APPLICATION OF DECISION TREE METHODS IN THE QUANTITATIVE ANALYZES TO DECIDE THE CREDIT GRANTING AT JOINT STOCK COMMERCIAL BANK FOR INVESTMENT AND DEVELOPMENT OF VIETNAM QUANG NGAI BRACNCH

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Abstract: *nowadays, the decisive factor for success in all areas is always effectively associated with the capture,statistics and informative exploitation. Most management decisions must be made in uncertain conditions because managers have little information about what will happen in the future. A bank is a financial institution with a special position in the economy and credit operations contain many potential risks. Many quantitative techniques are used for making decision and Decision Tree Method is used as an effective tool to control and limit risks achieve desired goals in the banking. Therefore, the article uses the decision tree method in quantitative analysis to decide the credit granting at BIDV Quang Ngai.*
Keywords: *decision tree method, BIDV Quang Ngai, risks, quantitative analysis*

ПРИМЕНЕНИЕ МЕТОДОВ ДЕРЕВЬЕВ РЕШЕНИЙ В КОЛИЧЕСТВЕННОМ АНАЛИЗЕ ДЛЯ ПРИНЯТИЯ РЕШЕНИЯ О ВЫДАЧЕ КРЕДИТА В АКЦИОНЕРНОМ КОММЕРЧЕСКОМ БАНКЕ ИНВЕСТИЦИЙ И РАЗВИТИЯ ВЬЕТНАМА, ФИЛИАЛ КУАНГ НГАЙ

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Аннотация: *в настоящее время решающий фактор успеха во всех областях всегда эффективно связан с захватом, статистикой и информационной эксплуатацией. Большинство управленческих решений должны приниматься в условиях неопределенности, поскольку у менеджеров мало информации о том, что произойдет в будущем. Банк является финансовым учреждением с особым положением в экономике, а кредитные операции содержат много потенциальных рисков. Для принятия решений используются многие количественные методы, а метод дерева решений используется как эффективный инструмент для контроля и ограничения рисков для достижения желаемых целей в банковской сфере. Поэтому в статье метод дерева решений используется в количественном анализе для принятия решения о предоставлении кредита в БИДВ Куанг Нгай.*
Ключевые слова: *метод дерева решений, BIDV Quang Ngai, риски, количественный анализ.*

1. Problem Statement

The banking system serves as both the most important source of credit for the economy and an investor that drives economic development. When the banking system operates smoothly and healthily, it creates a flow of financial resources that are effectively circulated, allocated, and utilized, thereby stimulating sustainable economic growth. However, in a market economy, business risks are inevitable—particularly in banking operations, where risks can have chain reactions and increasingly complex manifestations. Credit risk tends to be concentrated mainly in the loan portfolio. Therefore, forecasting potential scenarios when making lending decisions to identify risks at an early stage is both essential and highly practical.

Bank lending decisions are a type of decision-making under conditions of risk. Currently, common quantitative techniques used in such decision-making include decision tables and decision tree methods. Within the scope of this study, it is recommended to apply the decision tree method to support lending decisions at the Quang Ngai Branch of the Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV Quang Ngai). The decision tree method is intuitive and easy to understand; users can comprehend the model after a brief explanation. This helps the bank effectively detect risks, prevent credit fraud, and make informed lending decisions.

2. Decision Tree Methodology

a. Decision Tree

The decision tree method is typically employed in situations involving multiple alternatives and events (states of nature), and where a series of decisions must be made sequentially. A decision tree is a diagram consisting of various nodes and branches.

There are two types of branches: **alternative branches** and **event branches**.

There are also two types of nodes: **decision nodes** and **event (chance) nodes**.

+ **Decision node**: Represented by a square. The branches stemming from this node indicate possible courses of action. At this point, the decision-maker must choose one alternative from a set of options, each leading to a sequence of possible outcomes.

+ **Event (chance) node**: Represented by a circle. The branches extending from this node represent potential outcomes or events that may occur, which are beyond the control of the decision-maker.

