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IMPROVED AHP-GROUP DECISION MAKING FOR INVESTMENT STRATEGY SELECTION

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Abstract. Investment strategy selection relies heavily on personal experience and behavior. This paper proposes an improved Analytical Hierarchy Process-group decision making (IAHP-GDM) model to reduce investment risk. This model applies the method of least squares to adjust group decision matrix in order to satisfy the property of positive reciprocal matrix in AHP. In addition, five experts from related fields are invited to evaluate investment risk that takes group wisdom to eliminate personal bias. An empirical study is conducted to compare the proposed model to AHP for group decision making model. The results show that the IAHP-GDM model is not only accurate and effective, but also consistent with realistic investment environment.

Keywords: group decision making, Analytic Hierarchy Process, MCDM, investment management.

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1. Introduction

There are many risks in investment strategy selection, such as social risk, policy risk, economical risk, credit risk, technological risk, interest rate risk and operating risk (Kent 1992; Better *et al.* 2008; Gao *et al.* 2008; Li *et al.* 2009; Peng *et al.* 2009, 2010; Shen 2009; Liaudanskienė *et al.* 2010), contract's risks (Zavadskas *et al.* 2010; Boguslauskas *et al.* 2011). Shyng *et al.*

(2010) suggest that past experiences of individuals usually affect their attitudes when they made investment decisions. In an attempt to make better investment decisions, many studies have been conducted to evaluate investment strategy and its risk (Metrick 1999; Bayraktar, Young 2010; Ba *et al.* 2011).

Over the past few decades, investment management has been an active research area (Barry, Starks 1984; Froot 1993; Jorion 2000; Malkiel 2003; Arljukova 2008; Binsbergen *et al.* 2008; Busse *et al.* 2010; Stoughton *et al.* 2011). From the investor's perspective, the decision process can be roughly divided into four components: problem recognition, information search, evaluation of alternatives and investment decision (Shyng *et al.* 2010; Keršulienė, Turskis 2011). The most important part is the evaluation of alternatives, which could create the best investment strategy for satisfying the investors' needs. The analytical hierarchy process (AHP) is often implemented in the risk evaluation to improve the effectiveness of investment management and decision analysis (Wijnmalen 2007). However, when establishing the judgment matrix by expert scoring, the AHP method is subjective, the evaluation result is not objective and sometimes different experts may reach different conclusions.

Consulting multiple experts reduces bias when the judgments are provided by a single expert (Ishizaka, Labib 2011). This paper proposes IAHP-GDM model for evaluation of investment alternatives, which not only overcomes the disadvantage of subjective decision, but also takes group wisdom to eliminate the bias generated by personal preferences. The method of Least squares (Cassel *et al.* 1999; Bozóki 2008; Yu *et al.* 2009) is introduced to revise group decision making matrix to become the positive reciprocal matrix.

The remaining part of this paper is organized as follows. Section 2 reviews the related works. Section 3 introduces some foundations of AHP and a previous proposed model: AHP for group decision making. Section 4 describes the IAHP-GDM model. In Section 5, an illustrative case of investment strategy selection is conducted to compare the IAHP-GDM model to the previous proposed AHP for group decision making model. Section 6 concludes the paper.

2. Related works

The AHP was introduced by Saaty in 1970s, and has been identified as an important method to solve multi-criteria decision-making problems of choice and prioritization (Satty 1978, 1979, 1980, 1986, 2003, 2006). AHP has been applied to solve many types of decision problems (Wind, Saaty 1980; Handfield *et al.* 2002; Li, Ma 2008; Nieto-Morote, Ruz-Vila 2011; Peng *et al.* 2011a).

In AHP method, the calculated priorities are suitable only if the pair-wise comparison matrix passes the consistency test when the reciprocity rule is respected within the pair-wise comparison process (Ishizaka, Lusti 2004). The pair-wise comparison matrix is composed of elements presented in a numerical scale, which is provided by decision makers based on their experiences and expertise. Thereby, the pair-wise comparison matrix could be inconsistent due to the limitations of experiences and expertise as well as the complexity nature of decision problem (Ergu *et al.* 2011a).

With the social development and technology advancement, decision-making process has also become more and more complex. It is often difficult to make a scientific and accurate decision-making only by single decision maker. The reasons are as follows (Kim, Ahn 1997):

1) A decision is usually made under time pressure, lack of knowledge and data cases.

