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Quantitative Analysis and Evaluation of Enterprise Group Financial Company Efficiency in China

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Abstract: As a special financial institution, the financial company has a significant impact on the financial market and real economy. Therefore, further study of the efficiency of financial companies is of great practical significance. China's financial company is equivalent to the "internal bank" of its affiliated group. Therefore, this paper refers to the quantitative analysis and evaluation method of the banking industry, combined with the data characteristics of the financial company's industry. This paper carries out quantitative analysis and evaluation of the efficiency of 79 Chinese enterprise group finance companies from 2011 to 2016 through the DEA model and the Malmquist index model. The results are as follows: From the static point of view (based on the DEA model), the overall efficiency of Chinese financial companies is low and the efficiency is less affected by scale efficiency than that of pure technical efficiency; from the industry classification, the efficiency of oil processing, steel, and nonferrous metal financial companies is better than other industries. From the dynamic point of view (based on the Malquist index model), the overall efficiency of financial companies from 2011 to 2016 has been slightly improved and the efficiency is easily influenced by the change of scale efficiency; from the industry category, the changes of the efficiency, scale efficiency and pure technical efficiency of financial companies of military industry are fastest, and the technical progress of the auto industry financial companies is optimal.

Keywords: financial company; efficiency; DEA model; Malmquist index model

1. Introduction

The world's first financial company, General Bank Finance, was born in 1716, and the world's first non-bank finance company was the US financial finance company founded in 1878. Internationally, financial companies can be generally divided into enterprise-affiliated finance companies and non-enterprise-affiliated finance companies. Enterprise-affiliated finance companies generally focus on consumer credit, corporate finance, and financial consulting, although financial companies in other countries have different focuses, but basically belong to non-bank financial institutions that promote the sale of goods as a feature. Due to the continuous development of economic globalization and the continuous advancement of financial reforms in various countries, the number of financial companies has been increasing and the scope of business has gradually expanded. This new combination of industry and finance plays an increasingly important role in the global financial market.

As the non-bank financial institution that makes financial markets most highly correlated with real economy, financial companies are an important part of China's financial market. With the rapid development of the market economy and gradual improvement of the relevant legal system

of supervision department, the number of Chinese enterprise group financial companies have continuously increased. The business is continuously innovating and the industry is gradually growing. By the end of the third quarter of 2017, there has been already 244 Chinese enterprise group financial companies and the number of service companies is more than 79,000. The consolidated statement assets of the finance company group are nearly 80 trillion yuan, the total internal and external assets are 77.5 trillion yuan. The total profit is 73.548 billion yuan and the profit status keeps well. The average non-performing asset ratio is only 0.03%, far lower than the average level of the banking industry. The industry average capital adequacy ratio is 22.27 and the asset quality tends to a good prospect.

In recent years, there are many kinds of indicators for financial institutions in performance evaluation. Thus, in research on the performance evaluation of financial institutions, scholars gradually focus on the efficiency index. The "Management Methods of Enterprise Group Financial Companies" promulgated by China Banking Regulatory Commission on 27 July 2004 clearly point out that financial companies are the non-bank financial institutions that provide enterprise group member units with financial management services in order to strengthen the centralized management of enterprise group funds and improve the use efficiency of enterprise group funds. It can be seen that the operating efficiency of financial companies is essential to the development of enterprise groups. Efficiency is the comprehensive measurement and evaluation of the ability of financial companies, including resource allocation capacity, resource use efficiency, etc. It can be reflected by the input-output ratio of financial companies in business activities. The technical efficiency in the DEA method means that the decision-making unit input the minimum elements under the certain output combination or obtain the maximum elements under the certain input combination and this reflects the efficiency of resource allocation of the decision-making unit. Thus, this paper will use the DEA method to study the technical efficiency of financial companies.

The differences between this paper and the existing research are: (1) Taking the data of 79 Chinese enterprise group financial companies from 2011 to 2016 as the sample, it not only expands the previous sample size of scholars but also emphasizes the timeliness, making the research results more representative; (2) this paper carries out static analysis for the efficiency by year with the use of the VRS model of DEA, then uses the Malmquist index model to analyze the dynamic change of efficiency, conduct empirical study on the efficiency of financial companies from different industries, discusses the change rule of industry efficiency of financial companies, and further broaden the research perspective; (3) on the basis of the research results of the efficiency of financial companies, it puts forward some suggestions to improve the efficiency of financial companies for companies themselves, the enterprise groups and other different main bodies, so as to promote the sustainable development of the industry of financial companies.