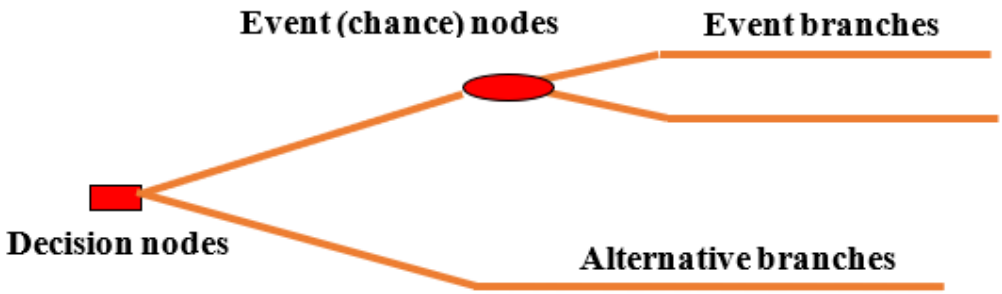

Fig. 1. Decision Tree Diagram

b. Steps for Applying the Decision Tree Method

- Step 1: Define the problem.
- Step 2: Construct the structure of the decision tree.
- Step 3: Assign probability values to the chance events.
- Step 4: Assign payoff values to each combination of alternative and event.
- Step 5: Calculate the maximum expected monetary values (EMVs) at each node of the tree, working from right to left.

3. Applying the Decision Tree Method in Credit Lending at BIDV Quang Ngai

a. The current situation at BIDV Quang Ngai

Table 1: Business Performance Results for 2023–2024

Unit: Million VND

Indicators	2023	2024	Disparity	
			Value	Proportion
1. Revenue	**44.527**	**42.484**	**-2.043**	-4,59%
Revenue from credit activities	32.705	31.438	-1.267	-3,87%
Revenue from non-credit activities	11.822	11.046	-776	-6,56%
2. Expenses	**39.547**	**38.351**	**-1.196**	-3,02%
Expenses from credit activities	29.407	28.380	-1.027	-3,49%
Expenses from non-credit activities	10.140	9.971	-169	-1,67%
3. Profit	**4.980**	**4.133**	**-847**	-17,01%
Profit from credit activities	3.298	3.058	-240	-7,28%
Profit from non-credit activities	1.682	1.075	-607	-36,09%

(Source: BIDV Quang Ngai Business Performance Reports)

Credit activities are inherently complex and carry significant risk. In the event of credit risk, the bank fails to recover the principal and interest from issued loans, yet it is still obligated to repay the principal and interest on mobilized funds when they mature. This imbalance between inflows and outflows can disrupt the bank's financial stability. When debts are not recovered, the credit capital turnover rate declines, leading to inefficient operations. Consequently, the bank may face liquidity shortages, eroding depositor confidence and damaging its reputation.

According to the Business Performance Results for 2023–2024, profits from non-credit activities—such as payment services, treasury services, and deposit services—account for only a small proportion of total profit. The branch's profits are primarily derived from credit activities, contributing 66% in 2023 and 74% in 2024. Therefore, BIDV Quang Ngai must implement effective credit risk management strategies. In addition to traditional approaches, modern quantitative analytical techniques can assist the bank in precisely estimating potential losses from unrecovered loans, as well as comparing multiple scenarios before making lending decisions.

A method that simultaneously represents multiple alternatives within a simplified structure is the Decision Tree. Lending decisions in banking involve evaluating multiple options (e.g., approving or rejecting a loan application, deciding between

investment and lending of mobilized funds) alongside various possible outcomes (e.g., whether the borrower repays or defaults, profitability of granting credit versus pursuing alternative investments). As such, BIDV Quang Ngai should adopt the decision tree method as a complementary tool to traditional measures in order to minimize credit risk prior to making lending decisions.

b. Application

BIDV Quang Ngai considers lending to a business. The loan amount is USD 900,000 for a term of one year with an annual interest rate of 8%. If the bank chooses not to lend, the same amount can be invested in government bonds with an annual interest rate of 3%.

