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A Study on the Development of China's Financial Leasing Industry Based on Principal Component Analysis and ARIMA Model

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Abstract: The sustainable development of China's financial leasing industry is a growing concern among scholars. This paper analyzes the development data of China's financial leasing industry from 2008–2021, using the dimensions of scale, speed, efficiency, structure, and quality. By employing principal component analysis, we construct the development index of China's financial leasing industry and analyze the reasons for changes in the development level of the industry from the internal structure of the index. The study finds that scale serves as a key factor in the development of China's financial leasing industry. While the contribution value of the structure factor shows fluctuations, the contribution values of the return and risk factors remain relatively stable. Using the ARIMA (Auto Regressive Integrated Moving Average) prediction model based on the principal component analysis, we establish the prediction model of the financial leasing industry change in the coming years. The study reveals that the financial leasing industry has entered a period of transformation, where the growth rate of its scale has dropped. Furthermore, this paper offers proposals to address the increasingly prominent asset-liability maturity mismatch problem, promote business structure optimization, enhance the contribution value of the structure factor and the income factor, and facilitate sustainable, higher-quality industry development.

Keywords: financial leasing; level index; principal component analysis; ARIMA; prediction model; evaluation index system; structural analysis

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1. Introduction

Leasing equipment instead of purchasing it outright is a viable option to consider in the finance industry [1]. The financial leasing industry began to rapidly evolve worldwide during the 1960s as it adjusted itself to meet the demands of economic growth. In the 1980s, China implemented reforms and introduced foreign investment, technology, and equipment, thus paving the way for the country's first financial leasing company to be established in 1981. Initially, the Chinese people had little knowledge of the financial leasing industry. Due to the lack of proper regulation, legal guidance, tax policies, and other supporting measures, China's financial leasing sector developed slowly and inconsistently. By the end of 1999, the combined assets of all financial leasing companies in China totaled only RMB 18.2 billion, placing the country 21st globally in terms of annual lease transaction volume [1].

In 2001, China joined the World Trade Organization, thereby agreeing to uphold the General Agreement for Trade of Services (GATS). According to GATS, China opened its financial market to member countries, granting foreign commercial banks and leasing companies' national treatment, and the ability to participate in financial leasing activities in China. Following the WTO Protocol, after five years of entering into the WTO, non-prudential measures that restrict the operation and establishment of foreign banks will be

eliminated. Foreign commercial banks and leasing companies may then apply for permission to establish financial leasing firms in China and engage in financial leasing activities.

To accommodate the opening up of the financial industry, the China Banking Regulatory Commission revised their Measures for the Administration of Financial Leasing Companies in 2007, again allowing Chinese commercial banks to enter the financial leasing field. Financial leasing firms controlled by commercial banks possess significant registered capital, with an operating leverage ratio that can reach up to 12 times. With strong support from their shareholders, the assets of these financial leasing companies increased exponentially in just a few years, spurring the industry to experience rapid development. By the end of 2021, the number of financial leasing firms operating in China rose from 12 in 2008 to 68 in 2021, with 47 of these companies established by banks holding or participating, accounting for nearly 70% of the total. The total assets of China's financial leasing industry expanded from CNY 80.2 billion in 2008 to approximately CNY 3.5 trillion in 2021, with an average annual asset growth rate of over 33%. Financial leasing firms under the control of banks drove China's development into the world's second-largest leasing market.

The robust development of China's financial leasing sector has garnered significant attention from Chinese scholars and experts. They have tracked and analyzed the sector's evolution, discovered some peculiar phenomena, and discussed the issues hidden behind it. Using 2021 as an example, among the new leasing volume in the same year, leaseback accounted for 90.15%, with direct leasing comprising only 9.85%. Finance leasing accounted for 92.95%, while operating leasing made up only 8.95%, of which nearly half was in Building-type fixed asset leasing, while equipment leasing accounted for a relatively low percentage. Is this style of leasing "true leasing"? Is it sustainable? These phenomena and questions have also drawn the attention of regulatory authorities. The China Banking Regulatory Commission believes that the Building-type fixed asset leaseback business is more akin to bank mortgage activities, rather than a genuine leasing business, and has begun to demand that financial leasing firms reduce their balance of leased assets for Building-type fixed assets incrementally.

In response to these phenomena and concerns, we have conducted an analysis of the global mature leasing markets, comparing them to the development of China's financial leasing industry.

Firstly, the lease penetration ratio is an essential indicator for measuring a country's financial leasing industry development. It serves as a reflection of the industry's maturity and acceptance level within a country. Currently, there are two commonly used metrics to evaluate this ratio: market penetration and GDP penetration. We collected data on China's GDP penetration ratio for comparison with developed countries such as the US and UK, as shown in Table 1 from the 44th edition of the World Leasing Yearbook [2]. In 2021, China's market penetration and GDP penetration ratio were 9.9% and 1.92%, respectively, while in the US, it was 22% and 2.06%, and in the UK, it was 35.2% and 2.89%. Despite total assets in China's financial leasing industry surpassing CNY 3.5 trillion, there is still a considerable gap compared to developed countries.

Table 1. A comparison of the GDP penetration ratio in different countries (%).

Annual	China	United States	United Kingdom	Germany	France	Canada	Sweden	Italy
2008	0.51	0.76	0.72	1.95	1.40	1.23	2.18	1.71
2009	0.82	1.23	0.67	1.66	1.20	0.98	1.98	1.26
2010	0.92	1.25	0.82	1.62	1.23	0.97	2.05	1.26
2011	0.94	1.77	2.15	2.04	1.29	1.37	1.94	1.12
2012	1.24	1.86	2.47	1.92	1.27	2.18	3.98	0.86
2013	1.11	1.92	2.67	2.01	1.25	0.71	3.82	0.87

Table 1. *Cont.*

Annual	China	United States	United Kingdom	Germany	France	Canada	Sweden	Italy
2014	1.29	1.95	2.84	1.87	1.12	1.69	3.30	0.80
2015	1.37	2.08	3.02	1.71	1.05	1.39	3.03	0.77
2016	1.84	2.06	3.11	1.85	1.58	1.69	3.93	1.37
2017	2.21	2.11	3.52	2.12	1.92	1.60	4.65	1.73
2018	1.9	2.08	3.26	1.86	1.88	1.43	3.75	1.73
2019	1.71	2.21	3.41	2.26	2.13	1.54	3.70	1.65
2020	2.02	2.11	3.08	2.08	2.17	1.73	3.77	1.56
2021	1.92	2.06	2.89	2.12	2.02	1.54	4.01	1.64

However, the COVID-19 pandemic in 2020 had a severe impact on the economy, which led to further volatility in the development of the financial leasing industry. To analyze this development further, we assumed no COVID-19 epidemic in 2020 and 2021, and that the growth rates of China's GDP and annual leasing volume remained constant with the average growth rates from 2015 to 2019 or 2019 itself, defined as scenarios 1 and 2. We found that the GDP penetration ratio in 2020 would decrease to 1.60 and 1.85, while in 2021, it would fall to 1.40 and 1.87, as shown in Table 2. Figure 1 demonstrates that the rapid development of China's financial leasing industry has aided in increasing the leasing penetration ratio. However, since 2018, the GDP penetration ratio of China's financial leasing industry has experienced fluctuation and decline, regardless of the scenario considered. The sustainable development of the leasing industry has encountered challenges, and the increase in the GDP penetration ratio has encountered difficulties.

Table 2. A comparison of the GDP penetration ratio under different scenarios.