Other parts of this paper are as follows: The second part is a literature review; the third part outlines the research methods; the fourth part presents the data and variables; the fifth part gives the empirical results and analysis; the sixth part provides a conclusion and enlightenment.

2. Literature Review

In recent years, the research on the efficiency of financial institutions has become a hot spot of concerned for scholars. The related research is also emerging and the research is mainly concentrated on the efficiency of financial institutions, the efficiency of financial companies, function, and other aspects.

2.1. He Comparative Study of Domestic and Foreign Financial Companies

Although foreign enterprise financial companies have been developing for nearly 300 years, the relatively theoretical studies are lagging behind. According to the results of the author's retrieval of relevant literature, there are few literatures in foreign literature to study the efficiency of financial companies. Through multi-party search, no relevant economic data of financial companies were found, therefore it is impossible to do empirical research temporarily.

As for the comparative study of domestic and foreign financial companies, Zhang Jianhua (1998) [1] believes that Chinese financial companies and financial companies in developed countries share common features, all of which belong to the group's credit institutions, but exist in terms of sources of funds and business scope. Foreign financial companies in developed countries are involved in a wider range of business and thus have more functions, so the development of China's financial companies cannot fully learn from foreign relevant experience. Wang Hongmiao (2002) [2] believed that American financial companies have clear positioning, flexible supervision, complete supporting policies and outstanding development advantages. Yuan Jieqiu, Zhu Yu and creamy Zhang Quan (2004) [3] found that U.S. financial companies' operating success is attributed to the following aspects: industrial development finance, supporting system integrity, financial business innovation, diversification of funding sources, and flexible supervision. Accordingly, the author suggests that the development of China's financial companies needs to improve the market environment to give full play to the advantages of professional investment and financing, and need to financial innovation, the supervision of financial companies should not be limited to institutional supervision model, etc.

2.2. Research on Efficiency of Financial Institutions

In terms of the research on efficiency of financial institutions, taking 11 economic entities in the world from 1971 to 1986 as the research object, Fecher and Pierre (1993) [4] analyzed the efficiency of financial institutions with the use of the DEA method and found that the efficiency of financial institutions is highest in Japan among these countries. In addition, Isik and Hassan (2002) [5] used the DEA method to study the efficiency of financial institutions in Turkey from 1988 to 1996. The empirical results show that the low technical inefficiency of financial institutions in Turkey is mainly caused by invalid scale. Eling and Luhnen (2010) [6] made an empirical analysis on the efficiency of insurance companies in 36 countries by using the DEA method. The results are that the efficiency of insurance companies in different countries has been improved in recent years. In addition, the efficiency of insurance companies is highest in Denmark and Japan among various countries, and the Philippines ranks last. Chortareas et al. (2012) [7] studied the efficiency of the banking industry in the EU countries by DEA method and believed that effective supervision will help to improve the efficiency of the banking industry in EU countries.

The research of foreign scholars on the efficiency of global financial institutions has matured, especially the study on the efficiency of the banking industry. For example, Sathye (2001) [8] analyzed the technical efficiency of Australian commercial banks and found that the reason for the lower efficiency of its joint-stock commercial banks than the world average level is the lack of the technological innovation capacity through the DEA method. Based on an unbalanced panel date, James et al. (2013) [9] analyzed the efficiency of 4050 banks in 72 countries from 1999 to 2007 and found that the supervision degree of banks is negatively related to bank efficiency. The greater the supervision degree is, the lower the bank efficiency is. Hidemichi et al. (2014) [10] studied the technical efficiency and productivity growth of the banking industry in India from 2004 to 2011 and measured the efficiency of three kinds of ownership of banks with the use of the innovative directional distance function model. The results indicate that foreign banks in India have a strong market position and the efficiency is higher. Then, the efficiency of state-owned and private banks is relatively low. The labor management, other income assets, and non-performing assets are the main factors behind the low efficiency of banks. In addition, Berg et al. (1992) [11], Fare et al. (1994) [12], Berger and Mester (1997) [13], Berger and Humphrey (1997) [14], Das and Shanmugam (2004) [15], Park and Weber(2012) [16], Barros et al. (2012) [17], Chang et al. (2012) [18], Assaf et al. (2013) [19] and other scholars studied the efficiency of banks in Norway, Turkey, Japan, South Korea, India, China and other countries from different angles and its influencing factors.

