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Retraction

Retracted: Factors and Economic Evaluation of Transnational Investment Risks

Discrete Dynamics in Nature and Society

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] G. Xiong and L. Wang, "Factors and Economic Evaluation of Transnational Investment Risks," *Discrete Dynamics in Nature and Society*, vol. 2021, Article ID 1030183, 9 pages, 2021.

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Research Article

Factors and Economic Evaluation of Transnational Investment Risks

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Transnational investment is featured by its large scale and high risks. During transnational investment, the frequent risks often bring a huge loss to the investors. Therefore, the risk factors should be included in the economic evaluation of transnational investment projects. However, the existing evaluation models and systems are rather complex, lacking a unified framework. Besides, there are few practical applications of these models or systems. To solve the problem, this paper explores the factors and economic evaluation of transnational investment risks. Firstly, an economic evaluation system was constructed for transnational investment projects, and the economic evaluation result was depicted in two aspects: economic income factors and investment risk factors. Then, the applicability and economic meanings of common indices were clarified one after another. After that, the economic evaluation flow was designed for risk-based transnational investment projects. Finally, an economic evaluation was performed on actual projects, which verifies the feasibility of the proposed evaluation method.

1. Introduction

China is poised to witness a fast and large-scale development of transnational investment, which is featured by its large scale and high risks [1–7]. Transnational investment could bring monetary or nonmonetary income. To maximize the expected income and make correct investment decisions, it is necessary to analyze the feasibility of the investment projects, i.e., evaluate the economy of the projects [8–14]. During transnational investment, the frequent risks often bring a huge loss to the investors [15–17]. Therefore, the risk factors should be included in the economic evaluation of transnational investment projects, and the selection mechanism should be improved to choose transnational investment projects that satisfy multiple feasibility and risk conditions. These measures are critical to the correct execution of investment decisions.

Since the launch of the Belt and Road Initiative, China has been speeding up the export of infrastructure. Through a multicase research, Huang et al. [18] summarized the lessons learned from overseas hydropower investment projects and provided some managerial insights to Chinese enterprises, banks, and governments investing in foreign infrastructure. Considering the operation in overseas markets, Grabovy and Orlov [19] described the actual procedures of Russian development enterprises for effective, all-round risk control of large investment projects and proposed thorough risk evaluation and management procedures, which include the application of special techniques and tools. Garcia-Canal and Fernandez-Mendez [20] treated the policy risk of the host country as a deterrent to attract and maintain foreign direct investment (FDI) and held that the investment value declines with the arbitrary changes of regulation.

The future change in the exchange rate presents one of the major risks to the economic evaluation of FDI. Lee and Sullivan [21] proposed an FDI economic evaluation model based on the purchasing power parity (PPP) theory and weighted average, trying to reduce the uncertainty related to the changing exchange rate. Miroshnikova et al. [22] surveyed the directions and investment forms of Russian-Sino cooperation and introduced the basic performance measurement principles for participants of international projects. Čulková et al. [23] suggested that investing in new production technologies promotes the investment economy of enterprises, in accordance with environmental principles.

Experts at home and abroad have explored extensively into the risk assessment and economic evaluation of transnational investment and proposed lots of analytical ideas and solutions. However, many of their solutions do not apply to special situations. The evaluation models and systems are very complex, lacking a unified framework. There have been no specific application cases. To solve the problems, this paper explores the factors and economic evaluation of transnational investment risks. The main contents are as follows. Section 2 constructs an economic evaluation system for transnational investment projects and depicts the evaluation result depicted in two aspects: economic income factors and investment risk factors. Section 3 further clarifies the applicability and economic meanings of common economic evaluation indices for transnational investment projects. Section 4 designs the economic evaluation flow for risk-based transnational investment projects. Finally, an economic evaluation was performed on actual projects, which verifies the feasibility of the proposed evaluation method.

Considering the rapid changes of international economy, this paper strives to accurately evaluate the economy of transnational investment projects under a dynamic environment. The traditional evaluation systems for investment projects were investigated and improved, making the research system of these projects more in line with the current international economic environment. In this way, the economy of transnational investment projects can be evaluated more accurately, and the relevant decision makers and investors will be given a greater number of more reliable data.

2. Economic Evaluation System

The economic evaluation of transnational investment projects aims to measure and judge whether risk factors could bring excess return to such a project without incurring high investment risks, using scientific methods and criteria. Therefore, this paper decides to describe the economic evaluation results of a transnational investment project from two aspects: economic income factors and investment risk factors. By combining qualitative and quantitative analyses, the evaluation system and core indices were established in the following principles: systematically, comprehensiveness, scientific nature, operability, and representativeness.

According to the features and realities of transnational investment risks in China, this paper divides the economic evaluation system for transnational investment projects into two subsystems, giving full consideration to the membership between economic income factors and investment risk factors. As shown in Figure 1, the subsystem of economic income factors mainly covers entrepreneurial ability of resource integration, corporate structure standardization and management level, investment project attributes and sustainable development capacity, market barriers, supply-demand relationships and competitiveness, national policy environment and infrastructure, national industrial structure, and employment situation. The subsystem of investment risk factors involves human resources and equity structural risks, product technology prospects and life risks, market acceptance and consumer preference risks, cash flow fluidity and investment plan risks, and exit channel and method risks.