2) Many of the attributes are difficult to quantify.

3) Single decision maker has limited expertise and information processing capacity, especially in complex and uncertain environment.

4) In group setting, all participants do not have equal expertise about the same problem. Their views can hardly be uniformed. Therefore, in order to reduce the decision-making mistakes, many important decisions are made by multiple decision makers, especially in companies or organizations.

Many researchers consider the AHP method to be well suited for group decision making due to its role as a synthesizing mechanism (Dyer, Forman 1992; Bard, Sousk 1990), where group members can use their experience and expertise to break down a problem into a hierarchy and solve it by the AHP steps (Kamal, Al-Subhi 2001). However, group decisions involving participants with common interests are typical of many organizational decisions (Alfares, Duffuaa 2008; Kamal, Al-Subhi 2001; Rao, Peng 2009; Wei, Tang 2011). There are four ways to combine the preferences into a consensus rating showed in the Table 1 (Ishizaka, Labib 2011).

Table 1. Four ways to combine preferences (Ishizaka, Labib 2011)

		Mathematical aggregation	
		Yes	No
Aggregation on	Judgments	Geometric mean on judgments	Consensus vote on judgments
	Priorities	Weighted arithmetic mean on priorities	Consensus vote on priorities

There are a few studies in AHP integrated the group decision-making. Korpela and Tuominen have applied this method to assess the applicability of the AHP in defining the goals of distribution logistics (Korpela, Tuominen 1997) and to analysis the project's logistics department in group settings (Korpela, Tuominen 1995). Dyer and Forman (1992) argued that AHP can help group decision-makers structure complex decisions, and synthesize measures of both tangibles and intangibles. However, the pair-wise comparison matrix could be inconsistent due to the limitations of experiences and expertise.

3. Preliminaries

Multi-criteria decision making (MCDM) method is a decision-making analysis method, which has been developed since 1970s. MCDM is the study of methods which concerns about multiple conflicting criteria (Choi, Woo 2011; Peng *et al.* 2011b; Soylu 2010; Kou *et al.* 2012). In the following sub-sections, we present the concepts of AHP, one of the widely used MCDM methods, and introduce AHP for group decision making method presented by Wu *et al.* (2011).

3.1. AHP

The analytic hierarchy process (AHP) proposed by Saaty (1980) is a widely used decision making analysis tool for modeling unstructured problems in political, economic, social, and management sciences (Levary, Wan 1998; Chang 1996; Tupenaite *et al.* 2010; Lin 2010; Cheng *et al.* 2011; Ergu *et al.* 2011b; Wu *et al.* 2010; Medineckienė, Björk 2011). Pair-wise comparison is an important part in AHP, completed by the experts (Kamal, Al-Subhi 2001; Liu, Shih 2005). Based on the pair-by-pair comparison values for a set of objects, AHP is applied to elicit a corresponding priority vector that represents preferences (Yu 2002).

3.2. AHP for group decision making

Analytic hierarchy process (AHP) for group decision-making model is applied to determine the index weight presented by Wu *et al.* (2011). There are three steps. First, the original index weight of each expert is calculated by applying AHP. Second, each expert weight is determined for group decision making. Finally, the index weight is obtained by considering each expert weight. Based on the size of criteria weight, AHP for group decision making is used to elicit the corresponding alternative priorities.

3.2.1. Determine original index weight

AHP is a decision-aiding method developed by Saaty (1985, 1990), Saaty, Zoffer (2011) to quantify relative priorities for a given set of alternatives on a ratio scale, based on the judgment of the decision-maker, and stress the importance of the intuitive judgments of a decision maker as well as the consistency of the comparison of alternatives in the decision-making process (Saaty 1980). The AHP approach has recently become popular in assessing criteria weights in various multi-criteria decision making problems. It elicits a corresponding priority vector interpreting the preferred information from the decision makers, based on the pair-wise comparison values of a set of objects. Since pair-wise comparison values are the judgments obtained from an appropriate semantic scale. AHP method is applied to determine original index weight.

3.2.2. Determine expert weight for group decision-making

AHP allows group decision making, where group members can use their experience and expertise to break down a problem into a hierarchy and solve it by the AHP steps (Kamal, Al-Subhi 2001). Since different experts have different criteria preferences, it is essential to give a certain weight for each expert. Assume there are n experts for group decision making.