2.3. Research on Efficiency of Financial Companies

Andrewsfen (1961) [20] proposed that financial companies usually achieve resource allocation by improving the operation efficiency. The resource allocation of corporate resources can promote economic development. Meanwhile, the financial company is a financial institution belonging to an enterprise group. The financial companies are superior to external financial institutions in assessing the borrower's business risks and can make full use of internal information to reduce the risk of non-performing loans. Based on market failure theory, Roberts and Viscione (1981a) [21] studied the reason for large enterprise groups setting up financial companies so that they can help enterprise groups to reduce information distortion and loan expenses, in order to effectively improve the internal market efficiency. Baryon (2008) [22] believed that the loan costs of finance companies are lower than those of bank loans from the credit standard of financial companies, so it is beneficial for enterprise group members to apply for credit business. Douglas et al. (2014) [23] analyzed the business situation of the financial companies in New Zealand in the 4 years after 2006. Through empirical research, it was found that the crisis of financial companies is related to the asset quality, capital adequacy ratio, and cash flow.

In China, Liu Jinlan and Hu Jingyu (2007) [24] measured the efficiency with 19 financial companies in 2002 as research samples. By comparing the efficiency of 19 financial companies, it was found that most of the inefficient financial companies rely heavily on the development of enterprise groups, causing that its financial function can't be effectively played. Zhang Wen (2010) [25] analyzed the efficiency of 32 financial companies in China in 2008 by DEA research method. It was found that the efficiency of different companies is quite different. More than 90% of the companies are inefficient and the main reasons for the inefficiency are the lack of an independent management concept and management model, weak business innovation ability, and narrow financing channels. You Jiaxing et al. (2011) [26] used non-parametric data envelopment analysis method to calculate the Malmquist index, so as to measure the efficiency of banks, and also carried out an econometric analysis of the inherent relationship between the financial liberalization process in China and bank efficiency. The study found that under the drive of financial marketization and open policy, the overall efficiency of China's banking industry has been significantly improved. The joint-stock commercial banks benefit more than state-owned commercial banks. Tian Yuqing and Yu Li (2012) [27] assessed the cost efficiency of 79 financial companies in China from 2009 to 2010 by the SFA method. It is found that financial companies can play a certain role in allocating resources, but cannot completely solve the redundancy problem of enterprise groups. Thus, financial companies still need to improve the cost control ability and enhance the regulatory function of the internal capital market under the guidance of the group. Zhu Nan and Tan Debin [28] studied the influencing factors of fund use efficiency and dynamic changes of the efficiency of 67 finance companies from 2007 to 2010 by DEA and Malmquist index methods. The results show that the capital use efficiency of most financial companies is ineffective, but the capital use efficiency shows an upward trend in the fluctuations year by year. Wang Chaoen et al. (2016) [29] used the data of manufacturing group enterprises in our country from 2007 to 2013 to analyze the relationship between the efficiency of financial companies and enterprise group innovation. The results show that there is a positive correlation between them and that improving the efficiency of manufacturing group enterprises has a positive effect on the development of enterprise innovative activities. However, the data used in this study only represent manufacturing group enterprises and do not reflect the efficiency of the whole financial company industry. There is no authoritative conclusion on industry efficiency.