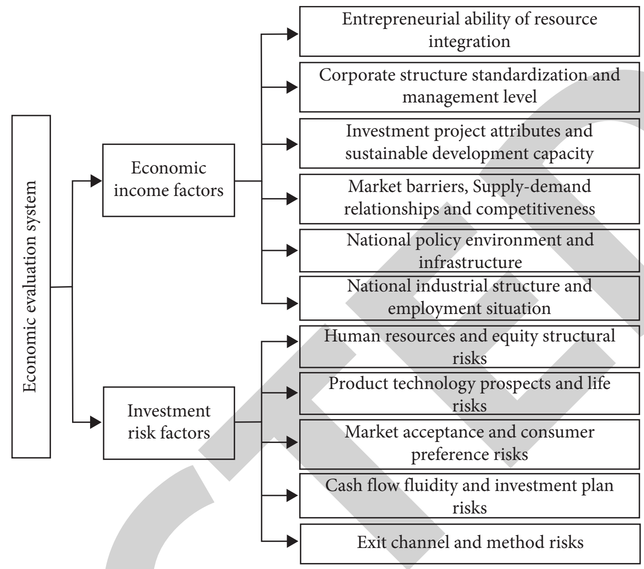

Figure 1: Contents and structure of the economic evaluation system for transnational investment projects.

3. Risks and Deterministic Analysis

In the pursuit of the maximal profit, transnational investment essentially seeks the minimization of the known risk factors, which is a common topic in economic evaluation of transnational investment projects. The accuracy of economic evaluation rests on the scientific nature of the evaluation criteria. In addition, traditional investment projects often ignore the assumptions that the fund sources are unrestricted, investment consequences are completely deterministic, and investment projects are indivisible. This paper innovatively assesses the common economic indices of transnational investment projects, further clarifies the applicability and economic meaning of different influence factors and indices, details the evaluation criteria and method for transnational investment projects, and thereby effectively overcomes the limitations on the applicable scope of the indices.

3.1. Economic Meaning of Net Present Value (NPV). NPV ID_{NPV} is one of the most important indices for the economic evaluation of transnational investment projects. This index is defined as the sum of the present values at the starting point of the initial investment period, converted from the net cash flow (NCF) of the project in each year by the benchmark rate of return (BRR) *i*. Let LR_τ and LC_τ be the inflow and output of cash, respectively, and *m* be the project cycle. Then, NPV can be calculated by

$$\mathrm{ID}_{\mathrm{NPV}}(i) = \sum_{\tau=0}^{m} (\mathrm{LR}_\tau - \mathrm{LC}_\tau)(1+i)^{-\tau}. \quad (1)$$

The evaluation criteria of $\mathrm{ID}_{\mathrm{NPV}}$ boil down to two rules. (1) If $\mathrm{ID}_{\mathrm{NPV}} \geq 0$, the transnational investment project is acceptable. (2) If $\mathrm{ID}_{\mathrm{NPV}} < 0$, the transnational investment project is unacceptable. If the sign of the cash flow of the project only changes once in the investment period, then the NPV value will increase monotonically with the growth of the discount rate.

Finding the first-order derivative of the BRR i in formula (1),

$$[\mathrm{ID}_{\mathrm{NPV}}(i)]' = -\sum_{\tau=0}^{m\tau} (\mathrm{LR}_\tau - \mathrm{LC}_\tau)_\tau (1+i)^{-(\tau+1)} \leq 0. \quad (2)$$

Finding the second-order derivative of the BRR i in formula (1),

$$[\mathrm{ID}_{\mathrm{NPV}}(i)]'' = \sum_{\tau=0}^{m\tau} (\mathrm{LR}_\tau - \mathrm{LC}_\tau)_\tau (\tau+1)(1+i)^{-(\tau+2)} \geq 0. \quad (3)$$

The above two formulas confirm that the calculation formula of NPV $\mathrm{ID}_{\mathrm{NPV}}$ is a monotonically decreasing concave function. For transnational investment projects, the NPV in the initial investment period is usually smaller than zero. If a project is feasible, the investor will get income in the late investment period, turning the NCF positive. It is unrealistic if all NCFs are positive. Based on $\mathrm{LR}_\tau - \mathrm{LC}_\tau > 0$, the result verified by formulas (2) and (3) is not rigorous enough.

Conventionally, a transnational investment project has a unique internal yield. Let T_0 be the investment at the start of the first year in the investment period; NP_j, $j = 1, 2, \ldots, m$, be the net income of the project at the end of each of the following years ($\sum_{j-1}^{m} NP_j > T_0$). Then,

$$\mathrm{ID}_{\mathrm{NPV}}(i) = -T_0 + \mathrm{NP}_1(1+i)^{-1} + \mathrm{NP}_2(1+i)^{-2} + \cdots + \mathrm{NP}_m(1+i)^{-m}. \quad (4)$$

Finding the first- and second-order derivatives of the BRR i in formula (4),

$$\mathrm{ID}'_{\mathrm{NPV}}(i) = \mathrm{NP}_1(1+i)^{-2} - 2\mathrm{NP}_2(1+i)^{-3} - \ldots - m\mathrm{NP}_m(1+i)^{-m-1} < 0, \quad (5)$$

$$\mathrm{ID}''_{\mathrm{NPV}}(i) = 2\mathrm{NP}_1(1+i)^{-3} + 2\times 3\mathrm{NP}_2(1+i)^{-4} + \ldots + m(m+1)\mathrm{NP}_m(1+i)^{-m-2} > 0. \quad (6)$$

