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Derivative Analysis of Financial Instruments for Risk Management of Small and Medium-Sized Enterprises Based on Fuzzy Evaluation

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ABSTRACT

With the deepening of economic globalization and the intensification of market competition, risk management has become a crucial task for enterprises. This article aims to analyze the development of financial instruments for risk management of small and medium-sized enterprises based on fuzzy evaluation. Firstly, we will introduce the basic principle and application of the fuzzy evaluation method and then analyze its application in risk management, especially for small and medium-sized enterprises. Next, we will elaborate on the main methods and applications of risk management financial instrument derivatives based on fuzzy evaluation, including selecting financial instruments, risk assessment, and response strategies. Finally, we will demonstrate the application and effectiveness of this method in practice through specific case studies and explore future development directions and challenges.

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1. Introduction

The vigorous development of the financial industry in China shows its strong vitality and influence because it adapts to and meets the needs of China's economic growth. In addition, people have more choices for managing and delivering their own funds and find their own channels to withstand or avoid the growing investment risk [1]. From the development experience of developed countries, industrial capital and financial capital will eventually be integrated deeply into the growth process of large-scale enterprises. Then, a complete chain of funds is formed. Hence, service and innovation become capable assistants for enterprises to continue moving forward [2]. Then, the timely emergence of derivative financial instruments helps enterprises to circumvent financial risks more effectively; at the same time, greater benefits can be created, even using the risk to create benefits [3].

The main bodies of international economic activities are enterprises of different scales

[4]. In the context of global economic integration, any change of the economic strategy will bring many certain or uncertain factors for enterprises and make the enterprise's finances face some unknown risks; the so-called good and bad is probably its meaning [5]. If enterprises desire to avoid financial risks, derivative financial instruments become more convenient; this is also an important reason that the derivative financial instruments can cover a thousand li in a single day and get the development. However, the double-edged nature of the financial instruments also means that there are more or less negative influences while gaining profits [6].

2. State of the Art

Hydropower projects belong to the scope of people's livelihood infrastructure; their construction scale is large, and the construction period is long, which involves many types of work; the technology and construction links are complex and small. These features are unmatched by other projects [7]. Although small hydropower projects can be refined in terms of size and cycle, the support obtained at the aspect of technical support, material support, management level and cultural law is also relatively small, and it can be said that the complexity and uncertainty of small hydropower projects are much higher than the large hydropower project [8].

Once the small hydropower project enters into the development stage, it means a steady stream of resources. Behind every resource investment, there is an independent risk. When all the risks are gathered together, the situation becomes very complicated, and the process becomes very difficult. Suppose the risk management awareness of the business managers is weak, and the risk management mechanism within the enterprise is not perfect. In that case, the recognition and judgment in the early stage of risk are lacking, and the fate of the enterprise becomes precarious [9]. Based on this realistic situation, studying the risk management of small hydropower projects and increasing their core competitiveness is necessary [10].

The research object of this paper is a small hydropower energy development project. Then, the theory and method of the study are the risk management theories. The purpose of this study is to identify, analyze and establish the risk assessment model, combine the actual situation of the project to determine the schemes and measures to prevent and deal with the risks to ensure the smooth development of various projects, maximize the protection of corporate income and achieve business development goals.

3. Methodology

3.1. Research on Derivative Financial Instruments and its Risk Monitoring

Derivative financial products are essentially financial contracts whose value depends on one or more underlying assets and indices. There are several types of derivative financial products: forward, futures, swap (swap), options and the combination forms of these basic types [11].

Finance and accounting give different explanations for the definition of derivative financial products.

Finance regards the derivative financial instruments as a tool to avoid the financial risks of the market, which is developed and enriched with the complex degree of financial risk management, and it can be seen as an upgraded version of basic financial instruments, only its connotation is relatively richer. So, the definition in finance is like this: the generated value and the price of relevant subject matter and its changing trend are generated based on future bilateral relationships or contractual agreements. The subject mainly includes goods, bonds, interest rates, exchange rates and various economic indicators. In short, derivative financial instruments are contracts for regulating and restraining the subject matter [12].