Annual	2015	2016	2017	2018	2019	2020	2021
GDP (Billion $)	9959.85	11,340.37	11,367.87	13,390.53	14,705.85	14,861.88	17,784.38
GDP (scenarios 1, Billion $)	9959.85	11,340.37	11,367.87	13,390.53	14,705.85	15,522.97	17,586.60
GDP (scenarios 2, Billion $)	9959.85	11,340.37	11,367.87	13,390.53	14,705.85	15,822.76	18,272.46
Annual leasing volume (Billion $)	136.45	208.66	251.23	254.42	251.47	300.21	341.46
Annual leasing volume (scenarios 1, Billion $)	136.45	208.66	251.23	254.42	251.47	248.55	245.67
Annual leasing volume (scenarios 2, Billion $)	136.45	208.66	251.23	254.42	251.47	293.00	341.38
GDP penetration ratio (%)	1.37	1.84	2.21	1.9	1.71	2.02	1.92
GDP penetration ratio (scenarios 1, %)	1.37	1.84	2.21	1.9	1.71	1.60	1.40
GDP penetration ratio (scenarios 2, %)	1.37	1.84	2.21	1.9	1.71	1.85	1.87

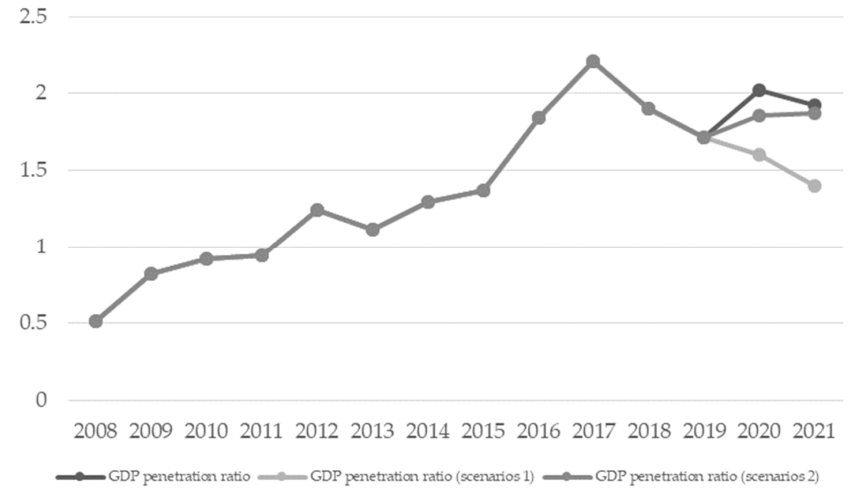

Figure 1. The GDP penetration ratio under different scenarios.

The second dimension concerns the proportion of equipment leasing. According to a survey report released by the Equipment Leasing and Finance Association (ELFA) in 2021, equipment leasing dominates the U.S. financial leasing industry, comprising over 90% of the total. The top five financed equipment types in the U.S. are transportation equipment, IT and related technical services, construction equipment, agricultural equipment, and industrial and manufacturing equipment. Meanwhile, data from the European Leasing Association indicates that combined vehicle and equipment leasing accounted for an average of 96.2% of new business from 2016 to 2021, with real estate leasing accounting for an average of 3.8%. On the other hand, in China, as per data from the China Banking Association, special and transportation equipment leasing constitutes approximately 55% of financial leasing companies' overall portfolio, while infrastructure leases such as water supply, heating, and sewage comprise around 30%, with other types of leases representing approximately 15%. It is worth highlighting that the percentage of equipment leasing business in mature leasing markets in Europe and America far surpasses that of equipment leasing assets in China.

The third aspect refers to the proportion of direct leasing. In mature leasing markets, where legal and tax policies are relatively robust, equipment is primarily leased through direct leasing, with leasebacks accounting for a minor proportion as they belong to capital financing. Meanwhile, in China, large and medium-sized enterprises use leasebacks as an alternative financing method to credit due to insufficient financial development and limited financial resources. Additionally, the leaseback business requires less professional capacity, which favors financial leasing companies seeking to expand their operations. Furthermore, the leasing policies in certain sectors such as vehicles, special equipment, and medical equipment are not entirely perfect, causing financial leasing companies to opt for the leaseback mode. As a result of these factors, leaseback has emerged as the primary driving force behind the growth of China's financial leasing industry.

The fourth aspect pertains to the classification of leases. As per a survey sample conducted by the China Banking Association among financial leasing companies, a whopping 55% of the leases served by China's financial leasing companies are large enterprises, followed by 28% for medium-sized enterprises, 15% for small-sized enterprises, and 2% for micro-enterprises. In contrast, in Europe, approximately two-thirds of the leases are private enterprises, with end customers accounting for roughly 30%, and public institutions making up only 3% of the lease composition. On the other hand, in the United States, the primary focus of new business revolves around serving small and medium-sized enterprises, with 39% of orders being small, 47% medium, and only 14% large.

After conducting a comparative analysis of the aforementioned dimensions, we have discovered discernible disparities between China's financial leasing industry and the evolution of established leasing markets in the United States and Europe. As such, the sustainability of China's financial leasing industry, along with other pertinent issues such as lingering complications, future action items, strategies to enhance leasing penetration, and the efficacy of proposed regulatory policies, are all imperative questions that demand careful consideration from esteemed experts and scholars.

To address this issue, we conducted a comprehensive review of current domestic and foreign research and attempted to uncover potential solutions. Financial leasing scholars have focused on several key areas, including:

Firstly, they carefully examine the structure and development trends of the financial leasing market. They provide an introduction to the origin and evolution of lease financing as a critical tool for asset financing [3,4]. Additionally, they discuss in detail the operation of leasing and the essential factors and policies that affect its development [5]. The authors stress the importance of regulation, accounting, taxation, and law in fostering the growth of the financial leasing industry. Furthermore, they identify the following five factors as drivers of development: economic environment, financing, policy, technology, and competition. After conducting a comprehensive comparison of the financial leasing industry's development across various countries, the authors identified six phases of the

leasing cycle: rentals, simple finance lease, creative finance lease, operating lease, new products, and maturity [6]. They then examine the peculiarities and problems of international leasing, viewing it as an integral part of the world economy's development and stabilization [7]. In addition, the authors discuss new outlooks and characteristics shown by the financial leasing industry in recent years. They analyze new opportunities and challenges facing the industry's growth and point out the direction of innovation and transformation for the industry [8–11]. Secondly, the authors investigate leasing product design and pricing strategies, which encompass the leasing mode of special equipment and conventional medium- to long-term equipment. They formulate leasing rates and conduct cash flow analyses, evaluations, and other related activities [12–16]. Thirdly, the authors explore the effects of financial leasing on enterprise financial decision-making and risk management. This includes making comparisons between leasing and direct purchasing, examining the substitution effect of leasing and debt or equity financing, and assessing the impacts on financial leverage and profitability [17–21]. Fourthly, the authors conduct comparative analyses of the international financial leasing market. They examine discrepancies in legislative environments, tax policies, and industry norms across different countries. They also discuss cross-cultural communication and risk control issues involved in leasing transactions [22–25]. Lastly, the authors engage in investigations and analyses of the regulations and policies of the financial leasing industry. This includes evaluating the roles and responsibilities of regulatory agencies, formulating and implementing regulatory rules, and assessing the impact of policy stimulation measures [26–28].

Scholars have established a general theoretical framework for examining the sustainable development of China's financial leasing industry. However, custom analysis is necessary to identify specific issues. The existing research primarily involves qualitative analyses with no measurable support for proposed solutions. This paper aims to address these gaps by constructing a development-level index and analyzing quantitative data. By assessing key drivers and potential structural problems in the financial leasing industry, regulators can craft guiding policies while financial leasing firms can make informed business decisions. To further guarantee stability and sustainability, an ARIMA model is utilized to predict future industry developments; this feature is of great practical importance.

The structure of this paper is as follows: Section 2 introduces the study area and outlines the analysis methods used. In Section 3, we present the principal component and industry development index, along with our predictions. Section 4 discusses the main findings, limitations, and potential directions for future research. Section 5 contains concluding remarks and policy recommendations.

2. Materials and Methods

2.1. Study Area

Prior to 2018, the Chinese financial leasing industry was divided into two categories of three institutions, as per different regulatory bodies. The first category comprised financial leasing companies established with the approval of the China Banking and Insurance Regulatory Commission, which belong to non-bank financial institutions. The second category belongs to general industrial and commercial enterprises and includes foreign-funded financial leasing companies and domestic pilot financial leasing companies. Foreign-funded leasing companies record their business operations with the former, while the latter need to gain approval for their establishment from the Ministry of Commerce and the State Administration of Taxation or their authorized institutions.