In addition, Chinese scholars are also deeply interested in the development model and functional positioning of financial companies. Yao Jinren (1996) [30] held that in the development process of industrial financial institutions, enterprise groups initially set up financial companies in order to improve the operating efficiency of funds within the group and achieve the maximization of capital value. Ji Min and Liu Hong (2000) [31] explored the function and development conditions of financial institutions within Chinese enterprise groups from another perspective. They believed that the growth

of industrial finance is related to industrial finance scale. The great industrial finance scale can make industrial finance stronger, so enterprise group financial companies shall strive to become professional industrial finance institutions to provide high quality service for the group industry. Li Hui (2013) [32] proposed the view that the finance company is the assistant to optimize the internal structure of enterprise groups. It can not only reduce the group cost input in the business process, but also helps to achieve the effective allocation of group resources. Therefore, financial companies need effective supervision and efficient management of enterprise groups in the development process. Only in this way can the financial service level and service quality be improved to a certain extent and the whole group be developed better and faster driven by the enterprise group.

2.4. Research Review

To sum up, the existing research has achieved fruitful results, which is the important basis of the study. However, there are still some shortcomings and it has left some space for the research of this paper. The theoretical study of Chinese scholars on financial companies is still in its infancy. The research contents and methods are from foreign research literature, but the efficiency of financial companies has not been deeply explored. However, more and more domestic scholars have begun to pay attention to the research on the efficiency of financial companies in recent years. Perhaps because the data of financial companies are not fully open to the public and the channels to obtain data are few, the research of domestic and foreign research on financial companies is mainly concentrated on development model, function positioning and other aspects, while the research on the efficiency of financial companies is less. But most research literature about the efficiency research only conducted horizontal comparison and analysis of specific years for the relative efficiency of some financial companies. The small number of samples may make research results not universal. The in-depth study on the dynamic changes of efficiency is lacking, especially the empirical research on financial companies is relatively few.

Therefore, on the basis of existing literature, this paper will further enrich the research contents and expand the perspective of research on the efficiency of financial companies: On the one hand, taking the data of 79 Chinese enterprise group financial companies from 2011 to 2016 as the sample, it not only expands the previous sample size of scholars, but also emphasizes the timeliness, leading to the research results being more representative. On the other hand, this paper will propose suggestions to improve the efficiency of financial companies. The research results will help the enterprise groups of financial companies to further optimize the financial company management, and help to provide references for financial companies to conduct industry ratings. Besides, it can help CBRC and other regulatory agencies to implement more effective classified regulation for financial companies, so as to ensure the sustainable development of the industry of financial companies.

3. Research Methods

Since financial companies can only conduct business within their groups, the main business of the majority of financial companies is deposit and loan business, which is similar to the traditional banking business. Therefore, for the research methods of industry efficiency of financial companies, the scholars' research methods of the banking efficiency can be used for reference. At present, for the measurement of bank efficiency, scholars generally choose data envelopment analysis (DEA) and stochastic frontier approach (SFA).

SFA belongs to the parameter method. It uses multivariate statistical analysis techniques to determine the unknown parameters in the frontier cost function and calculate the minimum cost and actual cost ratio. It presupposes the concrete form of efficiency boundary function and considers the disturbance of random error. However, Berger and Humphrey (1997) believed that one of the defects of the SFA method is that the pre-determined function form may lead to the deviation of efficiency measurement results.

　　　DEA belongs to the non-parametric method, a systematic evaluation method developed by operational researcher A. Charnes et al.　based on the relative efficiency evaluation concept. DEA method is a method to evaluate the relative efficiency of entities with the same input factors and the same output with the same function. The evaluated entity becomes the Decision Making Unit. The DEA method can comprehensively analyze the input and output data of the DMU, and can obtain the quantitative index of each DMU's comprehensive efficiency, and then classify each DMU according to this, determine the effective DMU, and indicate the extent and cause of other DMUs that are not effective, propose specific efficiency improvement methods, and provide management information to the competent authorities. The DEA method can also determine whether the input scale of each DMU is appropriate, and give the correct direction and degree for each DMU to adjust the input scale.

　　　Compared with the SFA method, the DEA method has the following advantages: The first is that the DEA method can handle multiple input and output items simultaneously, but not set the parameter or function form in advance; the second is that the DEA method does not require high sample size and it is more flexible in dealing with data. Besides, it can deal with the ratio form and non-ratio form data simultaneously; the third is that each DMU in the DEA method has strong objectivity, so it is not easily influenced by human subjective factors. Thus, this paper chooses the DEA method to study the efficiency of financial companies.