First, we determine the pair-wise comparison matrix $A=(a_{ij})_{m\times m}$, and the corresponding consistency ratio CR_k^t is obtained by AHP, $t\ (1\le t\le T)$ is the number of pair-wise matrix in AHP determined by each expert, $k\ (1\le k\le n)$ is the number of the experts. Then, the k^{th} expert weight P_k can be calculated by the following formula:

$$P_k^t=\frac{1}{1+\alpha CR_k^t}\ \ (\alpha>0, 1\le k\le n, 1\le t\le T). \qquad (1)$$

$$P_k = \frac{\sum_{t=1}^{T} P_k^t}{T} \quad (1 \le k \le n, 1 \le t \le T)\,. \tag{2}$$

When the parameter value α is too large or too small, the expert weight is usually difficult to be distinguished. In practice, the value of α is usually set to 10, to offer moderate distinguishing effects and good stability. Finally, the expert weight P_k^* can be obtained by normalizing formula (2) as follows:

$$P_k^* = \frac{p_k}{\sum_{k=1}^{n} P_k} \quad (1 \le k \le n)\,. \tag{3}$$

3.2.3. Determine final index weight

The final index weight is determined based on original index weight $W_i^k (1 \le i \le m)$ by AHP, and considered of expert weight P_k^*. This paper firstly applies AHP to get the original index weight W_i^k, and then takes expert weight P^* in group decision-making into account. The final index weight can be calculated as:

$$W_i = \sum_{k=1}^{n} W_i^k \cdot P_k^* \quad (1 \le k \le n, 1 \le i \le m)\,. \tag{4}$$

Finally, the index weight W_i^* of the i^{th} index can be normalized:

$$W_i^* = \frac{W_i}{\sum_{i=1}^{m} W_i} \quad (1 \le i \le m)\,. \tag{5}$$

When calculating the final index weight, the revised AHP introduces a number of experts to evaluate index weight in order to avoid different decision-making preferences by experts. This method introduces less subject judgment in decision matrix by combining the opinions of different experts.

4. Proposed model: IAHP-GDM

In the process of traditional AHP method, the key step is to determine the hierarchy structure in order to achieve the criteria weights, and in general, the matrix is determined by expert scoring. Because comparison matrix is one of the most important parts in AHP, there exist many studies in comparison matrix (Carmone *et al.* 1997; Fedrizzi, Giove 2007; Cao *et al.* 2008; Ergu *et al.* 2011c). The pair-wise comparison values are the judgments obtained by a suitable semantic scale. Therefore it is unrealistic to expect that the decision makers have either complete information or a full understanding of all aspects of the problem (Chang 1996; Levary, Wan 1998; Ergu *et al.* 2011b). In this paper, based on the previous research, we consider the views of multi-experts, and propose an IAHP-GDM model. In order to improve the evaluation accuracy away from the expert's subjective preferences as much as possible, we invite five experts from related fields to judge, and make the comprehensive analysis on the comparison matrix of each expert. In addition, when constructing the group decision making matrix, there is usually a disadvantage that the positive reciprocal property is not satisfied. Thereby, in this paper, the method of least squares (Bozóki, Lewis 2005; Liu *et al.* 2011) is further applied to improve group decision making matrix which makes the matrix satisfy positive reciprocal property. The steps are as follows:

1) Judge the relative importance of pair-wise indicators to the target in terms of expert scoring. Assume there are k ($1 \le k \le n$) experts, two indicators a, and b. The corresponding scores provided by expert k_1 are r_1 and r_2, respectively. Then the relative importance of a is $a_{k_1} = \frac{r_1}{r_2}$, and the relative importance of b is $b_{k_1} = \frac{r_2}{r_1}$.

2) Determine the overall relative importance of indicators to the targets. Since different experts have different knowledge, experiences, preference and so on, when calculating the overall relative importance of indicators to the targets, the maximum score and the minimum score should be removed. Therefore, the overall relative importance of indicator a and b to the target are $\frac{1}{m-2}\sum_{i=1}^{m-2} a_{k_i}$ $(1 \le i \le m)$ and $\frac{1}{m-2}\sum_{i=1}^{m-2} b_{k_i}$ $(1 \le i \le m)$ respectively.