Based on past experience, if no investigation is conducted on the borrowing companies, the probability that a company will repay both principal and interest on time is **0.95**. Conversely, there is a **0.05** probability that the company will default (i.e., go bankrupt), in which case the bank is assumed to lose the entire loaned amount.

If BIDV Quang Ngai conducts a pre-lending investigation, the result will be one of two outcomes:

- **T1:** Lending is recommended (favorable)
- **T2:** Lending is not recommended (unfavorable)

With the following possible events:

- **E1:** The borrower repays the loan
- **E2:** The borrower does not repay the loan

The cost of conducting an investigation is **USD 5,000** per case.

Based on statistics from 500 past cases, the following results were observed:

Table 2. Investigation Results at BIDV Quang Ngai

Events **Investigation Result**	**E_1** **Favorable**	**E_2** **Unfavorable**	**Total**
T_1	421	09	430
T_2	59	11	70
Total	480	20	500

(Source: Survey Report on Corporate Customers with Outstanding Loans at BIDV Quang Ngai)

- Step 1: Problem Identification

BIDV Quang Ngai is considering various options to make an optimal credit-lending decision (i.e., whether to conduct an investigation before granting credit, whether to approve the loan, or reject it and instead invest the funds in government bonds). The decision scenario faced by BIDV Quang Ngai is illustrated in the following decision tree:

- Step 2: Construct the Decision Tree

The possible alternatives are denoted as: S1, S2, S3, S4.

S_1 Represents the strategy of conducting an investigation before making the lending decision.

S_2 Represents the strategy of not conducting an investigation.

S_3 Represents the strategy of approving the credit.

S_4 Represents the strategy of rejecting the credit.

The events involved are T1, T2 and E1, E2.

T_1: Lending is recommended (favorable outcome)

T_2: Lending is not recommended (unfavorable outcome)