Formulas (5) and (6) show that the calculation formula of NPV $\mathrm{ID}_{\mathrm{NPV}}$ is a monotonically decreasing concave function and that

$$\lim_{i\longrightarrow\infty} \mathrm{ID}_{\mathrm{NPV}}(i) = -T_0. \quad (7)$$

There exists a horizontal asymptote to $\mathrm{ID}_{\mathrm{NPV}} = -T_0$. When $i = 0$, the following inequality holds:

$$\mathrm{ID}_{\mathrm{NPV}}(0) = \sum_{j=1}^{m} \mathrm{NP}_j - T_0 > 0. \quad (8)$$

For an unconventional transnational investment project with multiple investments and a nonunique internal rate of return (IRR), let T_0 denote the investment at the start of the first year in the investment period, $T_1, T_2, \ldots, T_j$ denote the additional investment at the start of each year from the first year to the jth year, respectively, and $\mathrm{NP}_{j+1}, \mathrm{NP}_{j+2}, \ldots, \mathrm{NP}_m$ be the net income of the project at the end of each of the years following the $j+1$th year, respectively. Then, the NPV $\mathrm{ID}_{\mathrm{NPV}}$ of the transnational investment project can be described as

$$\mathrm{ID}_{\mathrm{NPV}}(i) = -T_0 - T_1(1+i)^{-1} - \cdots - T_j(1+i)^{-j} + \mathrm{NP}_{j+1}(1+i)^{-(j+1)} + \cdots + \mathrm{NP}_m(1+i)^{-m}. \quad (9)$$

As shown in formula (9), when $i = 0$, the intersection of the NPV curve lies above the x-axis; when i tends to be infinitely great, $\mathrm{ID}_{\mathrm{NPV}}$ approaches $-T_0$. In the latter case, the NPV curve at least has one intersection $i = i^*$ with x-axis. Then,

$$\begin{aligned}\mathrm{ID}_{\mathrm{NPV}}(i) &= -T_0 - T_1(1+i)^{-1} - \cdots - T_j(1+i)^{-j} + \mathrm{NP}_{j+1}(1+i)^{-(j+1)} + \cdots + \mathrm{NP}_m(1+i)^{-m} \\ &= -T_0 + (1+i)^{-1}\left[-T_0 - \cdots - T_j(1+i)^{-j+1} + \mathrm{NP}_{j+1}(1+i)^{-j} + \cdots + \mathrm{NP}_m(1+i)^{-m+1}\right].\end{aligned} \quad (10)$$

Suppose $D = -T_1 - \ldots - T_j(1+i)^{-j+1} + T_{j+1}(1+i)^{-j} + \mathrm{NP}_{j+1}(1+i)^{-j} + T_j + \ldots + \mathrm{NP}_m(1+i)^{-m+1}$, $\lim_{i\longrightarrow\square} D = -T_1$, i.e., when i is sufficiently large, D is smaller than 0; then, $(1+i)^{-1}D$ is also smaller than 0, that is, $(1+i)^{-1}[-T_1 - \ldots - T_j(1+i)^{-j+1} + T_{j+1}(1+i)^{-j} + \mathrm{NP}_{j+1}(1+i)^{-j} + T_j + \ldots + \mathrm{NP}_m(1+i)^{-m+1}]$ is smaller than 0. When i is sufficiently great, $\mathrm{ID}_{\mathrm{NPV}}(i) < -T_0$. Finding the first-order derivative of the BRR i in formula (10):

$$\begin{aligned}\mathrm{ID}'_{\mathrm{NPV}}(i) &= T_1(1+i)^{-2} + \cdots + jT_j(1+i)^{-(j+1)} - (j+1)\mathrm{NP}_{j+1}(1+i)^{-(j+2)} - \cdots - m\mathrm{NP}_m(1+i)^{-(m+1)} \\ &= -(1+i)^{-2}\left[-I_1 - \cdots - jT_j(1+i)^{-(j+1)} + (j+1)\mathrm{NP}_{j+1}(1+i)^{-(j+2)} + \cdots + m\mathrm{NP}_m(1+i)^{-(m+1)}\right].\end{aligned} \quad (11)$$

The bracketed expression is the NPV function of derivative 1 of the transnational investment project. When $i = 0$, NPV $\mathrm{ID}^*_{\mathrm{NPV}-1}$ can be calculated by

$$\begin{aligned}\mathrm{ID}^*_{\mathrm{NPV}-1}(0) &= -T_1 - 2T_2 - \cdots - jT_j + (j+1)\mathrm{NP}_{j+1} + \cdots + m\mathrm{NP}_m > -j\left(T_1 + T_2 + \cdots + T_j\right) \\ &\quad + (j+T)\left(\mathrm{NP}_{j+1} + \cdots + \mathrm{NP}_m\right) > -j\left(T_1 + T_2 + \cdots + T_j\right) + j\left(\mathrm{NP}_{j+1} + \cdots + \mathrm{NP}_m\right) \\ &= j\left(-T_1 - T_2 - \cdots - T_j + \mathrm{NP}_{j+1} + \cdots + \mathrm{NP}_m\right) > 0.\end{aligned} \tag{12}$$

For an unconventional transnational investment project, there is only one solution when NPV $\mathrm{ID}_{\mathrm{NPV}} = 0$. If there exists a value $i_{\mathrm{th}-1}$ making $\mathrm{ID}^*_{\mathrm{NPV}-1}(i_{\mathrm{th}-1})) = 0$: when i is smaller than $i_{\mathrm{th}-1}$, $\mathrm{ID}^*_{\mathrm{NPV}-1}(i)$ is greater than 0; when i is greater than $i_{\mathrm{th}-1}$, $\mathrm{ID}^*_{\mathrm{NPV}-1}(i)$ is smaller than 0. Formula (11) shows that when i is smaller than $i_{\mathrm{th}-1}$, $\mathrm{ID}'_{\mathrm{NPV}}(i)$ is smaller than 0, and when i is greater than $i_{\mathrm{th}-1}$, $\mathrm{ID}'_{\mathrm{NPV}}(i)$ is greater than 0. This means the NPV function equation (9) continues to decrease and increase on the left and right of $i_{\mathrm{th}-1}$, respectively.