3.1. VRS Model Based on DEA Method

　　　There are CRS and VRS models in the DEA method (Wei Quanling 2006) [33]. this paper selects the VRS model. The CRS model needs to satisfy the assumed condition of invariable scale income and the VRS model is mainly used to study the efficiency evaluation in the case of variable scale income. In reality, due to the limitation of capital and other factors, it is less likely to be in the constant scale income for financial companies. Therefore, the VRS model is more suitable than the CRS model to study the efficiency of financial companies. The financial companies face strict credit size control and mainly assess and measure loan scale by absorbing the deposit size of member units, so the input control capacity of most financial companies is stronger than their output control capacity. Thus, this paper selects the input-oriented VRS model.

　　　The model assumes that there are K DMUs and each DMU can obtain Y output with the use of X input. The input vector of j DMU is X_j, and the output vector is Y_j. OS is the output relaxation of DMU and is the input relaxation of DMU. (constant vector. Through the K linear programming solver, the relative technical efficiency value of each DMU can be obtained v, the value range of v is from 0 to 1. If v is 1, the DMU is just on the frontier, indicating that the technique is effective. Namely, at the current input level, the output of DMU is optimal; if $v < 1$, it indicates that the technology has not reached the effective level. That is, there is a gap between the actual output and the optimal output of DMU).

　　　VRS's linear programming model is as follows:

$$\min\left[\theta_v - \varepsilon\left(\hat{e}_1^T IS + \hat{e}_2^T OS\right)\right]$$

$$\text{S.t.} \quad \begin{cases} \sum\limits_{j=1}^{K} \lambda_j x_j + IS = \theta_v X_0 \\ \sum\limits_{j=1}^{K} \lambda_j y_j - OS = Y_0 \\ \sum\limits_{j=1}^{K} \lambda_j = 1 \\ \\ \lambda_j \geq 0 (j = 1, 2..., K) \\ IS \geq 0, OS \geq 0 \end{cases} \quad (1)$$

　　　The technical efficiency can be further decomposed into two parts. The first part is pure technical efficiency influenced by management level, technological level, and other factors; the second part is

scale efficiency, which is influenced by enterprise size. The characteristics of two kinds of efficiency are similar to those of technical efficiency. If the efficiency is 1, DMU is effective. The closer the efficiency value is to 1, the more ineffective DMU is. However, the efficiency level is relatively higher.

3.2. Malmquist Index Model

The CRS model and VRS model in the DEA method are only suitable for cross-section data to horizontally compare the efficiency of DMU. Due to the increase of time factors, the production frontier during each period is different. Therefore, longitudinal comparison cannot be carried out in different periods. Malmquist index is the total factor productivity index with the use of time and cross-section data. It can be used in time series comparison of panel data and can effectively compensate for the defects of the DEA method.

In the 1950s, the Malmquist index was first proposed by Malmquist et al. After research and development for more than 20 years, in 1978, economists effectively combined the Malmquist index with the DEA model. Then this method was widely used in the measurement of productivity changes of various industries. In recent years, the Malmquist index has been widely used in the research on the productivity of modern agriculture, medical industry, and other industries. However, the literature about the empirical research on the cross-year dynamic changes of industry efficiency of financial companies with the method is rare in China. Only Zhu Nan and Tan Debin (2015) carried out empirical research on the efficiency and efficiency dynamic changes of 67 financial companies in China from 2007 to 2010 with the use of DEA and Malmquist index models. Therefore, by referring to the research method of the dynamic efficiency of the banking industry, this paper selects the Malmquist index model to study the static and dynamic efficiency of financial companies.

Malmquist index is the geometric average of total factor productivity index in $t + 1$ relative to t period. The model is as follows:

$$M_O(x_{t+1}, y_{t+1}, x_t, y_t) = \left[\frac{D_O^t(x_{t+1}, y_{t+1})}{D_O^t(x_t, y_t)} \times \frac{D_O^{t+1}(x_{t+1}, y_{t+1})}{D_O^{t+1}(x_t, y_t)} \right]^{1/2} \tag{2}$$

(x_t, y_t) is the input and output vector in the period of t, while (x_{t+1}, y_{t+1}) is the vector in $t + 1$ period; $D_O^t(x_t, y_t)$ is the output distance function of the input-output vector in t period with the technology in the period of t as a parameter, and $D_O^t(x_{t+1}, y_{t+1})$ is the output distance function in $t + 1$ period.

