



A Study on the Measurement of Collaborative Development of Financial Systems of Listed Companies Based on the Entropy-Coupling Coordination Degree Model-Taking BYD as an Example

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Abstract. The global automotive industry is currently undergoing a transition to new energy vehicles, and policies emphasize the establishment and improvement of corporate financial systems. Therefore, exploring the development and internal coupling of financial systems in new energy vehicle companies is of significant practical importance. This study uses the “entropy-coupling coordination” model to analyze the financial system of BYD. The analysis reveals the following: 1) BYD’s overall financial system score showed a continuous upward trend from 2020 to 2024. 2) For internal subsystems, solvency and profitability scored highly, while operational efficiency showed an initial decline followed by growth. 3) The degree of coupling coordination went through a process of “adjustment-low-level coupling-high-level coupling-benign resonance”.

Keywords: Financial System, Collaborative Development, Entropy-Coupling Coordination Model, BYD, New Energy Vehicles

1. Introduction

In the 1950s and 60s, with the development of computer technology, financial systems were proposed. The operation and maintenance of financial systems require the coordinated efforts of multiple sub-dimensions, and currently, a coupled coordination

model is commonly used to analyze their internal health, specifically including financial stability, growth potential, and coordination. As a crucial dimension supporting this development, exploring financial systems can effectively reflect the company's operational status and help it better achieve its financial goals.

Regarding the research on financial systems, different scholars have conducted diverse analyses, as follows. In terms of financial digital transformation, Tang and Cai (2025) proposed specific requirements for enterprises to improve efficiency and to make the four major strategies work together to improve the management capabilities of smart finance, providing a new path for the digital transformation of traditional financial management models [1]. Constructed a "compass model" based on the measurement problem of enterprise financial digital transformation, used the Word2Vec model to establish a multi-stage financial digital transformation dictionary, and used a steel company as a case to verify it [2]. In terms of financial risk warning, Wang et al (2025) used the Logistic regression model to predict and systematically analyze the financial distress of Chinese A-share listed companies, and found that the Logistic regression model can make good predictions from multiple aspects such as time period, results and effects, verifying the accuracy of the model in risk warning and providing a method for dynamic risk management [3]. In terms of collaborative development of financial management, Liu (2025) analyzed the opportunities and challenges that big data technology brings to corporate financial management, and proposed strategies such as web crawling technology and keyword matching algorithm for financial analysis, to help enterprises achieve digital transformation and improve the overall efficiency of financial management [4].

In summary, existing literature has made considerable progress in the research of current financial systems, with varying research scopes. However, most studies focus on a single dimension, lacking research on the degree of synergy among the various subsystems within the financial system. Therefore, this study utilizes the entropy method and a coupled coordination model, based on data from BYD's financial reports and annual reports from 2020 to 2024, to construct a measurement index system and method for the financial system of listed companies, calculate its internal and external coordination degree, propose optimization paths, and provide suggestions for the future development of listed companies.

2. Research Methods, Theories, and Data

2.1 Research Methods

Entropy Method. Entropy represents the degree of disorder in data. The smaller the entropy value, the more ordered the data is, the more information it provides, and the higher the weight. The larger the entropy value, the more disordered the data is, the less information it provides, and the lower the weight. This study uses the entropy method to calculate the annual score and weight. The specific calculation formula is as follows [5].

The first step is data standardization. Let x_{ij} represent the original data of the j -th indicator in the i -th sample, $\text{Max}x_j$ represent the maximum value of the j -th indicator in the sample, and $\text{Min}x_j$ represent the minimum value of the j -th indicator in the sample. X_{ij} represents the result of the normalization process.

$$\text{Positive indicator calculation: } X_{ij} = \frac{x_{ij} - \text{min}x_j}{\text{max}x_j - \text{min}x_j} + 0.0001(1)$$

$$\text{Negative indicator calculation: } X_{ij} = \frac{\text{max}x_j - x_{ij}}{\text{max}x_j - \text{min}x_j} + 0.0001(2)$$

$$\text{The second step is to calculate the weight of the index } p_{ij} = \frac{X_{ij}}{\sum_{i=1}^m X_{ij}}(3).$$

$$\text{The third step is to calculate the information entropy: } e_j = -k \sum_{i=1}^m p_{ij} \ln(p_{ij}),$$

where $k = \frac{1}{\ln m}(4)$

$$\text{The fourth step is to calculate the coefficient of variation of the } j\text{-th index: } g_j = 1 - e_j(5)$$

$$\text{The fifth step is to calculate the weight of the } j\text{-th index: } w_j = \frac{g_j}{\sum_{j=1}^n g_j}(6)$$

$$\text{The final step is to calculate the comprehensive score for each year: } S_i = \sum_{j=1}^n w_j \times p_{ij}(7)$$