Finding the second-order derivative of the BRR i in formula (12),

$$\begin{aligned}\mathrm{ID}''_{\mathrm{NPV}}(i) &= -2T_1(1+i)^{-3} - \cdots - j(j+1)T_j(1+i)^{-(j+2)} + (j+1)(j+2)\mathrm{NP}_{j+1}(1+i)^{-(j+3)} \\ &\quad + \cdots + m(m+1)\mathrm{NP}_m(1+i)^{-(m+2)} \\ &= (1+i)^{-3}\left[-2T_1 - \cdots - j(j+1)T_j(1+i)^{-(j-1)} + (j+1)(j+2)\mathrm{NP}_{j+1}(1+i)^{-j}\right. \\ &\quad \left. + \cdots + m(m+1)\mathrm{NP}_m(1+i)^{-(m+1)}\right].\end{aligned} \tag{13}$$

Similarly, when $i = 0$, $\mathrm{ID}^*_{\mathrm{NPV}-2}$ is greater than 0; when i tends to be infinitely great, $\mathrm{ID}^*_{\mathrm{NPV}-2}$ approximates $-2I_1$. Then, there exists a value $i_{\mathrm{th}-2}$ making $\mathrm{ID}^*_{\mathrm{NPV}-2}(i_{\mathrm{th}-2}) = 0$: when i is smaller than $i_{\mathrm{th}-2}$, $\mathrm{ID}^*_{\mathrm{NPV}-2}(i)$ is greater than 0 and $\mathrm{ID}'_{\mathrm{NPV}}(i)$ is smaller than 0; when i is greater than $i_{\mathrm{th}-2}$, $\mathrm{ID}^*_{\mathrm{NPV}-2}(i) < 0$ is smaller than 0 and $\mathrm{ID}'_{\mathrm{NPV}}(i)$ is greater than 0. Thus, the NPV function equation (9) is concave and convex on the left and right of $i_{\mathrm{th}-2}$, respectively.

3.2. Economic Meaning of IRR. Similar to NPV, IRR considers both the time value and the cash flow throughout the life of the project. The greatest strength of IRR is that its value directly depends on the cash flow of the project and has nothing to do with BRR. This objective metric becomes an important indicator of project economy, just like NPV.

For the economic evaluation of the transnational investment project, the discount rate making the NPV of NCF zero is defined as the IRR of the project:

$$\mathrm{ID}_{\mathrm{NPV}}\left(\mathrm{ID}_{\mathrm{IRR}}\right) = \sum_{\tau=0}^{m} (\mathrm{LR} - \mathrm{LC})_\tau \left(1 + \mathrm{ID}_{\mathrm{IRR}}\right)^{-\tau} = 0. \tag{14}$$

Because the marginal cost of the transnational investment project is characterized by BRR, IRR $\mathrm{ID}_{\mathrm{IRR}}$ of the project can be evaluated against. (1) If $\mathrm{ID}_{\mathrm{IRR}} \geq i$, the transnational investment project is acceptable. (2) If $\mathrm{ID}_{\mathrm{IRR}} < i$, the project is unacceptable.

As shown in formula (14), the IRR of the transnational investment project is an m-order polynomial, owing to the repeated additional investments in the operation period. It is rather complex to compute the m-order polynomial. Besides, the multiple positive roots obtained are not the IRR of the project. To solve these problems, IRR $\mathrm{ID}_{\mathrm{IRR}}$ of an unconventional transnational investment project was tested with a recursion formula (15). Let i be the solution to the formula of the internal return $\mathrm{ID}_{\mathrm{IRR}}$ obtained from the cash flow series of the project, τ be the base year of the investment period, and H_τ be the sum of final net cash values converted with the discount rate of i. Then,

$$\begin{aligned} H_0 &= (LR - LC)_0 H_1 = H_0(1+i) + (\mathrm{LR} - \mathrm{LC})_1 H_2 \\ &= H_1(1+i) + (\mathrm{LR} - \mathrm{LC})_2 \vdots \\ H_\tau &= H_{\tau-1}(1+i) + (\mathrm{LR} - \mathrm{LC})_\tau = \sum_{j=0}^{\tau} (\mathrm{LR} - \mathrm{LC})_j (1+i)^{\tau - j}.\end{aligned} \tag{15}$$

Under the following conditions, i is the only IRR of the transnational investment project:

$$\begin{cases} H_\tau < 0, & (\tau = 0, 1, 2, \ldots, m-1), \\ H_\tau = 0, & (\tau = m). \end{cases} \tag{16}$$

3.3. Relationship between NPV and IRR. Suppose the NPV and IRR of a transnational investment project change with the NCF. This section will discuss and demonstrate the change law of $\mathrm{ID}_{\mathrm{NPV}}$ and $\mathrm{ID}_{\mathrm{IRR}}$ induced by changing NCF.