In 2018, the Chinese government unified the financial leasing business under the supervision of the China Banking and Insurance Regulatory Commission. This paper primarily focuses on the financial leasing industry, which includes financial leasing companies approved and established by the China Banking and Insurance Regulatory Commission. As part of the financial industry, there are currently 68 financial leasing companies that have received approval from the commission.

2.2. Data Analysis

The financial leasing industry is an integral part of the economic system, evaluated through quantitative and qualitative measures. Quantitative factors include scale, speed, and operational efficiency, while qualitative factors include market structure and development quality. To assess China's financial leasing industry systematically, this paper uses indicators from five dimensions—scale, speed, efficiency, structure, and quality—to create a composite level index (Table 3).

Table 3. China's financial leasing industry development level evaluation index system.

First-Level Indicators	Second-Level Indicators	Explanation of Indicators	Unit
Scale and Speed	Total industry assets	Sum of total assets of each financial leasing company	(Billion Yuan)
	New leasing volume	Sum of the annual new leasing amount of each financial leasing company	(Billion Yuan)
Efficiency	Total industry profit	Sum of the total profit of each financial leasing company	(Billion Yuan)
	Return on Assets	Total industry profit/Total industry assets	%
	Economic Support Rate	(Total industry financial leasing assets + total industry operating leasing assets)/GDP	%
Structure	Percentage of operating lease assets	Total industry operating leasing assets/(total industry financial leasing assets + total industry operating leasing assets)	%
	Industry concentration CR5	Sum of the market shares of the top five financial leasing companies in the industry	%
Quality	Industry Non-performing Loads Ratio	Ratio of industry non-performing loads to all assets	%
	Total Asset Impairments Allowance	Total asset impairments allowance of the financial leasing industry	(Billion Yuan)

Financial leasing companies play a crucial role in stimulating economic growth by providing financing options to real economy businesses. The size of their total assets not only shows the scale but also indicates the market impact of the industry and reflects its development and evolution. Furthermore, the growth rate of new leasing showcases its pace of development.

To ensure efficient operations in the financial leasing industry, two critical factors come into play—quantity and rate. The industry's overall effectiveness is demonstrated by its total profit, with higher profits indicating better industry operation. Return on assets is an essential metric that measures operational efficiency, profitability, and management, and can also help identify areas of improvement. Additionally, a higher support rate for the financial leasing industry signifies greater economic significance.

The financial leasing industry includes operating and financial leasing. The six phases of Sudhir Amembal's leasing cycle suggest that the initial stages have a relatively higher proportion of financial leasing assets than operating leasing assets. As the industry matures, the proportion of operating leasing assets increases, highlighting the development of the industry. The ratio of operating leasing assets and CR5, reflecting the top-five companies' market share, helps determine market competition and structure.

Asset quality is crucial in determining the financial leasing industry's performance, with non-performing loans ratio measuring risk management abilities. Industries with higher non-performing loan ratios are generally at high risk, whereas a higher total impairment allowance indicates better resistance against risks.

2.3. Data Normalization

Based on the indicators chosen in Table 3, we collected data from the National Bureau of Statistics and the Financial Leasing Professional Committee of the China Banking Association to study the development of China's financial leasing industry from 2008 to 2021. To ensure comparability and eliminate dimensionality, we normalized the selected indicator scores using Z-Score normalization method through SPSS. Please refer to Table 4 for further details on the normalized data.

Table 4. Development data of China's financial leasing industry after standardization.

Annual	Total Industry Assets	New Leasing Volume	Total Industry Profit	Return on Assets	Economic Support Rate	Percentage of Operating Lease Assets	Industry Concentration CR5	Industry Non-Performing Loads Ratio	Total Asset Impairments Allowance
2008	−1.292	2.638	−1.310	1.136	−1.889	0.936	1.843	2.097	−1.049
2009	−1.224	1.112	−1.262	−1.096	−1.598	0.165	1.721	0.370	−1.020
2010	−1.093	1.112	−1.125	−.538	−1.019	−0.220	1.052	−1.357	−0.966
2011	−0.916	.349	−0.923	0.090	−0.739	−0.992	0.565	−1.357	−0.895
2012	−0.687	0.120	−0.628	0.927	−0.247	−0.992	0.504	−1.357	−0.756
2013	−0.507	−0.490	−0.329	2.113	−0.315	−1.377	0.200	−1.357	−0.549
2014	−0.285	−0.567	−0.174	0.927	−0.016	−0.606	−0.104	0.370	−0.380
2015	0.014	−0.490	−0.070	−0.817	0.493	−0.220	−0.530	0.370	−0.192
2016	0.383	−0.338	0.353	−0.399	1.069	0.551	−0.895	0.370	0.145
2017	0.563	−0.414	0.418	−1.027	0.933	0.936	−0.835	0.370	0.251
2018	1.095	−0.796	0.827	−1.445	0.905	0.165	−1.017	0.370	0.862
2019	1.063	−0.796	1.185	0.229	0.558	−0.220	−0.774	0.370	1.090
2020	1.322	−0.567	1.390	−0.050	1.010	−0.606	−0.835	0.370	1.538
2021	1.564	−0.872	1.649	−0.050	0.854	2.479	−0.895	0.370	1.921

Subsequently, in the second stage, we conducted KMO (Kaiser–Meyer–Olkin) and Bartlett's tests to determine if the insights in Table 4 were appropriate for PCA. Based on our results, with KMO value at 0.717 as displayed in Table 5, and a p-value deemed extremely small calculated from Bartlett's test of sphericity close to 0, it is apparent that our indicators and data passed the adequacy tests and are suitable for further PCA analysis.

Table 5. KMO test and Bartlett's test of sphericity.

The Kaiser-Meyer-Olkin metric of sampling adequacy		0.717
Bartlett's test for sphericity	Approximate cardinality	188.570
	df	36
	Sig.	0.000

2.4. Principal Component Analysis (PCA)

Principal component analysis (PCA) is a statistical technique that transforms and combines original variables into several new uncorrelated composite variables to capture as much information about the data as possible [29]. Scholars commonly use PCA to study complex systems, particularly in the context of economic and social development. For example, scholars have constructed China's financial development index using PCA to measure financial development [30,31] and evaluated the indices of the insurance and logistics industries through PCA [32,33]. In this paper, we apply PCA to reduce the dimensionality of indicators reflecting the development of China's financial leasing industry. By creating unrelated composite variables, we construct a comprehensive development index of the financial leasing industry. In general, the construction of the development index through principal component analysis includes the following steps:

The first step is to construct the sample matrix and normalize the data. Based on the data in Table 3, we construct an $n \times p$ matrix X, where $n = 14$, $p = 9$. Then the data are normalized to ensure that all variables are measured in the same units.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}. \quad (1)$$

The second step is to calculate the correlation matrix R. The correlation coefficient matrix of matrix X is the covariance matrix of X, as follows:

$$R = Cov(X) = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{12} & r_{22} & \cdots & r_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pp} \end{bmatrix} = \begin{bmatrix} 1 & r_{12} & \cdots & r_{1p} \\ r_{12} & 1 & \cdots & r_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & 1 \end{bmatrix}. \quad (2)$$

Among them:

$$r_{ij} = \frac{\sum_{k=1}^{n} \left(x_{ki} - \bar{x_i}\right)\left(x_{kj} - \bar{x_j}\right)}{\sqrt{\sum_{k=1}^{n} \left(x_{ki} - \bar{x_i}\right)^2 \sum_{k=1}^{n} \left(x_{kj} - \bar{x_j}\right)^2}}. \quad (3)$$

The third step is to calculate λ which is the eigenvalues of the matrix R and the eigenvectors associated with λ. Since R is a positive semi-definite matrix, its eigenvalues are all positive. We sort the eigenvalues from largest to smallest.

$$\lambda_1 \geq \lambda_2 \geq \cdots \lambda_p \geq 0 \quad (4)$$

The fourth step is to calculate the principal component contribution rate and select the appropriate principal component. In general, the mathematical criterion for selecting principal components is determined by the cumulative contribution rate of the principal components. For the principal component i, its contribution is as follows.

$$\lambda_i / \sum_{i=1}^{p} \lambda_i \quad (5)$$

The cumulative contribution rate of the first m principal components is as follows.

$$\sum_{i=1}^{m} \lambda_i / \sum_{i=1}^{p} \lambda_i \quad (6)$$

When the cumulative contribution rate reaches 85% to 95%, the associated principal component has reflected sufficient information. Therefore, it can be used to solve specific problems.