For the understanding of accounting to the derivative financial instruments, the discipline uses an abstract method, and the more is to carry out a series of determinations to the scope of application of various types of derivative financial instruments from the logical perspective. However, it seems that this determination to the description of the extension boundary is not clear, which is not convenient in the actual operation process, and it is also difficult to popularize. Derivative financial instruments have a role in future contracts. However, the company has assets and liabilities, which should be incorporated into the accounting system to show the company's operations more completely and objectively. Therefore, accounting should use this as a research focus to guide the subject in defining derivative financial instruments [13].

Figure 1. Risk management of water conservancy and hydropower energy projects

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There are several main risks of derivative financial instruments: the first is the forward contract risk. The most significant feature of this risk is that both the revenue and the risk coexist; the profit and the risk increase proportionally. For example, long-term foreign exchange contracts and long-term interest rate contracts are closely combined with the market; once the exchange rate or interest rate changes, the risk and income will fluctuate significantly. So mature markets like long-term contract risk, while in the areas with low credit levels and high mobility, the long-term contract risk is not applicable.

The second is the financial futures risk. It is characterized by the fact that the risks and benefits are fully open, all the rules follow the standard, and the margin system is used to ensure its performance. Then, the margin ratio is generally between 1% -5%, and this 1% -5% of leverage effects generated by the margin are used to reflect or even change the entire futures market, which looks at a leopard through a tube, and is a straw in the wind, so as to make more rational judgments.

The third is the financial options risk. Financial option risk assumes that buyers' and sellers' information and resource distribution are unequal. The seller bears most of the risks, and the buyer has more financial rights. he can also ask the seller to fulfil more financial obligations. Therefore, at the time of that the market is conducive to the buyer, he can ask the seller to fulfill the contract content, and in the case that the financial market is not conducive to the buyer, the loss is only the option fee. The rest of the losses are all borne by the seller.

The fourth is the financial swap risk. This is trade behavior outside the market that reflects the characteristics required by both sides of the transaction. The two sides can exchange money, interest rates, options, debts, etc., but these exchanges are not free to happen; they must comply with the market transaction regulation [14-15].

3.2. Risk Analysis and Evaluation of Small Hydropower Projects

Fuzzy risk management evaluation method: although the small hydropower energy project is small, many factors are involved. Each factor may have a decisive impact on the entire project, and the factors are intertwined, which makes the risk estimation and judgments very complex, so it is difficult and unrealistic to use classical mathematical methods to solve the risk of the market. The fuzzy comprehensive evaluation method overcomes the shortcomings of the classical mathematics method. It relies on the actual evaluation process, admits the difficulties in the evaluation process, directly confronts the differences of opinions in the expert review process and evaluates the focus of the differences in detail; then, it is closely combined with the external market environment to carry out the review, and the "big, medium, small", "excellent, good, medium, bad", "good, better, general, relatively poor, poor "and other relatively fuzzy assessments are carried out for the results of the problem by combining with parameters and indicators; next, the methods provided by fuzzy mathematics are used for calculation, the indirect qualitative and quantitative synthesis results are obtained, to provide a scientific and reliable basis for decision-making. The logic operation diagram is shown in Figure 2.

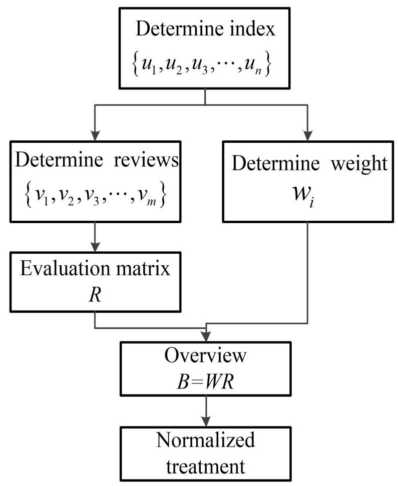

Figure 2. Fuzzy evaluation process

Determining the indicator set *U*: Before the assessment work, the first step is to make a detailed analysis of various indicators included in the assessment. Because the indicator is the smallest unit and the starting point for people to solve the problem, the target of different objects is different, and its content and complexity will also differ. So, the overall summary and specific description are essential, which can also help make the operation easier. Assuming that the number of index factors is n , which is recorded as $u_i\left(i=1,2,\cdots \mathrm{n}\right)$, then, these index factors constitute a finite set of evaluation factorsÿ

$$U=\{u_1,u_2,u_3,\cdots,u_n\} \tag{1}$$

Determining the comments set Vÿ Each index factor u_i corresponds to different reviews. According to the needs of the actual situation, the comments are divided into m levels, which is respectively recorded as *Vm*, then, the comments set of the index factor is constituted.