Figure 2 provides the NPV curve of transnational investment project with a single investment, where the

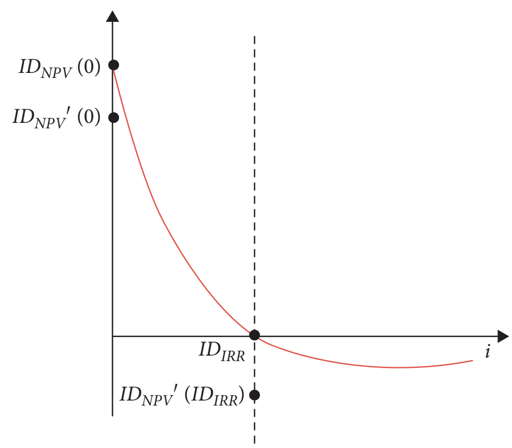

Figure 2: NPV curve of transnational investment project with a single investment.

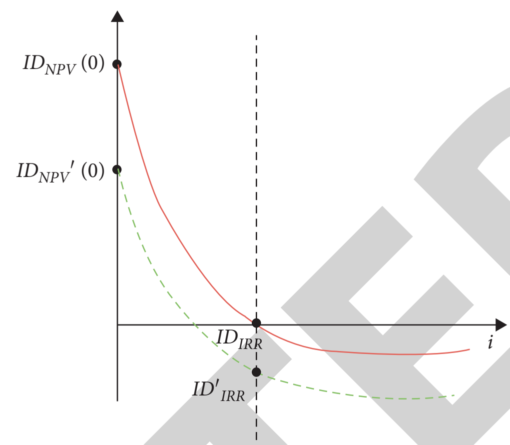

Figure 3: NPV curve of transnational investment project under decreasing NCF.

intersections of the curve with the x-axis and the y-axis are the algebraic sums of the IRR and the NCF of the project, respectively. When the BRR is fixed, the algebraic sum of the NCF decreases with the NCF. Figure 3 presents the NPV curve of the project in this case. It can be inferred that the intersection between the curve and the y-axis moved downward, and the point of the curve at $i = \mathrm{ID}_{\mathrm{IRR}}$ fell below the x-axis.

Figure 4 provides the NPV curve of transnational investment project with multiple investments. Figure 5 shows the change trend of the new NPV function under decreasing NCF. At this time, the curves of the functions are parallel to each other.

3.4. Other Dynamic Indices. For economic evaluation of transnational investment projects, the dynamic payback period V_τ is defined as the time needed to recover the investment cost, i.e., the time for the sum of net cash inflow to reach the total investment:

$$\sum_{\tau=0}^{V_\tau} (\mathrm{LR} - \mathrm{LC})_\tau (1 + i)^{-\tau} = 0. \tag{17}$$

If $V_\tau < m$, the transnational investment project is acceptable; if $V_\tau > m$, the project is not acceptable. Compared with static payback period, dynamic payback period fully considers the time value of funds and characterizes the fluidity of project funds and the time-varying project risks excellently.

The NPV ratio η_{NPVR} is defined as the ratio of NPV $\mathrm{ID}_{\mathrm{NPV}}$ of the transnational investment project to the present value of the investment G_σ:

$$\eta_{\mathrm{NPVR}}(i) = \frac{\mathrm{ID}_{\mathrm{NPV}}(i)}{G_\sigma}. \tag{18}$$

(1) If $\eta_{\mathrm{NPVR}}(i) \geq 0$, the transnational investment project is economically acceptable. (2) If $\eta_{\mathrm{NPVR}}(i) < 0$, the transnational investment project is economically unacceptable. η_{NPVR} characterizes the level of income of the project per unit of investment. It is the best index to arrange independent transnational investment projects by risks.

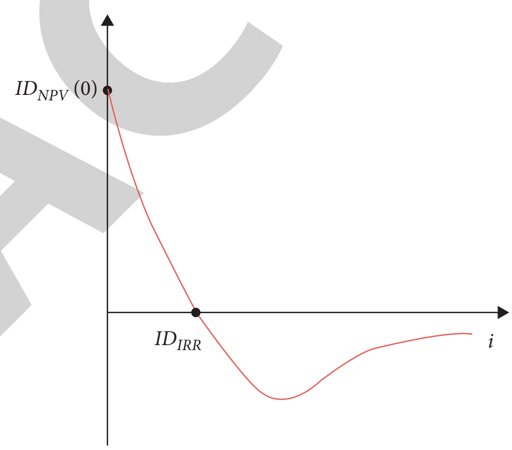

Figure 4: NPV curve of transnational investment project with multiple investments.

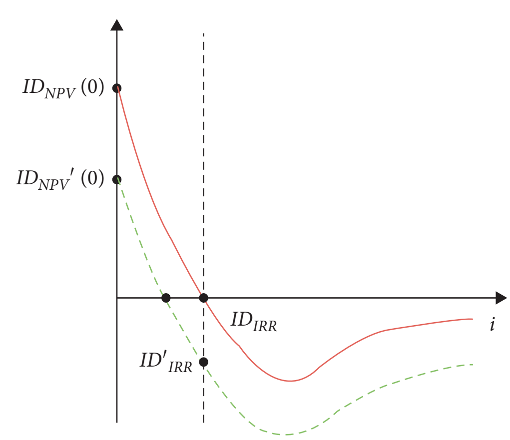

Figure 5: NPV curve of transnational investment project with multiple investments under decreasing NCF.

