0.6391
28. Tianjin	1039.39	419.7	487.5	2447.66	204.5	0.9005
29. Tibet	133.96	130.7	72.4	184.5	8.1	0.4197
30. Yunnan	1000.12	2349.6	410.5	2465.29	229	0.8132
31. Zhejiang	4740.27	2961.9	1397	9395.00	706.6	0.6917

C. Competence Potentiality Analysis

Lopez-Claros et al. [7] proposed nine key elements to evaluate the sustainable growth of a region, Adapted from this analysis framework, the evaluation criteria to assess the competence potentiality of provinces in China are shown in Figure 2.

The aforementioned LAVF is used and re-written below to conduct the evaluation, since it has been widely used in practical applications:

$$V(A^i) = \sum_{j \in \mathbf{Q}} w_j \cdot v_j(A^i), \quad (3)$$

where A^i is a province (alternative) for evaluation as listed in Table I; w_j is the weight for a criterion j, as shown in Figure 2; $v_j(A^i)$ is the value (performance) of A^i on criterion j; and $V(A^i)$ is the overall evaluation result for A^i, which is summarized in the tenth column of Table III.

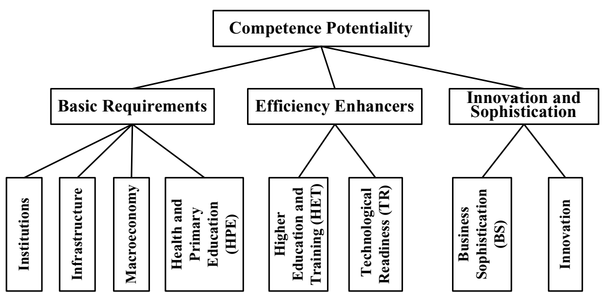

Fig. 2. Criteria for competence potentiality

Lopez-Claros et al. [7] suggested that the weights of basic requirements, efficiency enhancers, and innovation and sophistication for developing countries like China could be 0.5, 0.4 and 0.1, respectively. But they did not specify weights for the subcriteria. Here, the AHP method is used to estimate the weights at the subcriteria levels. Several pairwise comparison matrices were estimated by the authors and some other graduate students separately in the Conflict Analysis Group in the Department of Systems Design Engineering at the University of Waterloo. Then, the local weights are calculated using the eigenvalue method (The AHP software, Expert Choice [6], is employed to conduct the analysis.) and the averages are used as the representative local weights shown in Table II. Finally, the global weights for the subcriteria are calculated by the multiplication of the local and criteria weights. For example, the global weight for institutions under the basic requirements is obtained as $0.5(0.2) = 0.1$.

The values of each province over different criteria are represented by the numbers arranged between 0 and 1. These data were estimated by researchers and graduate students in the Conflict Analysis Group in the Department of Systems Design Engineering at the University of Waterloo (the average of the estimates are shown in Columns 2-9 of Table III). By multiplying the entries in each row in Table III by the appropriate global weights in the right column in Table II, the overall evaluation for each province is obtained as shown in the right column of Table III. For example, the final result of Anhui Province is calculated as: $0.1(0.6) + 0.15(0.5) + 0.15(0.6) + 0.1(0.4) + 0.24(0.7) + 0.16(0.6) + 0.06(0.6) + 0.04(0.7) = 0.593$.

TABLE II
THE WEIGHT INFORMATION

Criteria	Subcriteria	Local	Global
Basic Requirements (0.5)	Institutions	0.2	0.1
	Infrastructure	0.3	0.15
	Macroeconomics	0.3	0.15
	HPE	0.2	0.1
Efficiency Enhancers (0.4)	HET	0.6	0.24
	TR	0.4	0.16
Innovation and Sophistication (0.1)	BS	0.6	0.06
	Innovation	0.4	0.04

Based on the analysis results of competence efficiency and competence potentiality explained above, Figure 3 shows these two values for each province in the two dimensions consisting of efficiency and potentiality (numbers represent provinces in China as shown in Table I and III). Some observations are as follows:

- There are high correlations between the performance of competence efficiency and competence potentiality of provinces in China. Usually, if a province has a high value of competence efficiency, its competence potentiality is also high. Similarly, a low performance of competence efficiency is linked with a low value of competence potentiality for a province. For example, the three provinces consisting of Ningxia (20), Qinghai (21) and Tibet (29), have the lowest scores in both dimensions. This interesting phenomenon is obvious in China: people obtain not only much higher salaries in big cities and coastal regions but also better social benefits such as having more educational opportunities. Hence, the first choice for most intellectuals such as new graduates from universities in China, is to work and live in eastern provinces. This is closely connected with the previous centrally planned economy which had been implemented in China over thirty years since 1949. Even now, the central government still has dominant control of local provinces over various social and economic issues such as resources allocation and manufacturing production. For example, Sinkiang, like the Province of Alberta in Canada, has plenty of oil. But it gets much less economic benefit compared with Alberta, since the Chinese central government controls the oil production and sales, and most of the revenue is used to support the development of other regions.
- There are some provinces which have relatively low competence efficiency but high competence potentiality, such as Beijing (2), Jiangsu (16) and Zhejiang (31). Most of these provinces are located in Eastern China and coastal regions. Although these provinces have been relatively slow compared to southern coastal regions in adopting China's "reform and openness" which began in the 1980s, historically, many of these provinces were wealthy regions and had much potential to come up with high speed development. For example, Beijing did not develop as quickly in the 1980s, but it will host the 2008

TABLE III
THE COMPETENCE POTENTIALITY OF PROVINCES IN CHINA

Provinces	Institutions	Infrastructure	Macroeconomy	HPE	HET	TR	BS	Innovation	Final
1. Anhui	0.6	0.5	0.6	0.4	0.7	0.6	0.6	0.7	0.593
2. Beijing	0.8	0.85	0.75	0.85	0.9	0.9	0.9	0.8	0.851
3. Chongqing	0.5	0.6	0.5	0.5	0.6	0.5	0.6	0.6	0.549
4. Fujian	0.6	0.7	0.75	0.6	0.6	0.7	0.9	0.75	0.6775
5. Gansu	0.4	0.4	0.45	0.45	0.45	0.5	0.4	0.5	0.4445
6. Guangdong	0.8	0.85	0.9	0.85	0.7	0.8	0.95	0.8	0.8125
7. Guangxi	0.6	0.65	0.55	0.55	0.5	0.5	0.65	0.55	0.556
8. Guizhou	0.5	0.4	0.5	0.55	0.4	0.5	0.55	0.5	0.469
9. Hainan	0.5	0.5	0.6	0.5	0.4	0.4	0.65	0.6	0.488
10. Hebei	0.5	0.65	0.6	0.55	0.6	0.45	0.5	0.5	0.5585
11. Heilongjiang	0.5	0.65	0.65	0.55	0.7	0.7	0.65	0.55	0.641
12. Henan	0.4	0.65	0.7	0.5	0.45	0.55	0.6	0.5	0.5445
13. Hubei	0.65	0.6	0.7	0.65	0.75	0.65	0.7	0.65	0.677
14. Hunan	0.65	0.65	0.65	0.65	0.6	0.6	0.6	0.5	0.621
15. Inner Mongolia	0.4	0.65	0.65	0.4	0.4	0.4	0.5	0.4	0.481
16. Jiangsu	0.85	0.85	0.9	0.75	0.85	0.85	0.8	0.8	0.8425
17. Jiangxi	0.6	0.55	0.5	0.55	0.6	0.65	0.6	0.55	0.5785
18. Jilin	0.6	0.55	0.5	0.55	0.65	0.6	0.55	0.55	0.5795
19. Liaoning	0.65	0.65	0.65	0.55	0.6	0.55	0.65	0.6	0.61
20. Ningxia	0.3	0.4	0.4	0.4	0.4	0.35	0.35	0.4	0.379
21. Qinghai	0.25	0.35	0.4	0.35	0.35	0.3	0.4	0.3	0.3405
22. Shaanxi	0.55	0.65	0.65	0.55	0.65	0.7	0.6	0.6	0.633
23. Shandong	0.7	0.75	0.85	0.65	0.7	0.7	0.75	0.65	0.726
24. Shanghai	0.85	0.85	0.85	0.85	0.9	0.9	0.95	0.8	0.874
25. Shanxi	0.55	0.7	0.7	0.5	0.5	0.55	0.65	0.5	0.582
26. Sichuan	0.65	0.65	0.65	0.6	0.7	0.65	0.65	0.6	0.655
27. Sinkiang	0.4	0.65	0.7	0.55	0.45	0.5	0.5	0.5	0.5355
28. Tianjin	0.75	0.7	0.7	0.7	0.75	0.7	0.7	0.7	0.717
29. Tibet	0.4	0.55	0.35	0.3	0.4	0.4	0.55	0.4	0.414
30. Yunnan	0.5	0.5	0.55	0.45	0.5	0.5	0.4	0.4	0.4925
31. Zhejiang	0.8	0.85	0.9	0.85	0.85	0.85	0.9	0.9	0.8575

