

Research on Entrepreneurial Opportunity Evaluation Based on Grey-Fuzzy Assessment

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Abstract Opportunity evaluation is one of the most critical aspects in process of entrepreneurship. There are two kinds of entrepreneurial opportunity evaluation approaches, namely qualitative and quantitative research approaches. Based on Timmons' hierarchic index of opportunity evaluation, we establish a new method of opportunity evaluation that integrates grey assessment and fuzzy assessment. The grey clustering theory can be used to obtain the index grey statistics and structure the opportunity fuzzy subjection matrix that enables a comprehensive evaluation of opportunity. At last, a practical example is given to confirm the feasibility and the practicability.

Key words Opportunity evaluation; Grey-fuzzy assessment; Entrepreneurial opportunity; Grey theory

1 Introduction

Since the 1980s, scholars have increasingly recognized that entrepreneurship research plays a major role in employment and economic development, which also has gained rapid development. During thirty years of development, entrepreneurship research has made great progress. The most important progress is that entrepreneurship research system is formed which focuses on entrepreneurial opportunities. Defined from the perspective of business opportunities, entrepreneurship is the progress of identification, assessment and exploitation of opportunities, which create future goods and services^[1].

Entrepreneurial opportunities are defined as situations in which new goods, services, raw materials, markets and organizing methods can be introduced through the formation of new means, ends, or means-ends relationships^[2]. Assessment of entrepreneurial opportunities by entrepreneurs, which relates to whether the opportunity should be reasonable exploration and exploitation finally, is an important component of entrepreneurial processes.

2 Entrepreneurial Opportunity Evaluation Approaches

In qualitative research approaches of entrepreneurial opportunity evaluation, Longnecks^[3] points out five principles of these qualitative approaches: clear market demand and appropriate access of entry, sustainable competitive advantage, high return, combination with entrepreneurs, non-fatal flaw. Timmons^[4] proposes an evaluation system of entrepreneurial opportunity that contains 8 one-grade indices, 53 two-grade indices, which is the most comprehensive evaluation index system of entrepreneurial opportunity; Jiang Yanfu^[5] who made an empirical research on the orders of key indices of index system proposed by Timmons, suggests the 10 key indicators of entrepreneurial opportunity evaluation which is appropriate for Chinese entrepreneurs. Lei Jiasu^[6] suggests five dimensions for choosing market opportunities: market size, the time-horizon of opportunities' existence, the growing speed of market size over time, the five characteristics of good opportunities, the reality of special entrepreneurs. Zheng Bingzhang^[7], based on the Balanced Scorecard's four dimensions - financial, customer, internal factors, innovation and growth, proposes an index system using to assess entrepreneurial opportunities.

Quantitative research approaches to assess entrepreneurial opportunities are mainly composed of standard scoring matrix and Baty Choices Act. The standard scoring matrix approach is a method that chooses the important factors which influence the success of entrepreneurial opportunities, and then grades each of the important factors by the expert group with three levels of best (3 points), good (2 points) and general (1 point), and at last, calculates the weighted average points for each factor under all business opportunities, which can be used to compare the different entrepreneurial opportunities. The Baty Choices Act approach is a method that assesses entrepreneurial opportunities by designing 11 choice factors which is used to judge entrepreneurial opportunities. If an entrepreneurial opportunity only meets six or less than six choice factors, the entrepreneurial opportunity is likely undesirable; in contrast, if an entrepreneurial opportunity meets seven or more than seven choice factors, then the entrepreneurial opportunity is promising^[8].

The pure qualitative assessment approaches have some shorts, which would be difficult to give orders of several entrepreneurial opportunities; quantitative assessment methods also have two shorts. One short is that the division of assessment dimensions is less reasonable, which appears one-sidedness and overlapping and neglects the effect of mutual coupling between indices on the program. The other short is the lack of combination of subjective and objective assessment. Appraisers are subject to the constraints of knowledge and information, as well as personal preferences, and so assessment information provided by them is often incomplete or inadequate. To some extent, this affects the effectiveness of opportunity assessment.