Similarly, the net rate of return (NRR) of investment is defined as the difference between the total investment TI and the net income NI of the project. Let TI_τ be the net income of the project in the τth year and NI_τ be the project investment in the τth year. Then,

$$\eta_{\mathrm{NIRR}}(i) = \frac{-\sum_\tau \mathrm{TI}_\tau (1+i)^{-\tau}}{\sum_\tau \mathrm{NI}_\tau (1+i)^{-\tau}}. \tag{19}$$

(1) If $\eta_{\mathrm{NIRR}} \geq 1$, the transnational investment project is economically acceptable. (2) If $\eta_{\mathrm{NIRR}} < 1$, the transnational investment project is economically unacceptable. From the definition of η_{NIRR},

$$\begin{aligned}\eta_{\mathrm{NIRR}}(i) - 1 &= \frac{-\sum_\tau \mathrm{TI}_\tau (1+i)^{-\tau}}{\sum_\tau \mathrm{NI}_\tau (1+i)^{-\tau}} - 1\\ &= \frac{\sum_\tau \mathrm{TI}_\tau (1+i)^{-\tau} \sum_\tau \mathrm{NI}_\tau (1+i)^{-\tau}}{\sum_\tau \mathrm{NI}_\tau (1+i)^{-\tau}}\\ &= \frac{\mathrm{ID}_{\mathrm{NPV}}(i)}{G_\sigma} = \eta_{\mathrm{NPVR}}(i).\end{aligned} \tag{20}$$

With a numerical difference of 1, η_{NPVR} and η_{NIRR} are consistent in ranking. η_{NIRR} reflects the NRR of the transnational investment project, which to a certain extent demonstrates the income level per unit of investment.

Finally, the cost-benefit ratio η_{CBR} is defined as the benefit Q divided by cost W in each year of the project:

$$\eta_{\mathrm{CBR}} = \frac{Q}{W} = \frac{\sum_{\tau=0}^{m} \mathrm{LR}_\tau (1+i)^{-\tau}}{\sum_{\tau=0}^{m} \mathrm{LC}_\tau (1+i)^{-\tau}}. \tag{21}$$

(1) If $\eta_{\mathrm{CBR}} > 1$, the transnational investment project is economically acceptable. (2) If $\eta_{\mathrm{CBR}} < 1$, the transnational investment project is economically unacceptable.

4. Risk Factor Analysis

Before launching a transnational investment project, it is important to carry out a detailed economic evaluation of the cash flow and financial situation of the project in each year within the investment period. Since the contents, costs, and quantities of investment vary with the type of investment, a variety of indices should be considered in the risk factor analysis of the investment project.

NCF volatility is an important risk factor on the microlevel of transnational investment projects. It directly affects how much the overall evaluation is influenced by cash flow fluidity and investment plan risks. The rising or falling of NCF caused by positive or negative information manifests investment risks. Figure 6 explains the risk-based economic evaluation procedures of transnational investment projects. To take account of NCF volatility, the calculation formula of NPV ID_{NPV} was adjusted to incorporate the NCF volatility risk to the $\mathrm{ID}_{\mathrm{NPV}}$ result. Let μ be the risk adjustment coefficient; $\mathrm{ID}_{\mathrm{NCF}}^{\tau}$ be the NCF of the τth year; a be the first year of stable operation of the project. Then, $\mathrm{ID}_{\mathrm{NPV}}$ can be adjusted by

$$\mathrm{ID}_{\mathrm{RISK-NPV}} = \sum_{\tau=a}^{m} \frac{\mu \cdot ID_{\mathrm{NCF}}^{\tau}}{(1+i)^{\tau}}. \tag{22}$$

The risk amount is the risk-induced difference of economic evaluation result from the ideal value, i.e., the investment risks of a transnational investment project are reflected as the gap between the estimated economy A_{ES} and the ideal economy A_{ID} of the project. Taking $A_{\mathrm{ES}} < A_{\mathrm{ID}}$, for example, it is assumed that A is the risk amount, $\mathrm{CP}(\xi_1)$ and $\mathrm{CP}(\xi_2)$ are the cumulative probabilities of ξ_1 and ξ_2 under normal distribution, respectively, ψ be the period for the realization of A, and ε be the volatility rate. Then, the relationship between A_{ES}, A_{ID}, and A can be defined as

$$\begin{cases} A = A_{\mathrm{ID}}^{-i\psi}\mathrm{CP}(-\xi_2) - A_{\mathrm{ES}}\mathrm{CP}(-\xi_1),\\ \xi_1 = \dfrac{ln\left(A_{\mathrm{ES}}/A_{\mathrm{ID}}^{-i\psi}\right)}{\varepsilon\sqrt{\psi}} + \dfrac{\varepsilon\sqrt{\psi}}{2},\\ \xi_2 = \dfrac{ln\left(A_{\mathrm{ES}}/A_{\mathrm{ID}}^{-i\psi}\right)}{\varepsilon\sqrt{\psi}} - \dfrac{\varepsilon\sqrt{\psi}}{2}. \end{cases} \tag{23}$$

When ψ approaches project cycle m, $\lim_{\psi\longrightarrow m} A_{\mathrm{ID}}^{-i\psi} = -A_{\mathrm{ES}}$. Since $A_{\mathrm{ID}}^{-i\psi}$ is continuous in the economic evaluation of the project, when $\psi = m$,

$$\begin{cases} \xi_1 = \dfrac{\varepsilon\sqrt{\psi}}{2} = \dfrac{\varepsilon\sqrt{m}}{2},\\ \xi_2 = -\dfrac{\varepsilon\sqrt{\psi}}{2} = -\dfrac{\varepsilon\sqrt{m}}{2}. \end{cases} \tag{24}$$