The fifth step is to calculate the level index. Each principal component represents one or several variables. We need to construct a function to illustrate the relationship between the principal components and the variables, such as

$$F_n = a_1 \times X_1 + a_2 \times X_2 + \cdots + a_p \times X_p \quad (7)$$

The coefficients in the function F_n are obtained by dividing the loading matrix by the square root of the eigenvalues of the principal components. Suppose we select m principal components, the composite variable F_e is as follows.

$$F_e = \sum_{i=1}^{m} \left(\left(\lambda_i / \sum_{i=1}^{p} \lambda_i\right) \times F_m \times \left(\sum_{i=1}^{p} \lambda_i / \sum_{i=1}^{m} \lambda_i \right) \right) \quad (8)$$

Based on the composite variable, we can derive the level index *FLDI* as follows.

$$FLDI = F_e + 1 - F_{emin} \quad (9)$$

2.5. ARIMA Model

ARIMA is a highly effective statistical model used in univariate time series forecasting. It integrates three techniques: auto-regression, stationary differencing, and moving averages [34,35]. Auto-regression models the relationship between the dependent variable and its lagged values. Stationary differencing takes the difference of consecutive observations to eliminate any trend or seasonality in the data. Finally, the moving average utilizes past forecast errors to estimate future values. Together, these techniques create dynamic and

accurate models that can capture trends, patterns, and relationships in complex time series data. It has the advantages of a small sample size, reliance on endogenous variables without the need for other exogenous variables (i.e., relying only on the data itself), and simplicity of the model [36]. The mathematical representation of the ARIMA model is as follows

$$Y(t) = c + \varphi 1Y(t-1) + \varphi 2Y(t-2) + \ldots + \varphi pY(t-p) + \varepsilon t + \theta 1\varepsilon(t-1) + \theta 2\varepsilon(t-2) + \ldots + \theta q\varepsilon(t-q)$$

Among them, p represents the order of auto-regression, d represents the degree of differencing, q represents the order of moving average, $Y(t)$ is the time series data at time t, c is a constant term, εt is an error term, $\varphi 1 \ldots \varphi p$ are autoregressive coefficient, $\theta 1, \ldots \theta q$ are moving average coefficients.

This formula represents the general expression for ARIMA models. In particular, the autoregressive integrated moving average (ARIMA) model is a popular time series forecasting method, which combines auto-regression (AR), integration (I), and moving average (MA) components to produce forecasts. Due to its maturity and effectiveness, ARIMA is widely used in finance [37], economics [38], medicine [39], and other fields [40–42] where time series analysis plays a critical role in predicting future outcomes and understanding past behavior. To use ARIMA, follow these steps as shown in Figure 2:

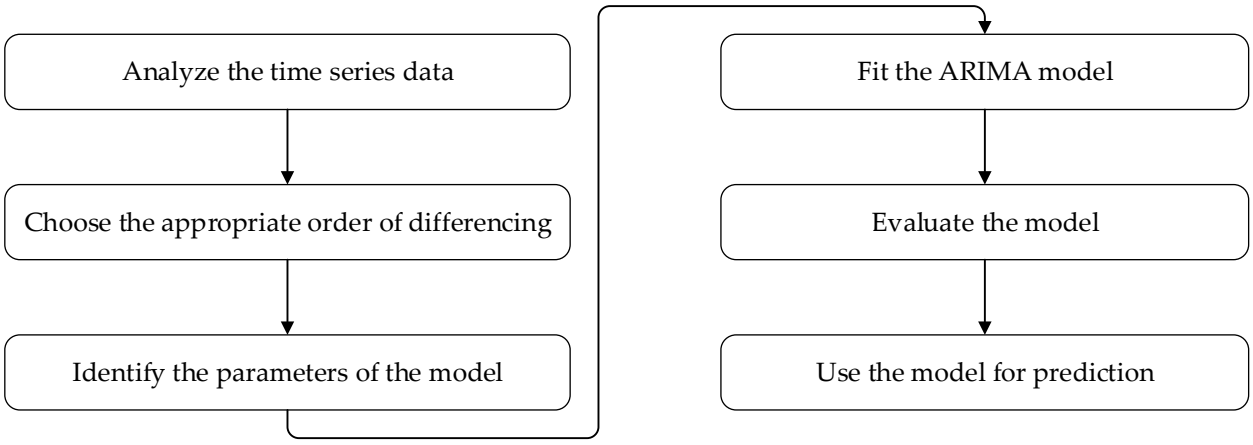

Figure 2. Steps to use ARIMA model.

The first step in using ARIMA is to analyze the time series data to determine its characteristics such as patterns, trends, and seasonality. This can be conducted using various tools such as visualizations, autocorrelation functions, and other statistical tests. The next step is to choose the appropriate order of differencing (d), which involves transforming the data by taking the differences of consecutive observations until it becomes stationary. A stationary time series has constant mean, variance, and covariance over time. Once the differenced data is stationary, the next step is to identify the parameters of the ARIMA model. The parameters are p, d, and q. p refers to the number of autoregressive terms, d is the order of differencing, and q is the number of moving-average terms. After identifying the parameters, the next step is to fit the ARIMA model on the data. This can be conducted using various algorithms such as maximum likelihood estimation (MLE), which estimates the parameters that maximize the likelihood of observing the data. Once the model is fit, the next step is to evaluate its performance by measuring its accuracy using metrics such as mean absolute error (MAE), root-mean-square error (RMSE), and others. After evaluating the model, it can be used for future predictions of the time series data. This involves forecasting future values of the dependent variable based on past observations and estimated parameters of the ARIMA model.

3. Results

3.1. Principal Components

We apply PCA to reduce the dimensionality of the normalized data in Table 4. After that, we extract the principal components. Since there are nine indicators in Table 3, the PCA can generate nine components. However, only those with a high eigenvalue are selected as principal components (PCs) and the others can be ignored. We derived the total variance and the eigenvalue scree plot by SPSS software, as shown in Table 6 and Figure 3. It can be seen from Table 6 and Figure 3 that the cumulative variance contribution of the first four variables reached 96.605%. The first variable has the largest eigenvalue, explaining 62.517% of the total variance, and variables from the fourth to the ninth have smaller eigenvalues. Therefore, we extract the first four variables as principal components.

Table 6. Total variance.