The Malmquist index can be transformed into:

$$
\begin{aligned}
M_{OTP}(x_{t+1}, y_{t+1}, x_t, y_t) &= \left[\frac{D_O^t(x_{t+1}, y_{t+1})}{D_O^t(x_t, y_t)} \times \frac{D_O^{t+1}(x_{t+1}, y_{t+1})}{D_O^{t+1}(x_t, y_t)} \right]^{1/2} \\
&= \left[\frac{D_O^t(x_{t+1}, y_{t+1})}{D_O^t(x_t, y_t)} \times \frac{D_O^{t+1}(x_{t+1}, y_{t+1})}{D_O^{t+1}(x_t, y_t)} \times \frac{D_O^t(x_{t+1}, y_{t+1})}{D_O^{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_O^t(x_t, y_t)}{D_O^t(x_t, y_t)} \right]^{1/2} \\
&= \frac{D_O^{t+1}(x_{t+1}, y_{t+1})}{D_O^t(x_t, y_t)} \times \left[\frac{D_O^t(x_{t+1}, y_{t+1})}{D_O^{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_O^t(x_t, y_t)}{D_O^{t+1}(x_t, y_t)} \right]^{1/2}
\end{aligned}
\tag{3}
$$

The left part of formula (3) represents the change of technical efficiency, and the left part represents technological progress. The research of Fare et al. (1994) showed that the Malmquist index (M) can be decomposed into technical progress and technical efficiency change index (TECH). The latter can be decomposed into pure technical efficiency change index (PTECH) and scale efficiency change index (SECH). Among them, the pure technical efficiency change index reflects the technological renewal speed in the field of production; the scale efficiency change index reflects the influence of input growth on M index changes; the technological progress reflects the changes of technological level.

$$M = TECH \times TP = PTECH \times SECH \times TP \tag{4}$$

M > 1 means that the total factor productivity of DMU shows an increasing trend from the *t* period to *t* + 1 period, while *M* < 1 means that the total factor productivity of DMU shows a declining trend from the *t* period to *t* + 1 period. The production frontier represents the optimal efficiency state under the existing technical conditions, so *TP* represents the *M* changes brought about by production frontier changes from the *t* period to *t* + 1 period. *TECH* > 1 means that the technical efficiency increases, while *TECH* < 1 means that the technical efficiency decreases. *PTCH* > 1 or *SECH* > 1 both mean that it is positively correlated with *M*.

3.3. The Application of DEA and Malmquist Index Model

3.3.1. The Literature on the Efficiency of Banking Industry Using the DEA Method

Based on the data of 18 big international Banks, Tang Qiming and Wen Fu (2011) [34] used the DEA model to conduct empirical research on the efficiency, risk and technological progress of Chinese commercial Banks. The whole factor productivity decreases because of technological change in Chinese and foreign Banks. Dong Zhu and Zhang Chunge (2011) [35] used the DEA model to make an empirical comparative study on the efficiency of China's large and medium-sized Banks and small commercial Banks. The scale efficiency between small commercial Banks is also related to their own scale. The larger the scale, the higher the scale efficiency. Zeng Jianhua (2011) [36] studied the efficiency of China's commercial Banks and the impact of international operation on efficiency. The international operation has a positive influence on the efficiency improvement of commercial Banks. Yang and Liu (2012) [37] made an empirical analysis of the efficiency of branches of Taiwan Banks by using the network DEA method, and found that the efficiency of branches of joint-stock Banks was higher than that of state-owned Banks, and further revealed the efficiency and improvement direction of branches through sensitivity analysis and other tools.

3.3.2. The Literature on Dynamic Change of Banking Efficiency by Using Malmquist Index Model

In terms of the dynamic change of efficiency, Zhu Chao (2006) [38] used the Malmquist Productivity index to study the dynamic efficiency changes of 13 commercial banks in China from 2000 to 2004, and found that the total factor productivity of China's commercial banking industry has dropped slightly. Wang Fubiu, Jie Chao and Shen Qian (2006) [39] using the Malmquist Total Factor Productivity index to empirically study the production efficiency of China's commercial banks from 1998 to 2004, it is found that the overall efficiency of China's commercial banks is on the rise, and the improvement in productivity is largely due to technological advances.