There are two types of uncertainty in assessment of entrepreneurial opportunities. First, Uncertainty is caused by unclear and incomplete information, namely grey; second, the boundary of assessment indices is not obvious, and a number of factors that impact assessment are ambiguous, namely fuzzy. Only using simple fuzzy approach leads to the loss of information, while only using grey method is hard to reflect possible cross-fuzzy defined by assessment indices. Therefore, during entrepreneurial opportunity evaluation with dual uncertainty, grey-fuzzy comprehensive assessment model is a scientific and effective method for assessment.

3 Grey-fuzzy Assessment Approach

3.1 Identification of the index system

Though comprehensive comparison of assessment index system of entrepreneurial opportunities from domestic and foreign scholars, the evaluation criteria suggested by Timmons[4] is relatively comprehensive, almost covering full content argued by other theories. The index system includes 8 categories of one-grade index, 53 categories of two-grade index, and respectively portrays the maximum and minimum potential of each index. So it can be as an evaluation index system of entrepreneurial opportunity. It is showed in table 1.

1) Industry and Market. High potential entrepreneurial opportunities should satisfy these conditions: customers can accept companies' products or services and are willing to pay for them; products have high value to customers; products have a long life term; the project is in a new industry and competition is imperfect; the industry market has large sales and its potential sales can reach from 10 million to 1 billion; the growth rate of industry market is more than 30-50%; the productive capacity of existing firms within the industry is almost completely saturated; within 5 years, the enterprise can occupy the leading position in the market and the market share can reach 20% above; the enterprise have low-cost suppliers.

2) Economic factors. High potential entrepreneurial opportunities should satisfy these conditions: the need of time to reach break-even point is less than 1.5-2 years; the break-even point will not gradually increase; investment rate of return and internal rate of return will be potential over 25%; project funding requirements are not great, and have access to financing; the growth rate of sales is higher than 15%; it can provide sustainable gross margin and gross margin is above 40%; it can provide long-lasting after-tax profit, and after-tax profit margin is more than 10%; assets to sales ratio is low; spontaneous flow of capital requirement is low; Research & Development (R & D) on capital requirements is low.

3) Harvest conditions. High potential entrepreneurial opportunities should satisfy these conditions: the added value brought by projects has relatively high strategic significance; capital market valuation multiples of enterprises are relatively high and have the historical comparability; there are existing or foreseeable exit strategies; capital market environment is favorable and capital flows can be achieved.

4) Competitive advantage. High potential entrepreneurial opportunities should satisfy these conditions: fixed and variable costs are low; the control of costs, prices and sales is high; it can obtain patent protection of ownership; competitors respond slowly and indifferently; it has legal or contractual exclusivity; it has well-developed network of relationships and has easy access to the contract; it has excellent key personnel and management team.

5) Management team. High potential entrepreneurial opportunities should satisfy these conditions: the entrepreneurial team is a combination of excellent managers; industry and technology experience of teams should achieve the highest levels of our own industry; the degree of integrity and honesty of teams should achieve the highest standard; the team should know which aspects of knowledge is lack.

6) Fatal flaw. High potential entrepreneurial opportunities should not have any fatal flaws.

7) Entrepreneur's *personal standards*. High potential entrepreneurial opportunities should satisfy conditions: entrepreneur's personal goals is consistent with entrepreneurial activities; the opportunity

can enable entrepreneurs to achieve the success of limited risks; entrepreneurs can receive the salary reduction and other losses; entrepreneurs are eager to start this kind of entrepreneurial life manner, not only to make a lot of money; entrepreneurs can bear appropriate risks and grow well under pressure.