E_1: The borrower repays the loan

E_2: The borrower does not repay the loan

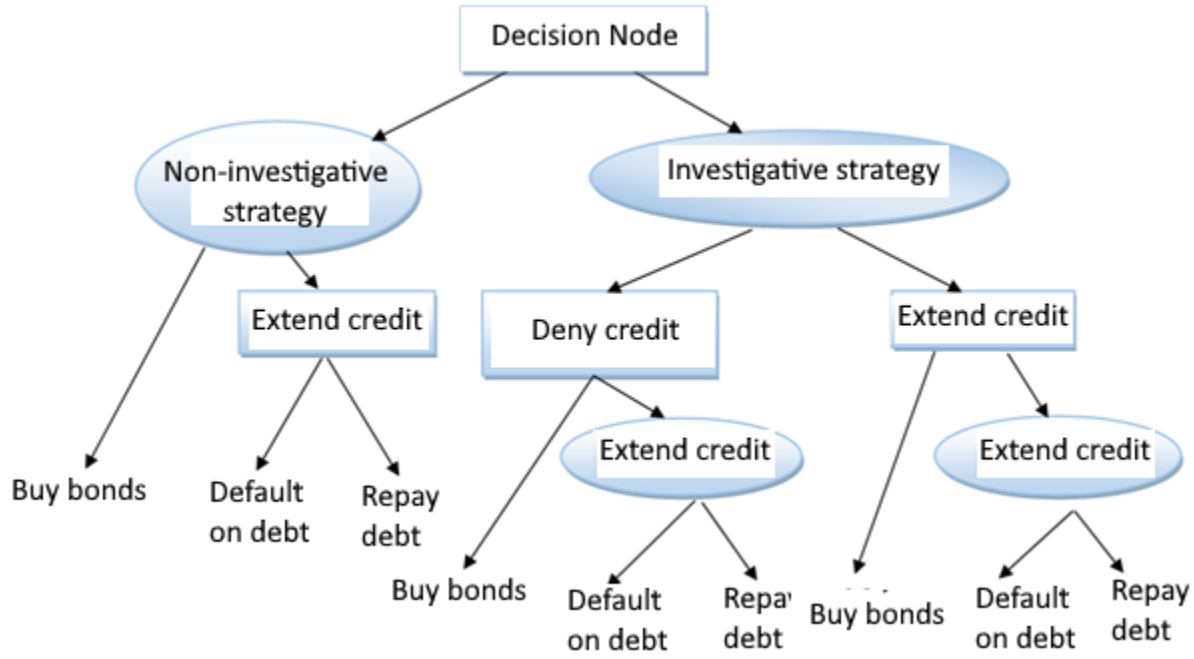

Fig. 2. Structure of the Decision Tree

- Step 3: Assign Probability Values to the Events (Figure 3)

$P(T_1) = \frac{430}{500}$; $P(T_2) = \frac{70}{500}$ $\quad$ $P(E_1/T_1) = \frac{421}{430}$; $P(E_2/T_1) = \frac{9}{430}$

$P(E_1) = 0{,}95$; $P(E_2) = 0{,}05$ $\quad$ $P(E_1/T_2) = \frac{59}{70}$; $P(E_2/T_2) = \frac{11}{70}$

- Step 4: Assign Payoff Values (Figure 3)

Estimated Profit Values from Lending Decisions:

$EMV_{S1} = 900.000 \times 8\% = 72.000$ (USD)

Estimated Profit from Investing in Government Bonds:

$EMV_{S2} = 900.000 \times 3\% = 27.000$ (USD)

- Step 5: Calculate the Maximum Expected Monetary Values (EMVs) and Make a Decision (Figure 3)

Strategy involving Pre-Lending investigation

*$S_1 - T_1$

Because $P(E_1/T_1) = \frac{421}{430}$; $P(E_2/T_1) = \frac{9}{430}$ therefore :

$EMV(S_3) = 72.000 \text{ x } \frac{421}{430} - 900.000 \text{ x } \frac{9}{430} = 51.656$ (USD)

* $S_1 - T_2$

Because $P(E_1/T_2) = \frac{59}{70}$; $P(E_2/T_2) = \frac{11}{70}$ therefore:

$EMV(S_3) = 72.000 \text{ x } \frac{59}{70} - 900.000 \text{ x } \frac{11}{70} = -80.743$ (USD)

Because $P(T_1) = \frac{430}{500}$; $P(T_2) = \frac{70}{500}$ therefore:

$EMV(S_1) = 51.656 \text{ x } \frac{430}{500} + 27.000 \text{ x } \frac{70}{500} = 48.204$ (USD)

Because the cost of conducting an investigation is 5,000 USD, in practice:

$EMV(S_1) = 48.204 – 5.000 = 43.204$ USD lớn hơn 27.000 USD

⇨ The bank's strategy is to conduct an investigation prior to making a lending decision.

Strategy without investigation

$P(E_1) = 0,95$; $P(E_2) = 0,05$

$EMV(S_3) = 72.000 \times 0,95 – 900.000 \times 0,05 = 23.400$ (USD) nhỏ hơn 27.000 USD

⇨ The bank's strategy is to invest in government bonds.