Coupled Coordination Model. The coupling and coordination model is mainly used to evaluate and analyze the coupling and coordination relationship between systems, measure the degree of coordination between multiple subsystems, and reflect whether the internal and external systems are operating efficiently [6]. This study will analyze four subsystems within the financial system, namely operating capacity (reflecting the company's capital turnover), solvency (reflecting whether the company can repay its

debts in a timely manner and judging the company's development), profitability (most directly reflecting whether the company can continue to develop and whether it has the ability to repay its debts), and growth capacity (reflecting the company's overall situation and reflecting its development potential and direction). The higher the degree of coordination among the four subsystems, the better the company's operating conditions and the higher its health. The specific calculation steps are as follows. The first step is to calculate the coupling degree C , which measures the degree of coordination between subsystems. U_n represents the number of subsystems. The specific formula is as follows:

$$C = \left[\frac{U_1 \times U_2 \times \dots \times U_n}{\left(\frac{U_1 + U_2 + \dots + U_n}{n} \right)^n} \right]^{\frac{1}{n}} \quad (8)$$

Among them, $C \in [0,1]$. The second step is to calculate the degree of coordination, D . A high D value indicates good coordination, while a low D value indicates a state of imbalance. Calculate the coordination index T , where $T = \alpha U_1 + \beta U_2 + \dots + \gamma U_n$, α , β , and γ represent the weights of each subsystem, and the formula is: $D = \sqrt{C \times T \alpha}$, β , and γ are the subsystem weights. The specific coupling levels are shown in Table 1.

Table 1. Determination of Coupling Degree.

Coupling degree C	Coupling and Coordination Degree
$C=0$	Unrelated coupling
$0 < C \leq 0.3$	Low-level coupling
$0.3 < C \leq 0.5$	Antagonistic phase
$0.5 < C \leq 0.8$	break-in period
$0.8 < C < 1$	High-level coupling
$C=1$	Benign resonance

2.2 Theoretical Support

The financial system is an organic whole, composed of four subsystems: operational capability, solvency, profitability, and growth capability. These subsystems are closely interconnected, and only through their efficient and coordinated operation, where the overall function exceeds the functions of each subsystem, can an enterprise achieve sustainable development and create value.

2.3 Sample Analysis and Data Sources

This study selects BYD as the research object. BYD is a representative enterprise in the new energy industry and is in a period of rapid development. Its financial data is readily available, timely, and relatively complete. The financial statements include various subsystems, and quantitative analysis can be carried out on operations, debt repayment, profitability, and growth capabilities. BYD’s financial system shows a synergistic development effect, which is suitable for measurement using a coupling and coordination model. In terms of data acquisition, panel data from 2020 to 2024 are selected, specifically obtained through the company’s annual reports.

3. Research and Analysis

3.1 Construction of the indicator system

Based on scientific validity, rationality, data availability, and uniqueness, and with reference to existing scholars’ indicator construction, a measurement indicator system for BYD’s corporate financial system, as shown in Table 1, was constructed. Furthermore, by substituting the data into formulas (1)-(6), weighted scores were obtained, as shown in Table 2.

Table 2. BYD Corporate Financial System Measurement Index System (2020-2024).

Primary indicators	Secondary indicators	Unit	Weight	Indicator Attributes
Operational capabilities	working capital	1,000 yuan	6.36%	positive
	Non-current assets	1,000 yuan	8.15%	positive
	Operating revenue	1,000 yuan	8.74%	positive
Debt repayment ability	Debt financing and amount raised by non-financial enterprises	Ten thousand yuan	5.92%	positive
	Current liabilities	1,000 yuan	7.41%	positive
	Non-current assets and liabilities	1,000 yuan	14.29%	positive
Profitability	Liabilities and Shareholders’ Equity	1,000 yuan	7.58%	positive
	Operating profit	1,000 yuan	9.93%	positive
	Net profit	1,000 yuan	9.93%	positive

	Shareholders' equity	1,000 yuan	6.51%	positive
Growth potential	Net profit from continuing operations	1,000 yuan	9.93%	positive
	Minority shareholders' profit or loss	1,000 yuan	5.23%	negative

3.2 Comprehensive and Subsystem Analysis

Substituting the data into formulas (1)-(7), we obtain the following comprehensive score (Fig1) and subsystem score (Fig2). From the comprehensive score of BYD's corporate financial system from 2020 to 2024, we find a gradual upward trend. Through segmented analysis, we find that during the slow upward period from 2020 to 2021, specifically, the new energy industry policy was in a transitional period, new energy vehicles had just been launched, the scale was still small, and the company needed time to develop. The pandemic impacted the economy, leading to a downturn, insufficient supply chain, and significant R&D investment. During the rapid upward period from 2021 to 2024, the reasons were: national policies promoted environmental protection and energy conservation, new energy vehicles became the main choice for customers, sales of various models increased, the company's sales volume increased, the scale gradually increased, and the international market expanded, R&D expenses decreased, and cash flow was sufficient.