Ingredients	Initial Eigenvalue			Extraction of Squares and Loading			Rotate Square and Load		
	Total	Variance of %	Accumulation %	Total	Variance of %	Accumulation %	Total	Variance of %	Accumulation %
1	5.627	62.517	62.517	5.627	62.517	62.517	5.326	59.176	59.176
2	1.826	20.285	82.802	1.826	20.285	82.802	1.159	12.874	72.051
3	0.862	9.580	92.382	0.862	9.580	92.382	1.152	12.796	84.847
4	0.380	4.223	96.605	0.380	4.223	96.605	1.058	11.758	96.605
5	0.214	2.379	98.984						
6	0.080	0.884	99.868						
7	0.009	0.096	99.964						
8	0.002	0.024	99.988						
9	0.001	0.012	100.000						

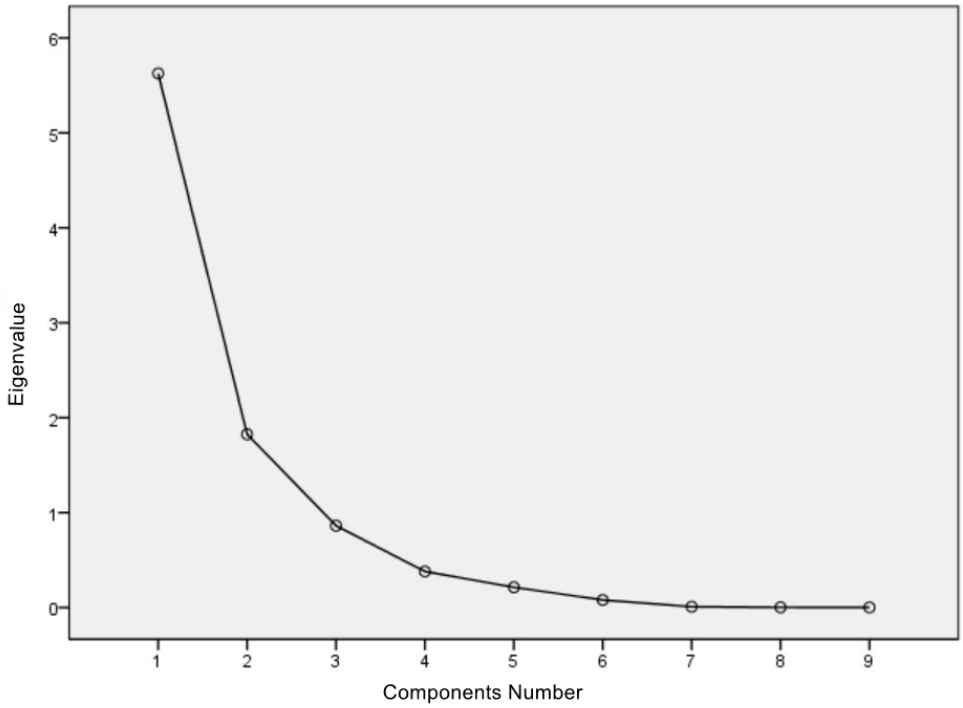

Figure 3. Scree plot.

We rotated the principal components through SPSS to give a better interpretation of the extracted variables. Table 7 shows the loading matrix. It can be seen that the variable F1 is significantly and positively associated with the three indicators of asset size, total profit, and economic support rate. Therefore, we define F1 as the Scale-variable of the financial leasing industry. Similarly, F2 is positively associated with the operating lease asset ratio, F3 is positively associated with the non-performing asset ratio of the industry, and F4 is positively associated with the return on assets, so we define F2, F3, and F4 as the Structural-variable, the Risk-variable, and the Return-variable of the financial leasing industry.

Table 7. Loading matrix.

	Variables			
	F_1	F_2	F_3	F_4
Total industry assets	0.944	0.243	0.154	−0.098
New leasing volume	−0.923	0.158	0.230	0.054
Total industry profit	0.952	0.240	0.132	−0.001
Return on Assets	−0.144	−0.164	−0.075	0.968
Economic Support Rate	0.956	−0.005	0.005	−0.186
Percentage of operating lease assets	0.131	0.886	0.338	−0.209
Industry concentration CR5	−0.968	0.015	−0.015	0.153
Industry Non-performing Loads Ratio	0.040	0.278	0.954	−0.076
Total Asset Impairments Allowance	0.886	0.357	0.162	−0.023

3.2. Development Index

We obtained the component matrix and component score coefficient matrix through SPSS, as shown in Tables 6 and 7. Based on the Equation (7), we multiply the coefficients in Table 8 with the original data to obtain F1, F2, F3, and F4 as shown in Table 9.

$$F_1 = 0.42 \times X_1 - 0.35 \times X_2 + 0.41 \times X_3 - 0.14 \times X_4 + 0.40 \times X_5 + 0.16 \times X_6 - 0.40 \times X_7 + 0.09 \times X_8 + 0.40 \times X_9 \quad (10)$$

$$F_2 = 0.03 \times X_1 + 0.35 \times X_2 - 0.001 \times X_3 - 0.30 \times X_4 - 0.14 \times X_5 + 0.60 \times X_6 + 0.15 \times X_7 + 0.61 \times X_8 + 0.09 \times X_9 \quad (11)$$

$$F_3 = 0.08 \times X_1 + 0.06 \times X_2 + 0.17 \times X_3 + 0.91 \times X_4 - 0.09 \times X_5 + 0.03 \times X_6 + 0.05 \times X_7 + 0.31 \times X_8 + 0.17 \times X_9 \quad (12)$$

$$F_4 = 0.03 \times X_1 + 0.04 \times X_2 + 0.07 \times X_3 + 0.14 \times X_4 - 0.14 \times X_5 + 0.65 \times X_6 + 0.15 \times X_7 - 0.69 \times X_8 + 0.18 \times X_9 \quad (13)$$

Table 8. Component score coefficient matrix.

	Variable			
	A_1	A_2	A_3	A_4
Total industry assets	0.42	0.03	0.08	0.03
New leasing volume	−0.35	0.35	0.06	0.04
Total industry profit	0.41	−0.001	0.17	0.07
Return on Assets	−0.14	−0.30	0.91	0.14
Economic Support Rate	0.40	−0.14	−0.09	−0.14
Percentage of operating lease assets	0.16	0.60	0.03	0.65
Industry concentration CR5	−0.40	0.15	0.05	0.15
Industry Non-performing Loads Ratio	0.09	0.61	0.31	−0.69
Total Asset Impairments Allowance	0.40	0.09	0.17	0.18

Table 9. Component matrix.

	F_1	F_2	F_3	F_4
Total industry assets	0.987	0.047	0.078	0.017
New leasing volume	−0.840	0.472	0.059	0.025
Total industry profit	0.977	−0.001	0.160	0.043
Return on Assets	−0.335	−0.404	0.842	0.086
Economic Support Rate	0.948	−0.187	−0.081	−0.087
Percentage of operating lease assets	0.370	0.814	0.030	0.401
Industry concentration CR5	−0.954	0.199	0.047	0.095
Industry Non-performing Loads Ratio	0.208	0.829	0.291	−0.425
Total Asset Impairments Allowance	0.943	0.116	0.157	0.111

Based on the Equation (8), we construct the composite variable F_e for the development of China's financial leasing industry as follows.

$$F_e = (62.517F_1 + 20.285F_2 + 9.580F_3 + 4.223F_4) \div 96.605 \quad (14)$$

According to Equations (9) and (14), we calculate the development score of China's financial leasing industry from 2008 to 2021 get the development index FLDI of China's financial leasing industry, as shown in Table 10, and the index changes as shown in Figure 4. As we can see in Figure 4, the development of China's financial leasing industry has steadily increased since 2008, with the development index rising from 1.13 in 2008 to 5.53 in 2021, and the development of China's financial leasing industry in this period can be divided into three stages.

Table 10. Composite variable and development index.