8) Strategic difference. High potential entrepreneurial opportunities should satisfy these conditions: business drivers are fit to the external environment; corporate management team has been the best; there are good service concepts in customer service management; the founder of the business trends to the times; the adopted technology has a breakthrough, which does not have many alternative products or competitors; it has flexible adaptability and can quickly make decisions to go on or give up; always look for new opportunities; pricing of our own firm keeps nearly flat with the market leader; have access to sales channels, or have existing network; allow mistakes and failures.

Table 1 Evaluation Index System of Entrepreneurial Opportunity

Attractiveness of opportunities (u_{ij})									
No. i	One-grade index	No. j	Two-grade index	No. i	One-grade index	No. j	Two-grade index		
1	industry and market	1	Product/service customer acceptance	4	competitive advantage	3	patent protection of ownership		
		2	product value			4	competitors' responding time		
		3	influence of product on markets			5	legal or contractual advantages		
		4	product life			6	relationships and network		
		5	industry structure			7	key personnel		
		6	market size			5	Management team	1	component of entrepreneurial teams
		7	industry growth rate					2	industry & technology experience of team
		8	productive capability of existing firms	3	Team integrity and honesty				
		9	availability of market share	4	Team awareness and honesty				
				10	cost structure	6	Fatal flaw		
2	economic	1	time to reach break-even point	7	Personal standards	1	consistence in personal & firm goals		
		2	whether break-even point can increase			2	risk of opportunity to entrepreneurs		
		3	potentiality of investment rate of return			3	opportunity cost		
		4	potentiality of internal rate of return			4	entrepreneurial Intentions		
		5	capital requirements of projects			5	risk / reward tolerance		
		6	growth rate of sales			6	stress tolerance		
		7	spontaneous flow capital		Strategic difference	1	consistence of drivers with environment		
		8	gross margin			2	team level		
		9	after-tax profit			3	service management		
		10	after-tax profit			4	access time		
		11	the capital requirement of R&D			5	technology breakthrough		
3	harvest conditions	1	strategic value	8	Strategic difference	6	strategic flexibility		
		2	valuation multiples			7	opportunity-oriented		
		3	withdrawal mechanism			8	pricing strategy		
		4	Capital market environment			9	distribution channels		
4	competitive advantage	1	fixed and variable costs			10	fault-tolerant space		
		2	the control of costs, prices and sales						

3.2 Grey-fuzzy assessment model

1) Determine the evaluation factors set. The evaluation factors set is:

$$U = \{u_1, u_2, \dots, u_8\}, \text{ where } u_i = \{u_{i1}, u_{i2}, \dots, u_{ij}, \dots, u_{in}\}, (i = 1, 2, \dots, 8).$$

2) Design an opportunity remark set. The opportunity remark set is designed as: $V = \{v_1, v_2, \dots, v_5\}$, v_1, v_2, \dots, v_5 respectively mean index remarks as "excellent", "good", "Medium", "poor" and "worst", the corresponding score of 5,4,3,2, 1.

3) Determine the weight set of evaluation indices. The weight is used to describe the relative importance of various indices to assessing purpose. Weights can be obtained by an average score calculated through experts' remarks in the form of distributed assessment, the Delphi method and AHP.

$$W = \{w_1, w_2, \dots, w_8\}, \text{ where } w_i \in [0,1] \text{ and } \sum_{i=1}^8 w_i = 1, (i = 1, 2, \dots, 8).$$

$$w_i = \{w_{i1}, w_{i2}, \dots, w_{in}\}, \text{ where } w_{ij} \in [0,1] \text{ and } \sum_{j=1}^n w_{ij} = 1, (j = 1, 2, \dots, n).$$

4) Organize assessment experts to remark each of evaluation factors for opportunities. Experts k (k=1, 2, ..., m) give remarks d_{ijk} to opportunities u_{ij} , then we can obtain an evaluation matrix D_i of the index i:

$$D_i = \begin{bmatrix} d_{i11} & d_{i12} & \dots & d_{i1m} \\ d_{i21} & d_{i22} & \dots & d_{i2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_{ij1} & d_{ij2} & \dots & d_{ijm} \end{bmatrix} \tag{1}$$