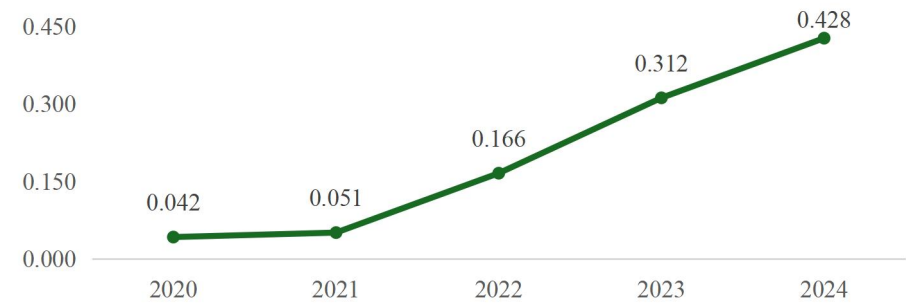


Fig.1. Overall score of BYD's corporate financial system (2020-2024).

For each subsystem, system analysis revealed that solvency performed better, showing a trend of initial decline followed by growth. Non-current liabilities had the highest weighting; the decline in 2021 was due to increased corporate spending and debt, leading to a decrease in solvency. However, with rapid corporate development, long-term solvency continued to grow. Secondly, profitability showed an upward trend, remaining flat in 2020-2021.

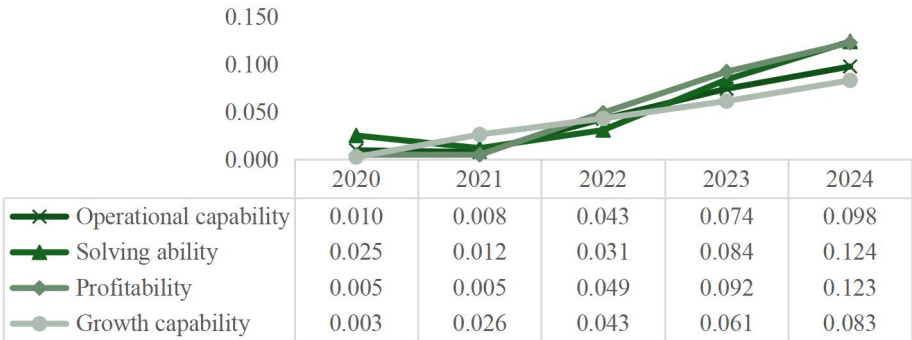


Fig. 2. Scores of each subsystem of BYD’s corporate finance system (2020-2024).

Later, with the expansion of corporate scale, technological improvements, and brand effect, operating profit increased, driving profitability improvement. Thirdly, operational efficiency showed an initial decline followed by growth. The decline in 2021 was due to increased sales volume and capital, delaying operational efficiency and leading to lower efficiency. Growth capability showed a mixed performance, but also maintained an upward trend. Net profit from continuing operations had a large weighting, reflecting the importance placed on the sustainability of corporate profits. Growth capability ensures the company’s future development potential.

3.3 Coupling Analysis

Substituting the data from 3.3 into formulas (8) and (9), we can obtain the following BYD corporate financial system coupling score (Table 3) and distribution (Fig. 3). Overall, the BYD corporate financial system coupling score shows an upward trend, which can be divided into a downward phase in 2020-2021, from the initial adjustment phase to a low-level coupling phase. The period from 2022 to 2024 is the upward phase, showing the best performance from high-level coupling to benign resonance.

Table 3. Coupling Score of BYD’s Corporate Financial System (2020-2024).