Annual	F_1	F_2	F_3	F_4	F_e	FLDI
2008	−3.75548	2.831242	1.630828	−0.33534	−1.68875	1.12758
2009	−2.94703	1.387603	−1.0681	−0.07072	−1.72479	1.09154
2010	−2.60434	−0.24106	−1.15591	0.784518	−1.81633	1.00000
2011	−2.04972	−1.25781	−0.64788	0.257233	−1.64357	1.17275
2012	−1.59387	−1.645	0.14414	0.338528	−1.34778	1.46855
2013	−1.22921	−2.4563	1.259795	0.254642	−1.17517	1.64115
2014	−0.29754	−0.66823	0.777965	−0.64465	−0.28389	2.53243
2015	0.598502	0.005075	−0.77636	−0.7228	0.279793	3.09612
2016	1.444482	0.305889	−0.26985	−0.19365	0.963784	3.78011
2017	1.685348	0.742114	−0.77219	0.02298	1.17091	3.98724
2018	2.454132	0.317042	−0.9896	−0.42351	1.538085	4.35441
2019	2.145468	−0.31331	0.655535	−0.28805	1.375044	4.19137
2020	2.619253	−0.40641	0.495119	−0.53912	1.635217	4.45154
2021	3.529989	1.399165	0.716548	1.559907	2.717437	5.53376

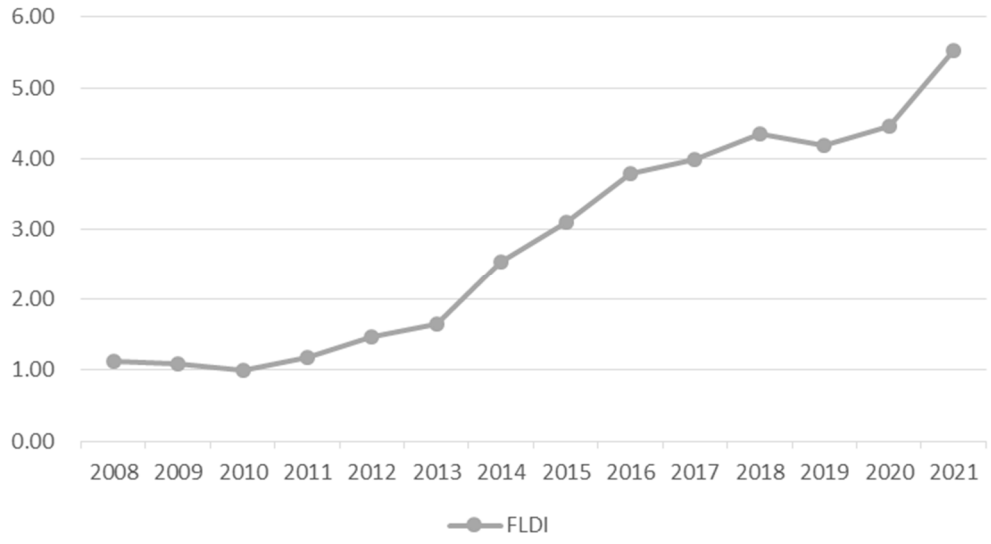

Figure 4. China's financial leasing industry development index from 2008 to 2021.

In the first stage, from 2008 to 2013, the number of financial leasing companies increased from 12 to 23, and the asset amount of the industry exceeded CNY 1 trillion for the first time. Nevertheless, the industry was still in the recovery stage.

In the second stage, from 2014 to 2018, with the strong support of national macro policies, the number of financial leasing companies increased from 23 to 66, and the asset amount approached CNY 3 trillion, with a growth rate is more than 200% in just five years.

Therefore, the industry development tended to mature, gradually moving from the recovery stage to the maturity stage.

In the third stage, from 2019 to 2021, the competition among financial leasing companies is more and more fierce, and the growth rate of the financial leasing industry is only 9.1%. At the end of 2021, the asset amount approached CNY 3.5 trillion. In this context, financial leasing companies try to explore new models and new areas of leasing services for the development of the real economy, and the industry begins to step into the stage of transformation.

3.3. Structural Analysis

To analyze the development of China's financial leasing industry, we used structural analysis to find the factors during its development. The index of the development level of China's financial leasing industry is a combination of four variables: scale, structure, risk, and return. We multiplied the values of the four variables by their weights to obtain the contribution value of each one to the composite variable score, as shown in Table 11 and Figure 5.

Table 11. The contribution value of each variable.

Annual	The Contribution Value of Scale-Variable	The Contribution Value of Structural-Variable	The Contribution Value of Risk-Variable	The Contribution Value of Return-Variable
2008	−234.7809	57.4317	15.6237	−1.4161
2009	−184.2393	28.1475	−10.2327	−0.2986
2010	−162.8155	−4.8898	−11.0739	3.3130
2011	−128.1424	−25.5146	−6.2068	1.0863
2012	−99.6436	−33.3688	1.3809	1.4296
2013	−76.8463	−49.8260	12.0691	1.0753
2014	−18.6010	−13.5551	7.4531	−2.7223
2015	37.4165	0.1029	−7.4377	−3.0523
2016	90.3045	6.2049	−2.5853	−0.8178
2017	105.3628	15.0538	−7.3978	0.0970
2018	153.4247	6.4312	−9.4806	−1.7885
2019	134.1280	−6.3556	6.2802	−1.2164
2020	163.7476	−8.2440	4.7433	−2.2767
2021	220.6840	28.3820	6.8647	6.5874

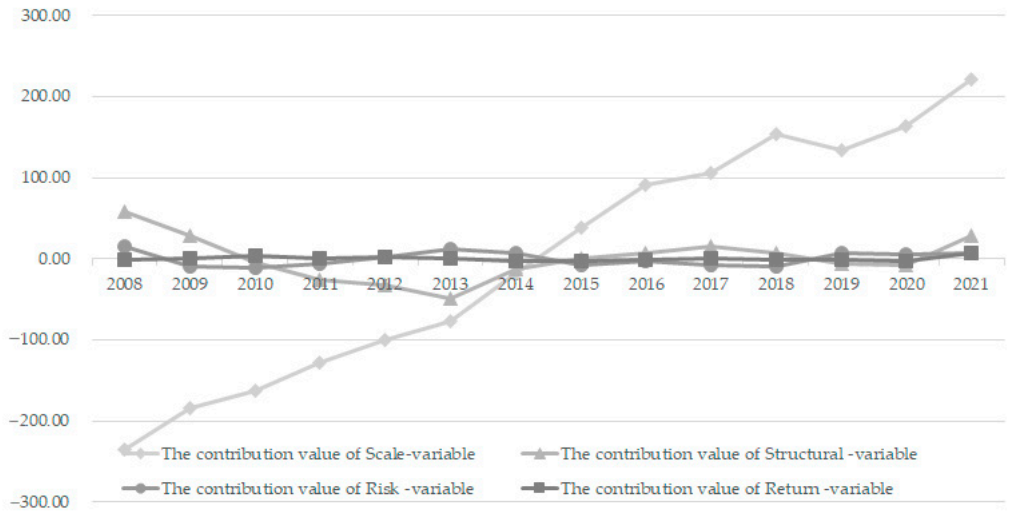

Figure 5. Contribution of each variable to the composite variable score from 2008 to 2021.

The contribution value of Scale-variable shows a visible rising trend and is the main factor influencing the development of China's financial leasing industry. From 2008 to 2014, the contribution value of Scale-variable showed a negative value which turned positive and increased after 2015, indicating that during the recovery stage of the financial leasing industry, the scale limited its development. With the development of China's economy and the continuous improvement of macro policies, the scale of the financial leasing industry

continues to expand, and the scale contribution value curve gradually changes in line with the trend of the industry development index curve, indicating that the scale factor has driven the industry development index.

The contribution value of the Structural-variable first declined and then rebounded. Before 2014, the contribution value of Structural-variable turned from positive to negative, indicating that during the recovery phase of the financial leasing industry, the newly established financial leasing companies were still not specialized enough, and their operating leasing business did not account for a high proportion, and they mainly carried out financial leasing business to control business risks. After 2014, the financial leasing companies established in the early stage improved their professional capabilities after a period of exploration. With the encouragement and support of related policies, financial leasing companies have vigorously expanded their operating leasing business in aviation and shipping. Therefore, the proportion of operating leasing businesses has continued to rise, and the value of structural contribution to the financial leasing industry has changed from negative to positive. Between 2014 and 2018, there were more than 45 new companies in the financial leasing industry. Their business was mainly financial leasing, making the structural contribution value rebound very limited and fluctuating. In 2019 and 2020, due to the economic downturn and the impact of COVID-19, the risk appetite of financial leasing companies decreased, the share of the finance leasing business increased, and the structural contribution turned negative again. In 2021, with COVID-19 under control and the rapid rebound of the economy, the structural contribution value rebounded rapidly.

There are fluctuations in the contribution value of the Risk-variable, while they are small. From 2008 to 2021, the average non-performing rate of China's financial leasing industry is 0.75%. It is worth mentioning that after 2014, the industry entered a mature period, and the average non-performing rate of the industry has been maintained at around 0.7%, indicating that the risks of China's financial leasing industry are generally controllable, and the asset quality remains stable.