5) Establish the evaluation grey type. As constraints of experts' level and differences of cognition, we can just only give the number of a grey whitening value. In order to truly reflect the degree of a special category which experts' remarks belong to, we need to determine the whitening weight function [9]. According to score grading standards, we obtain five assessment grey categories: $e = 1, 2, \dots, 5$. And the evaluation remarks of the corresponding is respectively "excellent", "good", "medium", "poor", "worst." And the corresponding Whitening weight functions as follows [10]:

The first grey category is defined as "highest" ($e=1$). And design grey number as $\otimes_1 \in [5, \infty]$, the whitening weight function as f_1 :

$$f_1(d_{ijk}) = \begin{cases} d_{ijk} / 5 & d_{ijk} \in [0, 5] \\ 1 & d_{ijk} \in [5, \infty] \\ 0 & d_{ijk} \notin [0, \infty] \end{cases} \tag{2}$$

The second grey category is defined as "high" ($e=2$). And design grey number as $\otimes_2 \in [0, 4, 8]$, the whitening weight function as f_2 :

$$f_2(d_{ijk}) = \begin{cases} d_{ijk} / 4 & d_{ijk} \in [0, 4] \\ (8 - d_{ijk}) / 4 & d_{ijk} \in [4, 8] \\ 0 & d_{ijk} \notin [0, 8] \end{cases} \tag{3}$$

The third grey category is defined as "medium" ($e=3$). And design grey number as $\otimes_3 \in [0, 3, 6]$, the whitening weight function as f_3 :

$$f_3(d_{ijk}) = \begin{cases} d_{ijk} / 3 & d_{ijk} \in [0, 3] \\ (6 - d_{ijk}) / 3 & d_{ijk} \in [3, 6] \\ 0 & d_{ijk} \notin [0, 6] \end{cases} \tag{4}$$

The fourth grey category is defined as "low" ($e=4$). And design grey number as $\otimes_4 \in [0, 2, 4]$, the whitening weight function as f_4 :

$$f_4(d_{ijk}) = \begin{cases} d_{ijk} / 2 & d_{ijk} \in [0, 2] \\ (4 - d_{ijk}) / 2 & d_{ijk} \in [2, 4] \\ 0 & d_{ijk} \notin [0, 4] \end{cases} \tag{5}$$

The fifth grey category is defined as “lowest” (e=5). And design grey number as $\otimes_s \in [0,1,2]$, the whitening weight function as f_5 :

$$f_5(d_{ijk}) = \begin{cases} d_{ijk} / 1 & d_{ijk} \in [0,1] \\ (2 - d_{ijk}) / 1 & d_{ijk} \in [1,2] \\ 0 & d_{ijk} \notin [0,2] \end{cases} \quad (6)$$

6) Calculate the grey weight value r_{ije} of each d_{ijk} according to $f_e(d_{ijk})$ (e=1, 2, 3, 4, 5), and establish the fuzzy membership matrix. Suppose the evaluation ratio y_{ije} is the e-th evaluation grey category of opportunity assessment index u_{ij} , and $y_{ije} = \sum_{k=1}^m f_e(d_{ijk})$. The total grey evaluation ratio

is $y_{ij} = \sum_{e=1}^5 y_{ije}$ which belongs to u_{ij} . The fuzzy membership from u_{ij} to the remark set V is $r_{ije} = \frac{y_{ije}}{y_{ij}}$ and $\sum_{e=1}^5 r_{ije} = 1$. The single factor fuzzy evaluation matrix R_i of the evaluation index i is:

$$R_i = \begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i15} \\ r_{i21} & r_{i22} & \cdots & r_{i25} \\ \vdots & \vdots & \ddots & \vdots \\ r_{ij1} & r_{ij2} & \cdots & r_{ij5} \end{bmatrix} \quad (7)$$