Year	Coupling degree C value	Coordination index T value	Coupling coordination degree D value	Coupling and Coordination Degree
2020	0.57	0.05	0.16	break-in period
2021	0.28	0.07	0.14	Low-level coupling

2022	0.93	0.35	0.57	High-level coupling
2023	1.00	0.71	0.84	Benign resonance
2024	1.00	0.99	1.00	Benign resonance

Specifically, the decline in the coupling score (C) in 2020-2021 was mainly due to the outbreak of the COVID-19 pandemic in 2020, which led to insufficient supply in the enterprise's production chain. Production of gasoline-powered vehicles was essentially halted, and new products needed time to launch, leaving enterprises in a downtime period, resulting in decreased operational capacity and debt repayment ability. In 2021, BYD expanded production, leading to increased interest expenses and a further decline in debt repayment ability. Internal system disruptions further reduced coupling. In 2020-2021, new energy enterprises experienced low profits but increased growth potential, indicating low coupling coordination.

The increase in the coupling score (C) from 2022 to 2024 was mainly due to the national "dual-credit" policy, which, starting in 2022, stimulated consumer spending. In 2023, economies of scale led to improvements in all indicators, including increased profits, debt repayment capacity, and operational efficiency. In 2023-2024, some BYD models became blockbuster products, doubling profits and further enhancing profitability and debt repayment capacity, demonstrating a high degree of coupling coordination.

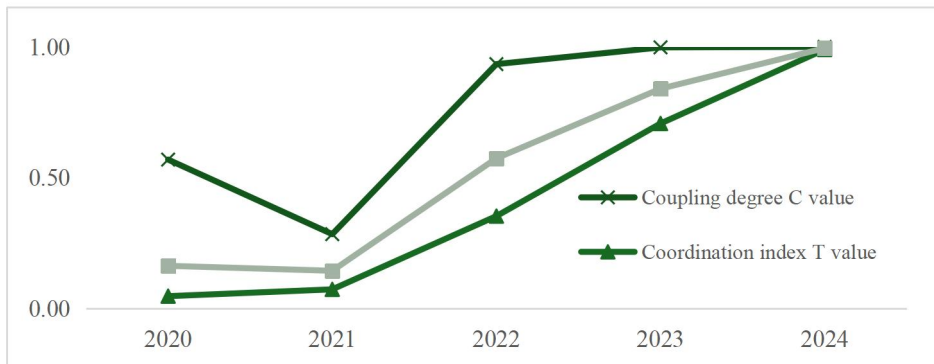


Fig. 3. Distribution of BYD's corporate financial coupling score (2020-2024).

4. Conclusion and Discussion

Through entropy analysis and coupling analysis, this study draws the following conclusions: 1) Comprehensive score analysis reveals that the overall score of the

financial system has increased rapidly due to technological improvements and scale expansion, showing a trend of slow start followed by rapid growth; 2) Through subsystem analysis, the four subsystems develop synergistically, forming a positive cycle. Operating capacity fluctuates before improving, solvency initially decreases then increases, profitability initially remains flat then increases, and growth capacity steadily improves; 3) Through coupling and coordination model analysis, the four subsystems develop synergistically, with the degree of coupling and coordination progressing from initial adjustment to eventual virtuous resonance. Based on the above analysis, the study predicts that the financial system will continue to exhibit virtuous resonance in the future. Due to time constraints and the selection of research subjects, this study suffers from poor practical application and insufficient focus on practicality. Therefore, future research conclusions can be used as theoretical support to achieve internal coupling and sustainable development of the financial system.

References

1. Tang Ninghua, Cai Yujie. How to improve the efficiency of enterprise financial management from the perspective of digital transformation [J/OL]. *Accounting Friend*, 2025,(S1): 110-114 [2026-02-13]. <https://link.cnki.net/urlid/14.1063.F.20251223.1018.056>.
2. Song Biao, Liu Gang, Qiao Hongyu. Research on the Measurement of Digital Transformation of Enterprise Finance [J]. *Accounting Friend*, 2025, (10): 102-110.
3. Wang Deqing, Xue Shoucong, Lu Zhihao, et al. Research on early warning of corporate financial distress based on functional logistic model [J]. *Operations Research and Management*, 2025, 34 (09): 46-52.
4. Liu Xiaohui. Opportunities and challenges of corporate financial management under the background of big data [J]. *Journal of Shanxi University of Finance and Economics*, 2025, 47 (S1): 175-177.
5. Cheng Sen. A KPI Design Method for Performance Appraisal of Water Conservancy Construction Enterprises Based on Entropy Method [J]. *Journal of Shandong University (Engineering Science)*, 2020, 50 (04): 80-84.
6. Xie Sixin, Hu Wei. Coupling and Coordination of High-Quality Economic Development and Technological Innovation: A Case Study of the Beijing-Tianjin-Hebei Region [J]. *Statistics and Decision*, 2021, 37 (14): 93-96.

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