3) Determine group decision making matrix according to the overall relative importance of each indicator to the target. This method to determine the group decision making matrix improves the accuracy and scientific level of AHP method.

4) Optimize group decision making matrix based on the method of least squares. Assume k experts give $A_1, \cdots A_k$ comparison matrices respectively. It is easy to know that each $A_k (1 \le k \le n)$ is positive reciprocal matrix. Let λ_l $(1 \le l \le n)$ be the weight coefficient of each expert, and it is a comprehensive quantitative indicator measuring expert's ability level. Assume each expert weight is the same, which is $\frac{1}{n}$. Then, gather all pair-wise comparison matrices provided by each expert to get group decision making comparison matrix $B = (\lambda_1 A_1 + \lambda_2 A_2 + \cdots \lambda_n A_n) = (b_{ij})_{m \times m}$, it is obvious to get $b_{ij} = \sum_{k=1}^{n} \lambda_i a_{ij}^{(k)}$ $(1 \le i \le m, 1 \le j \le m, 1 \le k \le n)$.

It is easy to get that matrix B cannot meet the reciprocal property. In this article, the method of least square is applied to revise group decision making comparison matrix B, and get another matrix B^*, which is very close to B and meets the positive reciprocal property. The specific steps are as follows:

First of all, we get the least squares mathematical programming problems:

$$\min \sum_{i=1}^{m}\sum_{j=1}^{m}(x_{ij} - b_{ij})^2$$
$$s.t. \begin{Bmatrix} x_{ij} \times x_{ji} = 1 \\ x_{ij} > 0 \ \ (1 \le i \le m, 1 \le j \le m) \end{Bmatrix}. \quad (6)$$

From the above characteristics of optimization problem of objective function, according to $x_{ij} = \frac{1}{x_{ji}}$, the question above can be changed into:

$$\min \left\{ \begin{array}{l} (x_{12} - b_{12})^2 + (\frac{1}{x_{21}} - b_{21})^2 + \cdots + (x_{1m} - b_{1m})^2 + (\frac{1}{x_{m1}} - b_{m1})^2 + \\ \cdots + (x_{m-1,m} - b_{m-1,m})^2 + (\frac{1}{x_{m,m-1}} - b_{m,m-1})^2 \end{array} \right\}. \quad (7)$$
$$s.t.\ x_{ij} > 0 \ \ (1 \le i \le m, 1 \le j \le m)$$

By mathematical derivation, the above problem can be further broken down as sub-problems:

$$\min \left\{ (x_{ij} - b_{ij})^2 + (\frac{1}{x_{ji}} - b_{ji})^2 \right\} . \quad (8)$$
$$s.t.\ x_{ij} > 0 \ \ (1 \le i \le m, 1 \le j \le m)$$

Let
$$f(x) = (x_{ij} - b_{ij})^2 + (\frac{1}{x_{ij}} - b_{ji})^2 . \quad (9)$$

When $x_{ij} \to 0$ or $x_{ij} \to +\infty$, the minimum value of $f(x) \to +\infty$ must be the stagnation, therefore it should further to satisfy:

$$2(x_{ij} - b_{ij}) + 2(\frac{1}{x_{ij}} - b_{ji})(-\frac{1}{x_{ij}^2}) = 0 . \quad (10)$$

Finally, we can get:

$$x_{ij}^4 - b_{ij}x_{ij}^3 + b_{ji}x_{ij} - 1 = 0 . \quad (11)$$

Find out all its positive solution which makes $f(x)$ the minimum. The solving process can be completed by the MATLAB.

5) Determine the preference order of each alternative. The procedures are consistent with the traditional AHP method.

Above all, the steps of the improved AHP based on the method of least squares can be summarized as follows:

Step 1: Determine the original comparison matrix $A_k = (a_{ij})_{m \times m}$ according to expert scoring.

Step 2: Determine the final overall relative importance between indicators to the targets.

Step 3: Determine group decision making matrix $B = \sum_{k=1}^{n} \lambda_k A_k$ according to the final overall relative importance of indicators to the targets.