The contribution value of the Return-variable remains stable. The curve of the contribution value stays around 0, and the curve deviation is not significant, indicating that the influence of the return factor on the financial leasing industry development index is small.

3.4. ARIMA Model Result

According to Figure 2, first, we use SPSS to analyze the original time series of FLDI. The original time series is shown in Figure 4. The ACF and PACF graphs were tested, and the results are shown in Figures 6 and 7.

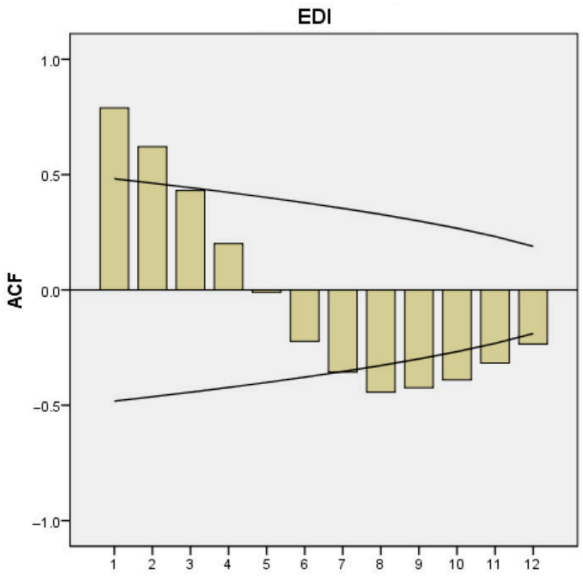

Figure 6. Original time series ACF graph.

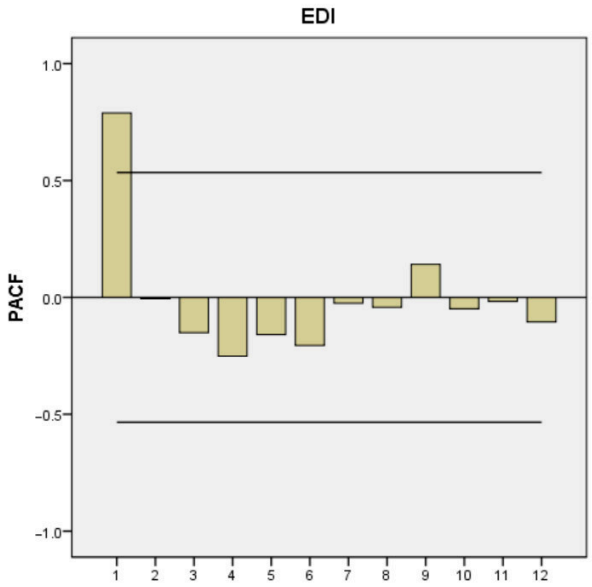

Figure 7. Original time series PACF graph.

From Figures 6 and 7, we can see that the original time series is non-stationary. So, the difference algorithm is applied to obtain the stationary time series. The significance of stationary is to make the fundamental characteristics of time series unchangeable with time. We perform first-order differencing on the original time series, and the results are shown in Figure 8. ACF and PACF tests were performed again, and the results are shown in Figures 9 and 10.

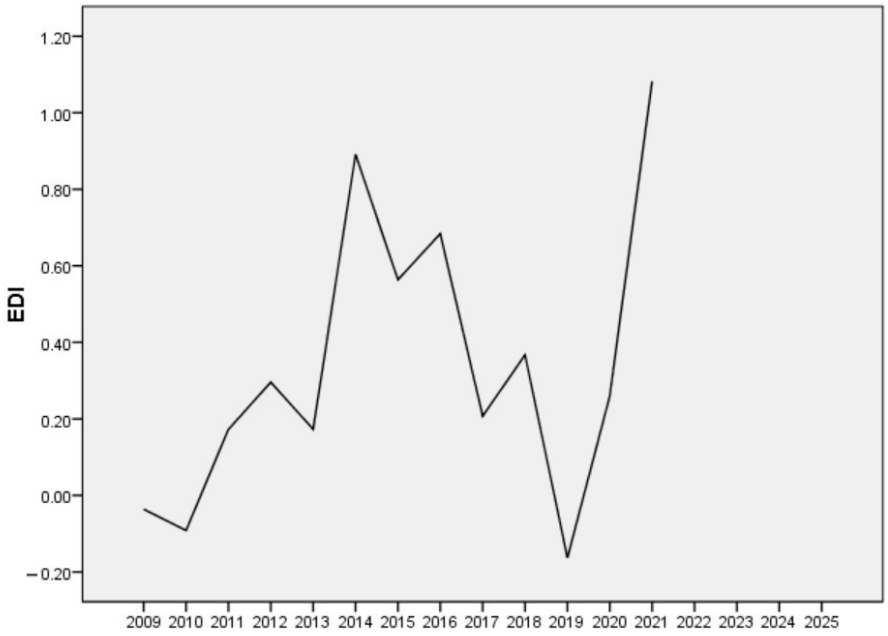

Figure 8. 1st order difference sequence.

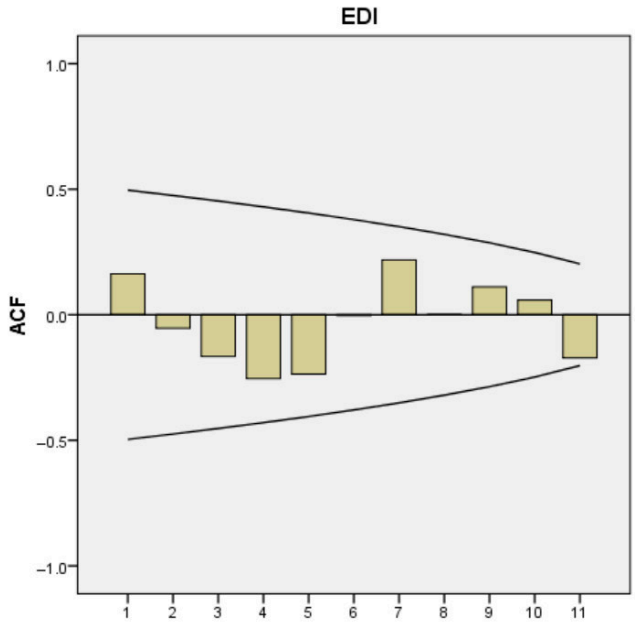

Figure 9. 1st order differential time series ACF graph.

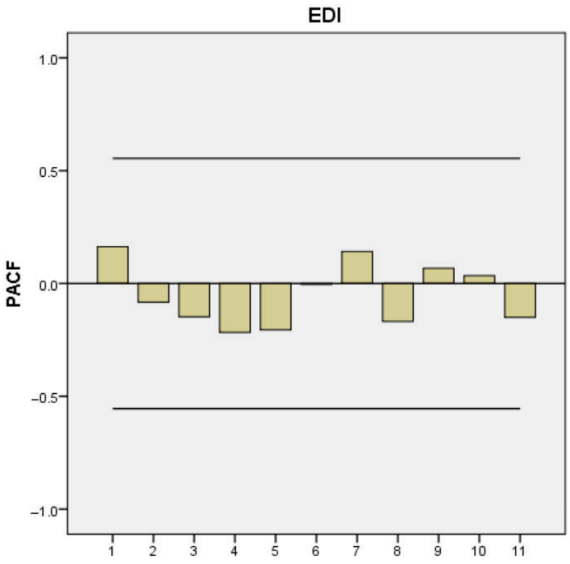

Figure 10. 1st order differential time series PACF graph.

From Figures 9 and 10, it can be seen that the time series after the first-order differencing is a stationary time series. Through the expert modeler of SPSS, the ARIMA model is identified as ARIMA (0, 1, 0). According to SPSS analysis results, R squared reaches 0.941, which is well fitted, as shown in Table 12:

Table 12. Model Statistics.