The risk amount A can be calculated by

$$A = A_{\mathrm{ID}}^{-i\psi}\mathrm{CP}(-\xi_2) - A_{\mathrm{ES}}\mathrm{CP}(-\xi_1) = A_{\mathrm{ID}}^{-i\psi}\left[2\mathrm{CP}\left(\frac{\varepsilon\sqrt{m}}{2}\right) - 1\right]. \tag{25}$$

If $A_{\mathrm{ES}} < A_{\mathrm{ID}}$, A is greater than 0. The risk amount coefficient ω can be derived by

$$\omega = 2\mathrm{CP}\left(\frac{\varepsilon\sqrt{m}}{2}\right) - 1. \tag{26}$$

The risk adjustment coefficient μ can regulate the NCF in the light of the risk amount in each year within the investment period of the transnational investment project. The value of μ can be obtained by deriving the NCF law in each year within the investment period and analyzing and processing the NCF volatility features in different periods of project operation. When the NCF increases, the value of μ can be calculated by

$$\mu = 1 + \omega = 2\mathrm{CP}\left(\varepsilon\sqrt{\frac{m}{4}}\right). \tag{27}$$

When the NCF decreases, the value of μ can be calculated by

$$\mu = 1 - \omega = 2\left[1 - \mathrm{CP}\left(\varepsilon\sqrt{\frac{m}{4}}\right)\right]. \tag{28}$$

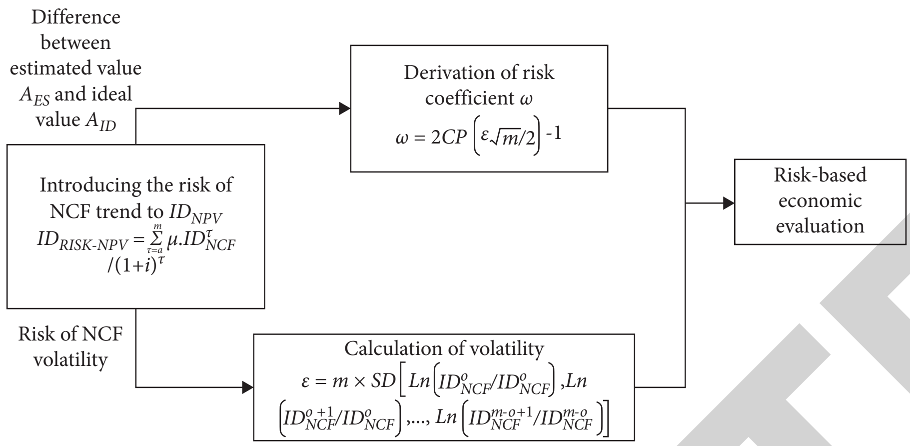

Figure 6: Risk-based economic evaluation procedures of transnational investment projects.

Let ID_{NCF}^{o} be the NCF in the first year within the investment period of the transnational investment project and $SD\{A_1, A_2, \ldots, A_m\}$ be the standard deviations of $\{A_1, A_2, \ldots, A_m\}$. Then, the volatility can be calculated by

$$\varepsilon = m \times SD\left[Ln\left(\frac{ID_{NCF}^{o}}{ID_{NCF}^{o}}\right), Ln\left(\frac{ID_{NCF}^{o+1}}{ID_{NCF}^{o}}\right), \ldots, Ln\left(\frac{ID_{NCF}^{m-o+1}}{ID_{NCF}^{m-o}}\right)\right]. \tag{29}$$

5. Experiments and Results' Analysis

This paper takes the observations on China's transnational investment projects in computer information system development in 2015–2020 as the panel data for economic evaluation and risk analysis. As shown in Table 1, the NCF of these projects increased year after year. In the initial year of 2015, there was a net cash outflow. In the early period of project operation (2016-2017), the project income was yet to stabilize. From 2018 to the end of the investment period, the NCF variation gradually stabilized. Therefore, this paper decides to compute the value of μ from 2018 and onward.

To solve the NCF volatility, the first step is to divide the NCF in the current year within the investment period with that in the previous year. Starting from 2018, the NCF of the transnational investment projects increased year by year. Table 2 presents the relative change ratios of NCF. The NCF volatilities from 2018 to 2024 were calculated. In the 10-year investment period, the volatility of NCF was 0.1795, and the risk adjustment factor was 1.2944. Table 3 lists the discount rate adjustment coefficients (DRACs) for 2018–2024.

Next, the indices were recalculated in the presence of NCF risk, aiming to verify the effectiveness of the NCF risk-based economic evaluation of transnational investment projects. A series of comparative experiments were designed. Firstly, the economic evaluation indices before and after the introduction of the risk were contrasted. Before risk introduction, the NPV and dynamic payback period were 1,121,334,700 yuan and 12.48 years, respectively. After risk introduction, the NPV and dynamic payback period were 823,461,100 yuan and 11.98 years, respectively. The investment rate of return was 6.47% and 6.88% before and after risk introduction, respectively. Next, the discounted values before and after risk introduction were compared (Table 4).

Table 1: NCFs of the transnational investment project.