$$V=\{v_1,v_2,v_3,\cdots,v_m\} \tag{2}$$

The general evaluation set is as follows:

$$\begin{aligned} V &= (large,\ medium,\ small), \\ V &= (high,\ medium,\ low), \\ V &= (excellent,\ good,\ medium,\ bad) \end{aligned} \tag{3}$$

The establishment of evaluation matrix *R*: according to the actual background, data, etc., experts conduct the fuzzy assessment of various indicators of each decision-making; then, the distribution of comment level is obtained, and a decision matrix *R* of the decision-making is constituted. In general, the way of expert system voting can be used to construct *R*. Assuming that the evaluation factor set of a decision is set as $\{u_1, u_2, u_3, \cdots, u_n\}$, the comment set of the index factoris $\{v_1, v_2, v_3, \cdots, v_m\}$. There are experts and the index factorsof the decision-making is evaluated. Then, the comment of b experts is, the element of the matrix R is.

Determining the weight *W*ÿ the factors in the index set need to be considered comprehensively when evaluating a strategy. Moreover, the importance of each factor is often not the same, so the weight set that corresponds to the factor set needs to be established:

$$W = \{w_1, w_2, \cdots, w_n\}, \sum_{i=1}^{n} w_i = 1 \tag{4}$$

Comprehensive evaluation: the process of fuzzy comprehensive assessment is to transform the fuzzy set W on the evaluation factor set R into the new set B on the set V, that is:

$$B = WR \tag{5}$$

Among them, *B* is the result of a fuzzy comprehensive evaluation for a decision, which is the m-dimensional vector; *W* is the weight, which is the *n*-dimensional vector; *R* is an *n*×*m* evaluation matrix:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \tag{6}$$

Among them, r_{ij} represents to consider from the *ith* factor, and the possibility degree of the *jth* comment is made.

Normalization processing: to obtain a comparable comprehensive evaluation result, each decision's fuzzy evaluation result B needs to be processed. Assuming that the fuzzy evaluation result vector B of a decision is $(b_1, b_2, \cdots, b_m)$, then, the result of normalization processing is recorded as $B' = (b'_1, b'_2, \cdots, b'_m)$, among them:

$$b'_i = \frac{b_i}{\sum_{j=1}^{m} b_j}, i = 1, 2, \cdots, m \tag{7}$$

Finally, the results of all the decisions produced in the analysis process are evaluated, and then the optimal decision from the clear analysis is determined, thereby maximizing revenue.

4. Result Analysis And Discussion

4.1. Small Hydropower Project Overview

Sichuan Province is extremely rich in water resources; Aba Mingda hydropower station relies on the first-class tributary Duke River of the Dadu River in Sichuan, which is 16 kilometres away from the county seat and belongs to the runoff diversion type power station. The installed capacity is 6 × 1600Kw, the design head is 26.5m, the design flow is 24m3/s, the average

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annual power generation is 36.15 million *Kwh*, the firm capacity is 2500Kw, the total investment of the power station is 46.88 million yuan and the time of the plan is 24 months. The project is located in a plateau cold area at an altitude of 3200m; the adequate construction time is only six months each year, and the project's progress must be strictly controlled. Otherwise, people need to wait a year. Among them, the increase is not only the project's cost but countless other visible or invisible losses.

To successfully pass the project approval process, the original owner set the installed capacity to 20MW and the project approval to 4.8MW in accordance with the planning, which caused subjective defects and omissions in the bidding process. In addition, there are two channels for the primary sources of funds. The main is national poverty alleviation, then supplemented by treasury funds, so this is a semi-state-owned water and electricity energy project.