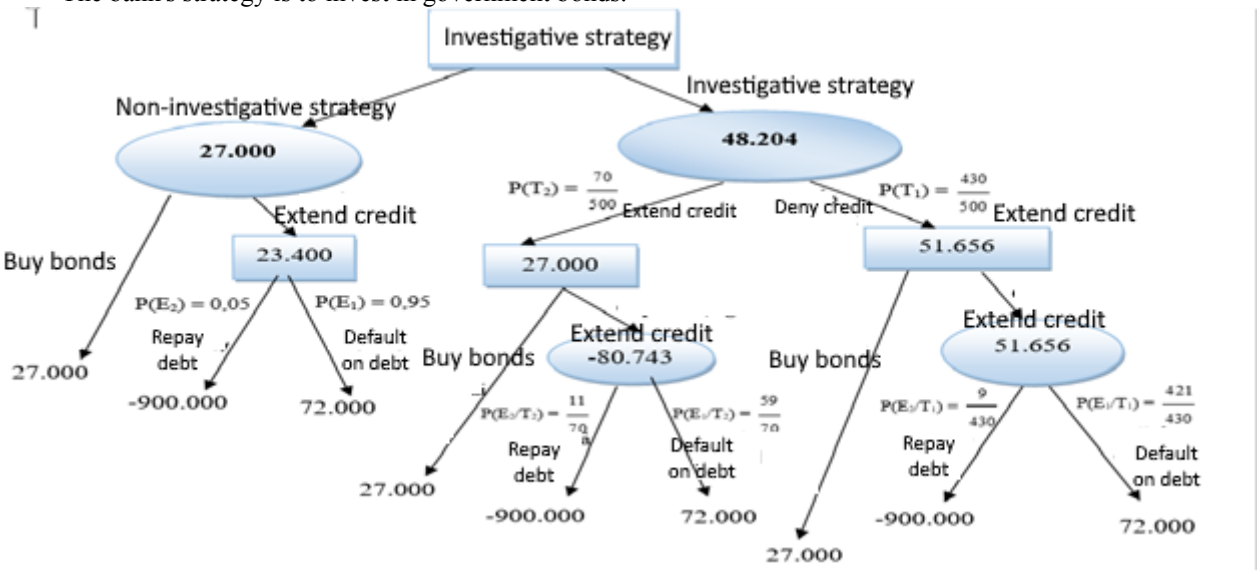

Fig. 3. Decision Tree Structure.

Through the structure of the Decision Tree, it becomes evident that prior to approving a loan, additional alternatives can be considered. This method also highlights potential adverse outcomes, such as a possible loss of 80,743 USD if the bank approves the loan and the borrower defaults. This approach helps mitigate risk, and the application of the Decision Tree technique enables the bank to achieve higher expected returns in this high-risk activity (43,204 USD > 27,000 USD).

Without applying the decision tree method	**Using the decision tree method**
Approving the loan to the enterprise yields a profit of 27,000 USD.	- If the investigation result recommends granting credit, the profit is 43,204 USD. - If the investigation result recommends not granting credit, the funds are allocated to government bonds, yielding a profit of 27,000 USD.

4. Conclusion

Quantitative analysis techniques in management assist banks in understanding and applying quantitative methods in decision-making by utilizing models and mathematical tools that quantify risk values and expected returns among different alternatives. The application of the Decision Tree method in calculating a credit loan at BIDV Quang Ngai has helped the bank improve the accuracy of credit risk prediction, thereby reducing risk and enabling better control over related risks to minimize potential losses.

The Decision Tree represents multiple alternatives within a single structure, allowing predictions on how customers might respond to loan interest rate adjustments, identifying which customers are likely to accept new credit product offers, which have a higher risk of default on a loan, and how to foster more beneficial customer relationships. This approach enables BIDV Quang Ngai to better understand current and potential customers, subsequently formulating policies and solutions to provide appropriate products and services, planning and implementing differentiated special incentives to retain customers.

In summary, banks regularly make decisions related to their credit granting processes. The success or failure of a decision heavily depends on the information available to the bank. Even with the same information, different banks may make different decisions. Banks always aspire to make accurate decisions; however, this is not always achievable in practice. Risk inevitably accompanies credit decisions. A seemingly good decision may yield unexpected negative outcomes, while a seemingly poor decision may result in positive outcomes. Therefore, the challenge lies not only in making the right decisions but also in managing unforeseen risks associated with those decisions. Consequently, banks need to enhance their capabilities in information analysis and processing, approach and evaluate issues effectively, improve judgment and forecasting skills regarding the environment and investment trends, and incorporate a degree of intuition and artfulness in credit decision-making to achieve operational efficiency.

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