Year	ID_{NCF}	Year	ID_{NCF}
2015	−754812.62	2020	85498.6135
2016	42745.4435	2021	87715.6927
2017	64523.5612	2022	90556.6492
2018	82844.9347	2023	97164.4264
2019	84619.3245	2024	107826.3465

Table 2: Relative change ratios of NCF.

Year	ID_{NCF}	Ratio
2015	80324.4261	1.0000
2016	83191.5682	1.0196
2017	83495.7257	1.0249
2018	85149.9563	1.0184
2019	87941.7214	1.0283
2020	90521.1576	1.0295
2021	92358.5493	1.0229
2022	96489.4189	1.0465
2023	101675.1504	1.0501
2024	118982.3471	1.1688

Table 3: DRACs for 2018–2024.

Year	Interest rate	DRAC
2015	5.1782	1.4135
2016	4.8456	1.3642
2017	5.1625	1.4083
2018	5.0674	1.3971
2019	5.1593	1.4592
2020	5.0385	1.3734
2021	5.1976	1.3955
2022	4.9435	1.5618
2023	5.1348	1.1912
2024	4.9764	1.5163

Table 4: Discounted values before and after risk introduction in 2015–2024.

Year	Before risk introduction	After risk introduction
2015	39254.21	38911.52
2016	54593.58	51178.95
2017	63765.37	75822.19
2018	65084.46	70835.37
2019	57481.25	69541.95
2020	54812.79	58625.24
2021	46982.23	53275.47
2022	47945.84	49462.74
2023	43218.76	43621.95
2024	42482.35	42337.63

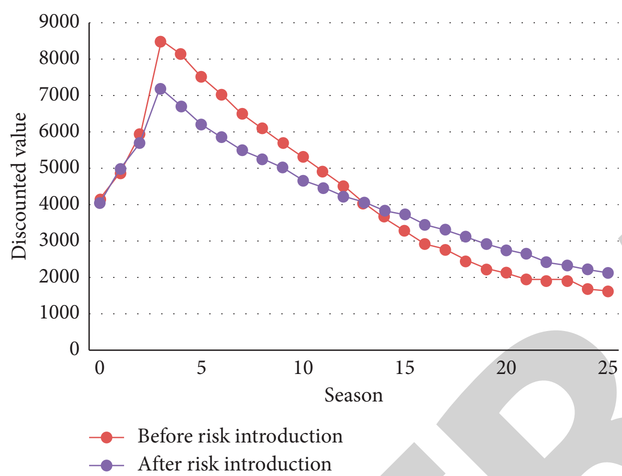

Figure 7: Seasonal discounted value curves before and after risk introduction.

Figure 7 shows the seasonal changes of the discounted value. From early 2015 to late 2017, the discounted value after risk introduction was higher than that before risk introduction. Afterwards, the discounted value after risk introduction was lower than that before risk introduction in each season, and the gap continued to widen. It can be inferred that the investment income in the early investment period can effectively improve the expected income of the projects within the investment period. The investment income in the late investment period is slightly below the expectation, highlighting the importance of considering the control and use of early period income within the investment period.

This paper further designs a comparative experiment to contrast the economic evaluation of five mutually exclusive transnational investment projects. Table 5 presents the economic evaluation indices of each project in 2018–2024.

As shown in Table 5, the five projects can be ranked in the descending order of NPV as Project 2 (1,442,031,600), Project 1 (1,426,075,400), Project 3 (1,217,799,200), Project 4 (1,165,536,500), and Project 5 (967,373,200). Project 2 had the greatest NPV, highest IRR, and largest risk-return ratio. From the angle of NPV, Project 2 achieved the best results in economic evaluation. The five projects can be ranked in the descending order of IRR as Project 4 (37.52%), Project 5 (35.41%), Project 2 (34.52%), Project 3 (28.94%), and Project 1 (27.55%). Project 4 had the highest IRR, that is, this project is economically optimal in terms of IRR. If NPV is associated with IRR, then the economic strength and weakness of the transnational investment projects can be judged by the risk-return ratio. As shown in Table 5, the risk-return ratios of Projects 1–5 were 36.72, 48.65, 37.43, 41.91, and 35.46, respectively. Hence, Project 2 is the economic optimal project in terms of the risk-return ratio.

Table 5: Economic evaluation indices of different projects.

	NPV	IRR (%)	Risk-return ratio
Project 1	142607.54	27.55	36.72
Project 2	144203.16	34.52	48.65
Project 3	121779.92	28.94	37.43
Project 4	116553.65	37.52	41.91
Project 5	96737.32	35.41	35.46

6. Conclusions

This paper mainly investigates the risk factors and economic evaluation of transnational investment. First of all, an economic evaluation system was construction for transnational investment projects, aiming to depict the economic evaluation result from two perspectives, namely, economic income factors and investment risk factors. Next, the authors clearly defined the applicability and economic meanings of common indices for economic evaluation of transnational investment projects and detailed the procedures of economic evaluation for risk-based transnational investment project. Through experiments, the NCF in the current year within the investment period was divided with that in the previous year and used to compute the NCF volatility. The DRACs were obtained, and the discounted values before and after risk introduction were compared in details. Finally, a comparative experiment was designed to contrast the economic evaluation of five mutually exclusive transnational investment projects. The comparison verifies the feasibility and effectiveness of our method.

The proposed model can be applied well in actual cases of transnational investment and be promoted to similar projects or the projects with a comparable NCF. However, the model needs to be further improved to predict future data more accurately. Big data analysis is the trend of economic evaluation of investment projects. It opens a new way to realize better, more complete, and more accurate economic evaluation of investment projects.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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