The project comprises the first hub, diversion tunnel, pressure pipeline, ground plant, and four main components. The first hub consists of flood discharge scissors, intake work, overflow dams, corresponding anti-seepage and energy dissipation and revetment buildings. The diversion system is arranged on the right bank. It is designed as a non-pressure water diversion tunnel, which is the straight wall arch section, and the full length is 4230; then, the water diversion terminal has a front pool, which is a partly bright, partly dark front pool. The effective volume of the front pool is 5500m3. The pressure pipe adopts a single tube to supply water independently. The plant comprises the main plant, tail pool, booster station, flood dike, incoming highway, etc. The preliminary approval omissions cause serious deviations from the budget, and the final investment is more than once expected, which is an example of a larger change in the construction of the engineering.

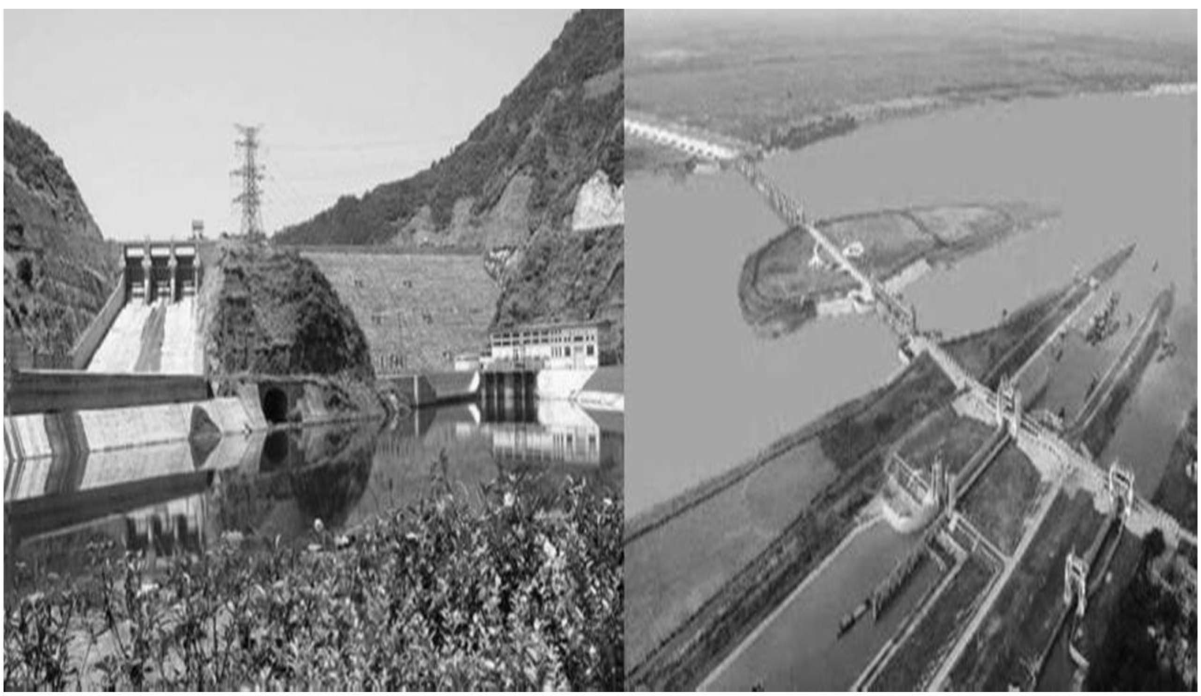

Figure 3. Risk construction of hydropower project

4.2. Fuzzy Comprehensive Evaluation of Risk-Accounting Business

The weight determination of various project risk factors: the total risk of the project implementation was recorded as *A*, the technical ring risk was *C1*, the environmental risk was *C2*, the management risk was *C3*, and the economic and financial risk was *C4*. According to the qualitative analysis of project risk, the judgment matrix of the total risk of project implementation was obtained, as shown in Table 1 below:

A	C1	C2	C3	C4
C1	1	1	1/2	1/2
C2	1	1	1/2	1/3
C3	2	2	1	1/4
C4	2	3	4	1

Table 1. Project to determine the total risk of the matrix

That is:

$$A = \begin{bmatrix} 1 & 1 & 1/2 & 1/2 \\ 1 & 1 & 1/2 & 1/3 \\ 2 & 2 & 1 & 1/4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$$

The weight of each risk for the total risk of the project can be calculated as W:

$$W = \begin{bmatrix} 0.1582 \\ 0.1382 \\ 0.2264 \\ 0,4771 \end{bmatrix}, \quad AW = \begin{bmatrix} 1 & 1 & 1/2 & 1/2 \\ 1 & 1 & 1/2 & 1/3 \\ 2 & 2 & 1 & 1/4 \\ 2 & 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} 0.1582 \\ 0.1382 \\ 0.2264 \\ 0,4771 \end{bmatrix} = \begin{bmatrix} 0.6482 \\ 0.5687 \\ 0.9386 \\ 2.1139 \end{bmatrix}$$

Assuming that the maximum feature of the judgment matrix is $\lambda_{\max}$, then there is:

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{[AW]_i}{nW_i} = \frac{1}{4}\left(\frac{0.6482}{0.1582} + \frac{0.5687}{0.1382} + \frac{0.9386}{0.2264} + \frac{2.1139}{0.4771}\right) = 4.1968$$

Therefore, the consistency index calculation *CI* can be obtained:

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{4.1968 - 4}{4-1} = 0.0656$$

From the Table, it can be obtained that the average random consistency index was $RI = 0.9$. The random consistency ratio was $CR = CI / RI = 0.0729 < 0.1$, which indicated that the consistency of the judgment matrix satisfied the requirement and the weights were not logically wrong.

It can be seen that the risk influence degree of technical risk, environmental risk, and management risk on the overall goal of the project in the Mingda Hydropower Project in Aba Prefecture, Sichuan Province was 15.82%, 13.82%, 22.64%, and 47.71%, respectively.

The determination of the weight of the sub-factors: the impact degree of the sub-factors of the risk was obtained, as shown in Table 2 and Table 3:

C1	D1	D2	D3	D4	D5	D6	Weights
D1	1	2	3	4	2	5	0.3315
D2	1/2	1	2	3	2	4	0.2199
D3	1/3	1/2	1	3	3	2	0.1799
D4	1/4	1/3	1/4	1	2	3	0.1048
D5	1/2	1/2	1/2	1/2	1	4	0.1138
D6	1/5	1/4	1/3	1/3	1/4	1	0.0500

Table 2. The degree of influence of the technical risk sub-factors

C1	D7	D8	D9	D10	Weights
D7	1	1	3	3	0.4750
D8	1	1	3	3	0.3750
D9	1/3	1/3	1	1	0.1250
D10	1/3	1/3	1	1	0.1250

Table 3. The degree of influence of environmental risk subfactors

The fuzzy matrix of the risk is a set constituted by the degree of memberships of all sub-risk factors under the same risk. Table 1-3 shows that the following single-factor fuzzy evaluation matrix can be secured. This paper took the technical risk as an example to carry on the numerical calculation:

$$R = \begin{bmatrix} 0.3 & 0.3 & 0.1 & 0.2 & 0.1 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.3 & 0.4 & 0.1 & 0.1 & 0.1 \\ 0.4 & 0.2 & 0.1 & 0.2 & 0.1 \end{bmatrix}$$

$$B = WR = R_1 = \begin{bmatrix} 0.3114 & 0.2991 & 0.1450 & 0.1445 & 0.1000 \end{bmatrix}$$

Analysis of the evaluation results: from the beginning of the project, the project did not consider all the risk factors, which resulted in the late actual construction being always in the state of plugging. This blind optimism, which did not take into account the actual situation, brought the deep hidden trouble buried in the construction phase of the project. In addition, the latter part of the substantial increasing capital investment made the main bodies struggle to cope, and the capital chain faced an imminent fracture crisis, resulting in a serious lag in the progress of the project. Ultimately, the construction costs rose substantially, and there was no way to determine if the price was consistent with the local price level. Moreover, in the construction process, the attributes and limitations of the output channel weren't considered clearly. After the construction, many projects were not put into use, which greatly wasted the resources and increased the project's degree of risk. This is a typical blind project that only considers politics rather than the market.