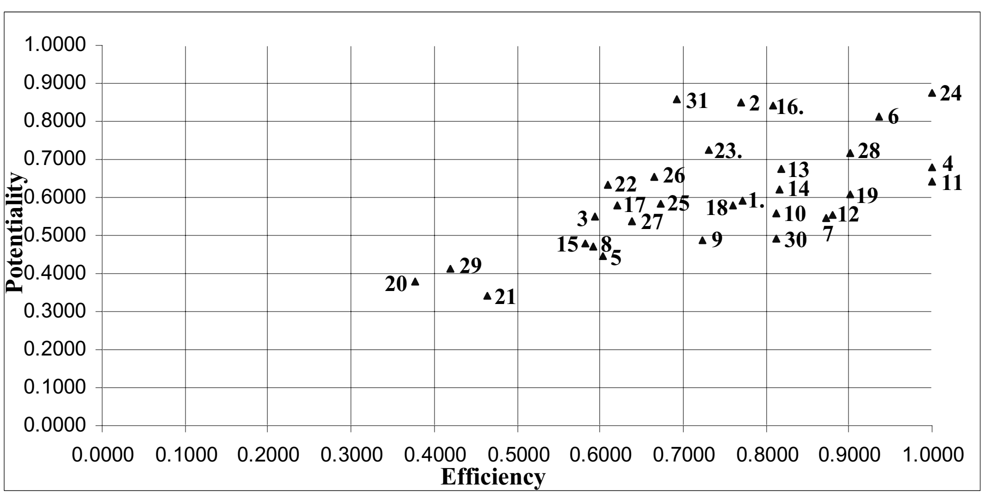

Fig. 3. Generic strategic analysis

Olympic Games which is expected to boost the economy of China, especially in Beijing.

- There are also a few provinces which have relatively low scores of competence potentiality compared with the value of competence efficiency, including Fujian (4) and Guangdong (6). Many of these provinces are inshore regions which have taken advantage of the Chinese policy of "reform and openness". Their economic situations are better than other inland provinces. But with the rapid development of energy requirements in China and the new campaign of "China Western Development" initiated in 2000 to boost the underdeveloped western regions of China, the inland provinces such as Shaanxi (22), which has supplied more than half of the coal consumed in China, will have more development opportunities.

V. Conclusions

A country's prosperity depends on its competitiveness in its delivery of goods and services. Sound macroeconomic policies and stable political and legal institutions are necessary, but not sufficient conditions, to ensure a prosperous economy [11]. An understanding of the microeconomic foundations of competitiveness is fundamental to having a sound national economic policy. Therefore, competence analysis of nations, regions and cities constitutes a key step for executing sound social economic planning for a country.

In this paper, a framework of generic strategic analysis which was initiated by Porter [9] is designed to carry out quantitative analyses of regions' competence. Following the description of the theory of generic strategic analysis, a framework to determine the strategic performance comparison of regions was explained, and the quantitative tools to implement the analysis, three multiple criteria decision analysis models, were subsequently introduced. Finally, a case study of the competence analysis of provinces in China was used to demonstrate the proposed procedure.

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