Model	Number of Predictors	Model Fit Statistics		Ljung–Box Q(18)			Number of Outliers
		Stationary R-Squared	R-Squared	Statistics	DF	Sig.	
FLDI	0	-2.220×10^{-16}	0.941		0		0

Figure 11 shows the autocorrelation function graph (ACF) and partial autocorrelation function graph (PACF) after first-order difference. It can be seen from Figure 11 that both ACF and PACF are stable.

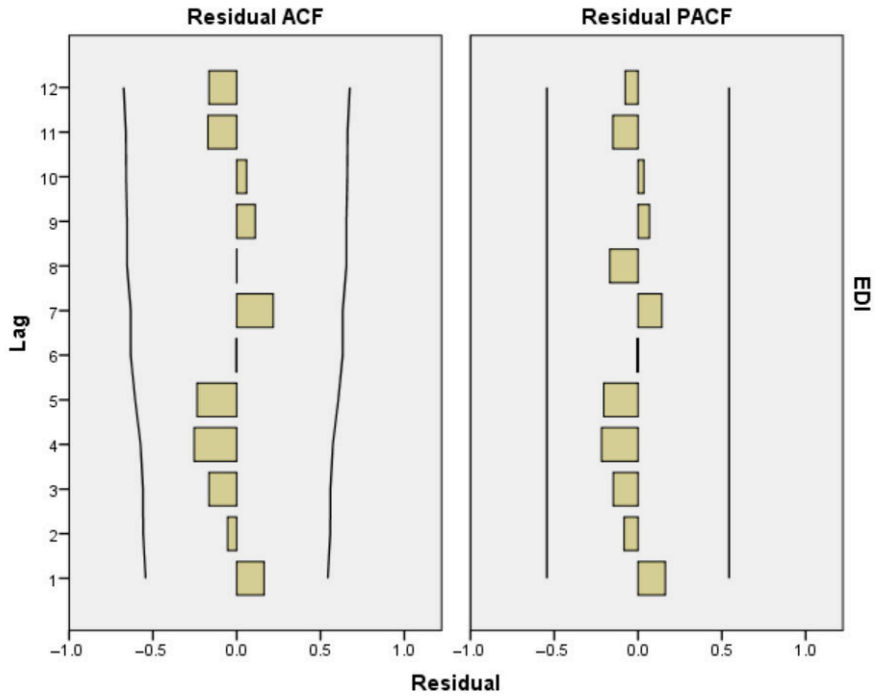

Figure 11. ACF and PACF diagrams of residuals.

Based on FLDI data from 2008 to 2021, an ARIMA model was created to project the next four years' trend of China's financial leasing industry, as demonstrated by Figure 12. The y-axis indicates the principal component values obtained from previous years' China financial leasing development data. The vertical black line denotes the predicted period, with the blue bold line representing the projected value. Additionally, the UCL and LCL indicate control lines both on and off-line, respectively. Overall, the curve's trend indicates that China's financial leasing industry is expected to continue its growth trajectory from 2022 to 2025 but at a slower rate. Specifically, the industry growth rate will decrease from an average of 13% seen from 2008–2021 to approximately 5.6% over 2022–2025, as shown in Table 13.

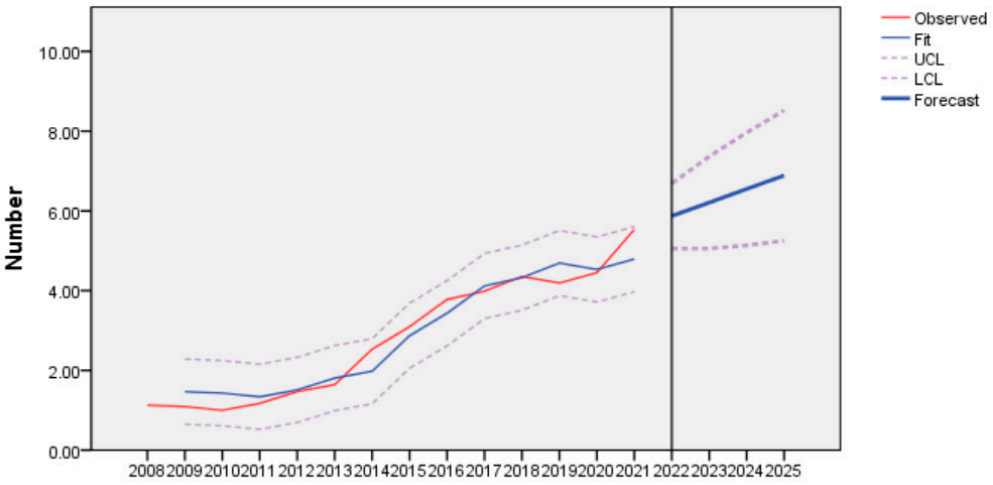

Figure 12. Forecast trend curve.

Table 13. Model prediction results.

Model		2022	2023	2024	2025
FLDI	Forecast	5.87	6.21	6.55	6.89
	UCL	6.69	7.37	7.97	8.52
	LCL	5.06	5.06	5.14	5.26

4. Discussion

The present study aimed to analyze the development of China's financial leasing industry using principal component analysis. The evaluation index system and composite variable based on nine indicators were constructed from four aspects: scale, speed, efficiency, structure, and quality, providing quantitative data support for optimizing policies of the financial leasing industry and financial supervision.

The study identified three stages—recovery, maturity, and transformation—that positioned the development trend of China's financial leasing industry over the past 14 years. The scale variable was found to be the main factor influencing its development. Meanwhile, structural, risk, and return variables had a small impact. Therefore, focusing on improving structure and return variables' contribution value is crucial to promoting its development quality.

In this context, we used an ARIMA model to predict the financial leasing industry's development in China. However, we acknowledge that predicting changes in the next few years through each indicator is challenging since they reflect the industry's complex multiple dimensions. Principal component analysis effectively reduced financial leasing development data to construct a comprehensive index that allows us to visualize the industry's changes and find optimization directions.

The challenges to the sustainable development of China's financial leasing industry are increasing due to factors such as stricter financial market regulation and intensified competition. To tackle these issues, we need to conduct further research on the coordination between the development of the financial leasing industry and economic development.

However, there are limitations in our study. Firstly, it focuses solely on financial leasing companies, thereby potentially excluding other leasing companies. Secondly, the research sample was relatively limited, while some indicators related to the development of the financial leasing industry are difficult to quantify. Thirdly, although we divided the industry's development into three stages based on two criteria, we recognize that this division can be further explored and optimized.

In conclusion, our study has provided valuable insights into the development of China's financial leasing industry. It underscores the importance of robust evaluation systems and monitoring the industry's development trends for sustainable growth. Future research can expand our study by adding more indicators, broadening the research sample and exploring the coordination between the financial leasing industry and economic development.

5. Conclusions and Policy Recommendations

This study analyzes the development of China's financial leasing industry from 2008 to 2021 and identifies key factors affecting its sustainability. Based on the findings, the following recommendations are proposed:

The government should deepen the implementation of policies promoting the financial leasing industry, improve financing regulations, reduce financing costs, and enhance the contribution of Return-variable to the development of the industry to strengthen the momentum of sustainable development.

The regulatory authorities should support eligible financial leasing companies to issue bonds, carry out listing financing, promote asset securitization, introduce insurance funds, further broaden the medium- and long-term funding channels of financial leasing companies, enhance the proportion of medium- and long-term financing, and alleviate the problem of asset-liability mismatch in the industry.

Leasing companies should accelerate the construction of specialized capabilities, improve comprehensive risk management systems, strengthen model innovation, optimize business structures, and continuously deepen the application of financial technology to enhance the contribution value of structural-variable to the development of the industry. They should also comply with the trend of the Internet of Everything, promote digital transformation, and play the risk mitigation role of leased equipment to achieve differentiated development and build their core competitiveness.

In conclusion, it is essential to gain an in depth understanding of the development of China's financial leasing industry, propose measures to promote the industry's development, and improve the quality of its development to promote sustainable growth in the industry.

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