Step 4: Determine the final group decision making comparison matrix by the method of least squares. According to the least squares mathematical programming function, for $1 \le i \le m, 1 \le j \le m$, find out all the positive solutions of $x_{ij}^4 - b_{ij}x_{ij}^3 + b_{ji}x_{ij} - 1 = 0$ by MATLAB, and mark b_{ij}^* which make the function $f(x) = (x - b_{ij})^2 + (\frac{1}{x} - b_{ji})^2$ get minimum value. Let $b_{ji}^* = \frac{1}{b_{ij}^*}$, and it is easy to get $B^* = (b_{ij}^*)_{m \times m}$ which is a final group decision making comparison matrix and meets positive reciprocal matrix.

Step 5: Determine the preference order of each alternative according to the standard AHP steps.

5. Empirical studies

In this section, an empirical study on investment strategy selection is displayed to illustrate the application of our proposed model for evaluating and selecting the best investment alternative of fund investment, bonds investment, stock investment, and real estate investment.

5.1. Problem description

As the number of alternative investment opportunities brought out, financial advisers have played a more and more prominent role in allocating assets and investment plan (Stoughton *et al.* 2011). And a well-made financial investment plan can help to achieve good asset allocation. The investment strategy selection is essential to decrease loss caused by risks and win better investment benefit. With regard to financial hardship, research suggests that the past experiences and expertise of individuals usually affect their attitudes towards making investments (Shyng *et al.* 2010). In this paper, we focus on identifying different types of information and criteria to select the best investment strategy which create more personalized investment alternative for satisfying the investors' needs. Thereby, IAHP-GDM model is proposed for evaluation of the investment alternative to select the best investment strategy.

5.2. Decision hierarchy structure and index system

There are many risk classifications in investment management, such as systemic risk, market risk, industry risk and so on. To evaluate the investment strategy, decision hierarchy structure and eight important criteria are determined by the experience and expertise of the expert team and by reviewing existing literatures (Teichroew *et al.* 1965; Davanzo, Nesbitt 1987; Fried, Hisrich 1994; Ginevičius, Zubrecovas 2009). The expert team is composed of five experts in the field of investment. And we select fund investment, bonds investment, stock investment and real estate investment as the assessment objects. The decision hierarchy structure is presented in Figure 1.

In Figure 1, there are four levels in the decision hierarchy structure for investment strategy selection. The overall goal of the decision process is determined as "Select best investment strategy: A". It is the first level of the hierarchy structure. The criteria level is the second level including "Profitability: B1" and "Security: B2", which is the standard measuring whether the target can be achieved. The third level is the sub-criteria level including eight criteria: "Investment opportunities: C1", "Liquidity: C2", "Prospect: C3", "Expected profit: C4", "Payback period: C5", "Transaction costs: C6", "Interest rate risk: C7" and "Credit risk: C8". The final level of hierarchy structure, that is the fourth level, is investment alternative level including "Fund investment: D1", "Bonds investment: D2", "Stock investment: D3" and "Real estate investment: D4".

5.3. Empirical analysis

In this section, an empirical case is conducted to verify the proposed model in comparison with AHP for group decision making proposed by Wu *et al.* (2011). After conducting the decision hierarchy structure for solving investment problem, the pair-wise comparison matrix