5. Conclusions

With the global integration of the capital market, derivative financial instruments have become an indispensable constituent part of the market. The large-scale, massive investment in energy power projects is related to the benefits of all community sectors; people pay great attention to the project. Furthermore, the number of small hydropower energy projects has also increased the focus of attention. Therefore, from the perspective of risk management, it's necessary to analyze the derivative financial instruments accounting business management flow. In this paper, the fuzzy evaluation model was used for the mathematical analysis, and the following conclusions were obtained: firstly, in small hydropower development projects, managers undertake a great responsibility; they must comprehensively, objectively and rigorously analyze each indicator. Meanwhile, they must always monitor the possible problems, especially for those unstable factors, the initiative prevention means are adopted; secondly, the risk awareness management and training within the enterprise need to remain unremitting, the staff must have the risk response and management knowledge, and then, the enterprise's risk management mechanism is established and improved under the market environment and internal mechanisms, to provide a solid guarantee for the development of the project.

References

[1] Embrechts, P. (2016). Quantitative risk management. *Journal of Risk Management, 35*(2), xvi.

[2] Hoyt, R. E., and Liebenberg, A. P. (2011). The value of enterprise risk management. *Journal of Risk & Insurance, 78*(4), 795–822.

[3] Christoffersen, P. (2012). *Elements of financial risk management* (2nd ed.). Elsevier Monographs, 82(1), 121–151.

[4] Cole, S., Giné, X., Tobacman, J., et al. (2013). Barriers to household risk management: Evidence from India. *Social Science Electronic Publishing, 5*(1), 104.

[5] Cornett, M. M., McNutt, J. J., Strahan, P. E., and Tehranian, H. (2011). Liquidity risk management and credit supply in the financial crisis. *Journal of Financial Economics, 101*(2), 297–312.

[6] Schrand, C., and Unal, H. (2010). Hedging and coordinated risk management: Evidence from thrift conversions. *Journal of Finance, 53*(3), 979–1013.

[7] Sodhi, M. M. S., Son, B. G., and Tang, C. S. (2012). Researchers' perspectives on supply chain risk management. *Production & Operations Management, 21*(1), 1–13.

[8] Bebbington, J., Larrinaga, C., and Moneva, J. M. (2011). Corporate social reporting and reputation risk management. *Accounting, Auditing & Accountability Journal, 21*(3), 337–361.

[9] Anderson-Cook, C. M. (2015). Quantitative risk management: Concepts, techniques, and tools, by Alexander J. McNeil, Rudiger Frey, & Paul Embrechts. *Journal of the American Statistical Association, 101*(476), 1731–1732.

[10] Zhang, C., Liu, N., and Chu, W. (2016). Key technologies and risk management of deep

tunnel construction at Jinping II hydropower station. *Journal of Rock Mechanics and Geotechnical Engineering, 8*(4), 499–512.

[11] Froot, K. A., Scharfstein, D. S., and Stein, J. C. (2012). Risk management: Coordinating corporate investment and financing policies. *The Journal of Finance, 48*(5), 1629–1658.

[12] Yuan, L., Zhou, J., Li, C., and Duan, Q. (2016). Benefit and risk balance optimization for stochastic hydropower scheduling. *Water Resources Management, 30*(10), 3347–3361.

[13] Leland, H. E. (2010). Agency costs, risk management, and capital structure. *Journal of Finance, 53*(4), 1213–1243.

[14] Thun, J. H., Hoenig, D. (2011). An empirical analysis of supply chain risk management in the German automotive industry. *International Journal of Production Economics, 131*(1), 242–249.

[15] Jha, A., Lamond, J., Proverbs, D., and Singh, A. (2013). *Cities and flooding: A guide to integrated urban flood risk management for the 21st century.* World Bank Publications, 52(5), 885–887.