7) Overall evaluation. The overall evaluation value of factor i is $B_i = [b_1, b_2, \dots, b_5] = w_i \circ R_i, (i = 1, 2, \dots, 8)$, and the symbol “ \circ ” means weighted calculation.

$$R = [B_1, B_2, \dots, B_8]^T \quad (8)$$

Then calculate R using the fuzzy matrix, and we can obtain a systemic fuzzy assessment matrix M:

$$M = [M_1, M_2, \dots, M_5] = W \circ R \quad (9)$$

At last, we know the overall evaluation value of opportunities through $C = M \cdot V^T$.

4 A Practical Example

In this paper, we study an entrepreneurial team in Hefei, and use the evaluation index system and model to evaluate the entrepreneurial opportunities which they face. The team was formed in September 2009 and has 6 members, whose average age is 26 years old. And most of members have associate degree. In the early years, the team's principal business is agent of SIM cards and network cards of telecommunications carriers. Now the team has developed to have five self-employed business hall and act for a comprehensive range of business operators. Now the team faces the choice of the following three opportunities.

Opportunity S1: increase sales of SIM cards and network cards and focus on becoming an outstanding agent of operators.

Opportunity S2: develop application software, and commit to becoming an application developer in the 3G industry, such as remote medical care system.

Opportunity S3: run hotel chain, and commit to being a well-known regional chain hotel.

Invite five experts in the University of Science and Technology School of China of Management to score 53 indices of the evaluation system. And then calculate the average of each index. At last, obtain all the weights of the one-grade and two-grade indices.

$$W = \{0.111, 0.115, 0.123, 0.112, 0.135, 0.145, 0.125, 0.135\}$$

$$w_1 = \{0.137, 0.080, 0.089, 0.061, 0.105, 0.099, 0.125, 0.105, 0.112, 0.086\}$$

$$w_2 = \{0.089, 0.070, 0.115, 0.112, 0.087, 0.098, 0.075, 0.089, 0.109, 0.070, 0.086\}$$

$$w_3 = \{0.266, 0.295, 0.216, 0.223\}$$

$$w_4 = \{0.136, 0.163, 0.158, 0.090, 0.127, 0.122, 0.204\}$$

$$w_5 = \{0.301, 0.268, 0.196, 0.235\}$$

$$w_6 = \{1.000\}$$

$$w_7 = \{0.175, 0.170, 0.142, 0.165, 0.170, 0.179\}$$

$$w_8 = \{0.073, 0.110, 0.115, 0.107, 0.102, 0.094, 0.084, 0.068, 0.081, 0.065\}$$

Please five experts in the University of Science and Technology School of China of Management to score every assessment indices of three opportunities. And obtain the evaluation matrix. Then calculate the evaluation matrix according to approaches from part III. At last, we gain the fuzzy assessment matrix of three opportunities.

$$M^{S1} = [0.3450, 0.3210, 0.0728, 0.0176, 0.0012]$$

$$M^{S2} = [0.2602, 0.2752, 0.0616, 0.0284, 0.0032]$$

$$M^{S3} = [0.2114, 0.2518, 0.0592, 0.0482, 0.0019]$$

$V = \{5, 4, 3, 2, 1\}$, according to $C = M \cdot V^T$, we can calculate the overall values of three opportunities, respectively as 3.2637, 2.6468, 2.3397. So opportunity S1 is the best appropriate opportunity to the team.

5 Conclusions

The entrepreneurial opportunity evaluation approach based on grey-fuzzy assessment has two advantages. First, it rationally makes use of experts' knowledge to overcome evaluator's subjective dependence. Second, it considers the effect of cross-cutting and coupling between evaluation indices on projects, reducing the difficulty of the evaluation index system measurement and the human factor error during the evaluation process. The empirical study implies that the grey-fuzzy evaluation method is feasible and effective to evaluate entrepreneurial opportunities.

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