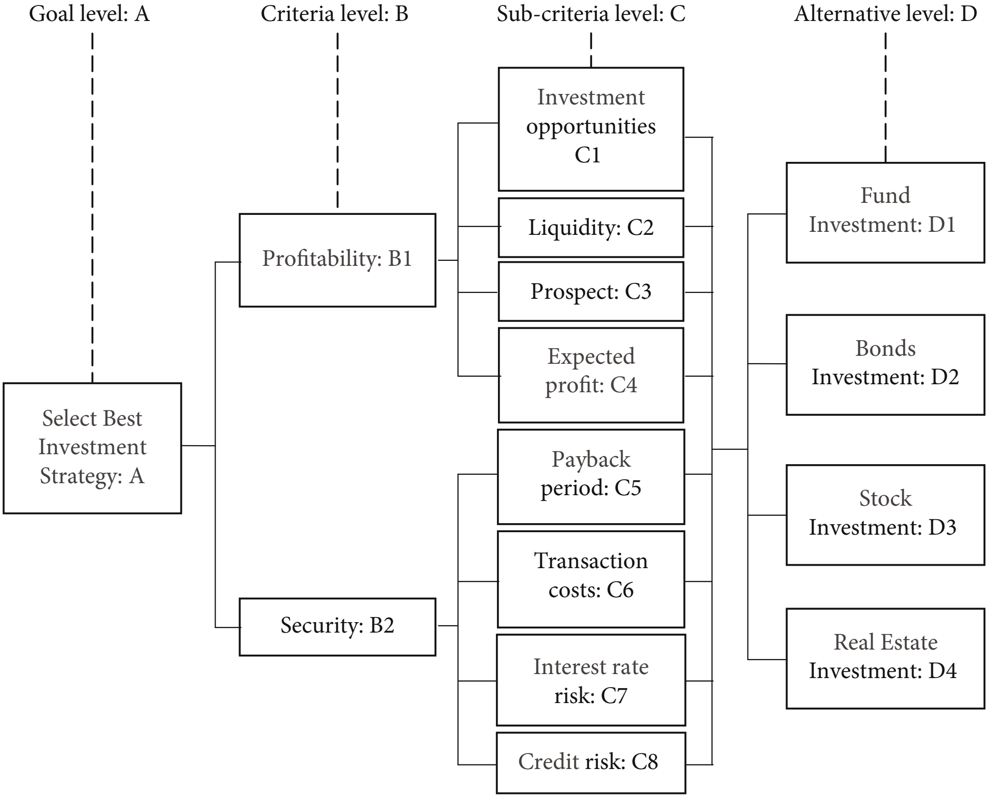

Fig. 1. The hierarchical structure of the decision making problem

used in evaluation process is calculated by the proposed model. In order to eliminate the bias generated by personal preferences, we consulted five experts to construct pair-wise comparison matrix by researching on investment market. And, the pair-ware comparison matrix is obtained by expert scoring, as shown in the Table 1–11 of Appendix. In the experiment, first of all, we introduce the current IAHP-GDM model for investment strategy selection. Then, the previous model (Wu *et al.* 2011) is applied as comparison analysis to illustrate that the proposed model in this paper is effective and efficient. The specific process is as follows:

First of all, the IAHP-GDM model is applied to select the best investment strategy for investment management. The evaluation process is as follows:

1) Determine group decision making comparison matrix according to the steps 1–3. The group decision making matrix is the key step of the proposed model.

2) Determine the final group decision making comparison matrix revised by the method of Least squares according to the step 4. In addition, the criteria weight and consistency test are determined by the standard AHP steps.

3) Determine the preference order of each alternative according to step 5. The results are showed in Table 2. From Table 2, we can get that the real estate investment is the best investment strategy, followed by stock investment, fund investment, and bonds investment.

Table 2. Alternative rank of IAHP-GDM model

Investment Strategy	Evaluation Value (EV)	Rank
Bonds Investment	0.1399	4
Fund Investment	0.1865	3
Stock Investment	0.3095	2
Real Estate Investment	0.3641	1

Then, the previous model presented by Wu *et al.* (2011) is applied to determine the alternative rank by comparison to illustrate that the current proposed model is effective and efficient. There are three steps as follows:

1) Determine original index weight. The original index weight according to each expert is calculated by applying AHP.

2) Determine expert weight. Each expert weight for group decision making is determined by the formula in the Section 3.2.2. By calculating, the weight of five experts is obtained as 0.1960, 0.2193, 0.2090, 0.1783 and 0.1974.

3) Determine alternative rank. The final index weight is obtained by considering each expert weight. According to the final index weight, alternative rank can be determined by the Section 3.2.3.

To illustrate which method is more effective, comparison analysis and difference degree analysis are applied for evaluation. The results are showed in the Table 3.

Table 3. Result comparison

Investment Strategy	AHP for group decision-making			IAHP-GDM model		
	EV	Rank	DD	EV	Rank	DD
Bonds Strategy	0.1853	4	3.35%	0.1399	4	33.31%
Fund Strategy	0.1915	3	53.00%	0.1865	3	65.95%
Stock Strategy	0.2930	2	12.70%	0.3095	2	17.64%
Real Estate Strategy	0.3302	1		0.3641	1	

EV: Evaluation Value; DD: Different Degree

In Table 3, the ranks of investment strategy of the two models are the same. The rank of real estate investment, stock investment, fund investment and bonds investment is 1, 2, 3, 4. The best investment strategy is real estate investment, followed by stock strategy, fund strategy, and the worst is bonds investment. The most effective investment strategy to achieve maximum profits is real estate investment. However, which method is better? Different degree analysis on investment strategy is further applied, as shown in the Table 3. The calculation of the different degree can be obtained as follows: Assume there are two alternatives: A, and B, the different degree of A and B alternatives is defined as:

$$\text{different degree} = \frac{BEV - AEV}{AEV} \times 100\% . \tag{12}$$

For example, the different degree of Bonds Strategy and Fund Strategy in IAHP-GDM model is calculated as follows:

$$\text{different degree} = \frac{0.1865 - 0.1399}{0.1399} \times 100\% = 33.31\% \,. \tag{13}$$

From Table 3, we can see that different degrees obtained by IAHP-GDM are larger than those obtained by AHP for group decision-making model, which indicate that the proposed model is more accurate and effective than AHP for group decision-making model.

6. Conclusion

In an uncertain economic decision environment, investors face the unprecedented challenges and opportunities. In order to make the investment decision reduce loss caused by risks and achieve better investment benefit, this paper proposes an IAHP-GDM model for investment strategy selection. In this model, the maximum score and the minimum score are removed when group decision making is conducted to make the decision fair and justice. The method of least squares is applied to revise group decision making matrix to satisfy positive reciprocal property of AHP. In addition, five experts from related research field are invited to evaluate investment risk problem that takes group wisdom to eliminate the bias generated by personal preferences. An empirical study compares the proposed model to the previous research model. The results show the proposed model in this paper is more accurate and effective, and the research results are consistent with realistic investment environment. These findings support the view that this proposed model can offer good investment strategies for better investment management.

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Appendix

Table 1. B-A level comparison matrix of five experts

B-A	Profitability: B1	Security: B2
Expert 1	8	6
Expert 2	7	7
Expert 3	5	7
Expert 4	7	4
Expert 5	3	7

Table 2. C-B1 level comparison matrix of five experts

C-B1	Investment opportunities: C1	Liquidity: C2	Prospect: C3	Expected profit: C4
Expert 1	8	7	7	6
Expert 2	5	6	5	7
Expert 3	6	5	7	8
Expert 4	9	8	7	5
Expert 5	4	6	5	8

Table 3. C-B2 level comparison matrix of five experts

C-B2	Payback period: C5	Transaction costs: C6	Interest rate risk: C7	Credit risk: C8
Expert 1	5	7	9	8
Expert 2	6	7	7	8
Expert 3	8	6	6	8
Expert 4	4	6	9	7
Expert 5	7	6	5	8

Table 4. D-C1 level comparison matrix of five experts

D-C1	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	5	3	8	7
Expert 2	7	6	7	8
Expert 3	6	7	3	5
Expert 4	4	2	8	7
Expert 5	7	8	4	7

Table 5. D-C2 level comparison matrix of five experts

D-C2	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	7	6	9	7
Expert 2	7	3	6	8
Expert 3	7	8	3	5
Expert 4	4	3	8	6
Expert 5	5	6	4	8

Table 6. D-C3 level comparison matrix of five experts

D-C3	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	6	7	4	8
Expert 2	7	4	5	9
Expert 3	4	7	3	6
Expert 4	5	2	8	7
Expert 5	4	5	7	8

Table 7. D-C4 level comparison matrix of five experts

D-C4	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	6	3	8	5
Expert 2	6	4	6	8
Expert 3	6	5	7	4
Expert 4	5	3	9	7
Expert 5	4	6	7	9

Table 8. D-C5 level comparison matrix of five experts

D-C5	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	4	8	2	7
Expert 2	8	5	7	7
Expert 3	6	6	8	7
Expert 4	7	3	9	8
Expert 5	5	6	8	9

Table 9. D-C6 level comparison matrix of five experts

D-C6	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	7	8	7	4
Expert 2	7	6	7	8
Expert 3	6	7	5	6
Expert 4	7	6	9	8
Expert 5	7	6	4	8

Table 10. D-C7 level comparison matrix of five experts

D-C7	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	4	2	3	5
Expert 2	6	7	7	7
Expert 3	6	8	5	6
Expert 4	5	4	8	6
Expert 5	3	5	8	6

Table 11. D-C8 level comparison matrix of five experts

D-C8	Fund Investment	Bonds Investment	Stock Investment	Real Estate Investment
Expert 1	4	2	7	5
Expert 2	5	8	7	6
Expert 3	6	7	4	5
Expert 4	5	3	8	7
Expert 5	4	4	2	6

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