In summary, this paper refers to the most commonly used methods and models for studying banking efficiency. It is feasible to use the DEA method and Malmquist index model to evaluate the efficiency and dynamic change of efficiency in China's financial companies.

4. Data and Variable

4.1. Sample Selection

This paper will take the annual data of 79 financial companies as the sample, and the sample period is from 2011 to 2016. these samples are widely distributed in petrochemical engineering, energy, electricity, military, coal, automobile, steel, non-ferrous metals, machinery manufacturing, national defense science and other industries and the asset scale account for more than 70% of the total scale of Chinese enterprise group financial companies, so the selected samples can represent the characteristics of the industry of financial companies to a large extent.

4.2. Input-Output Index Selection

The income of the industry of financial companies is mainly composed of the following parts: Interest income (loan interest income, bill discounting interest income and current interest income of

financial institutions, etc.), commission and commission income (the revenue obtained through entrust loans, insurance agency, investment and financing consultancy and other intermediate businesses), and investment income (the revenue obtained through purchasing bonds, stocks and other negotiable securities). The interest income accounts for the largest proportion, followed by investment income. The expenses of the industry of financial companies mainly consist of interest expenses (deposit interest expense, current interest expense of financial institutions and other interest expenses), commission and commission expenses (the expense given by entrust loans, insurance agency, investment and financing consultancy and other intermediate businesses to the third party), and operating expenses (business and management fees, business tax, additional and other business expenses). The interest expenses account for the largest proportion.

Based on the thought of the intermediary method, referring to the research results of Li Shuangjie and Gao Yanyu (2014) [40], this paper believes that financial companies convert the absorbed deposits, interbank financing (expressed by interest expenses) and administration expenses into loans and investment and actively carry out the intermediate business (expressed by charges and commission expenses), so as to obtain interest income, fees and commission income, investment income, etc. Therefore, the input indexes are interest expenses, fees and commission expenses and management expenses. The output indexes are interest income, fees and commission income, and investment income.

4.3. Index Correlation Analysis

According to the empirical rule, the repetition between the selected input indexes and output indexes shall be avoided, but the input indexes and output indexes are positively correlated. Therefore, this paper uses the SPSS statistical software and Spearman's rho method to conduct correlation analysis for input and output indexes. The results show that there is a significant positive correlation between interest expenses and investment income, interest income, fees and commission income. In addition, fees and commission expenses are positively correlated to interest income, fees and commission income, and investment income. In addition, the business and management fees are also positively correlated with investment income, interest income, fees and commission income.

4.4. Index Rationality Test

In the using process of the DEA method, it is required that the number of decision-making units Q, the input index X and output index Y satisfy the formula, "$2(X + Y) \leq Q$". In the input-output index system selected by this paper, the input index is 3, the output index is 3, and the empirical sample is 79. $2 \times (3 + 3) \leq 79$. It meets the requirement of the DEA model for "degree of freedom", indicating that the index selection passes the rationality test.

4.5. Descriptive Statistics

The input indexes selected in this paper are interest expenses, commission and commission expenses, business and management fees, and the output indexes are interest income, commission and commission expenses, and investment income. Before the empirical test, it first carries out descriptive statistics on the six indicators. The results show that the maximum values, minimum values, mean values and standard deviation of the absorbed deposits, loans, foreign investment, operating costs and other indexes of Chinese financial companies from 2011 to 2016 are quite different. Table 1 takes the data in 2016 as an example to illustrate the data differences.

Table 1. Descriptive Statistics of Input-output Indexes in 2016.

Variable	Minimum Value	Maximum Value	Mean Value	Standard Deviation
Interest expense	327,128.15	970,554,170.68	67,156,471.08	130,332,657.71
Charges expense	-	73,299,680.70	2,276,670.64	9,896,098.11
Business and management fees	1,007,717.75	373,250,695.69	14,041,360.31	43,843,455.77
Interest income	7,488,836.10	1,979,680,644.37	165,436,931.09	291,213,211.47
Commission income	-	150,564,400.75	6,262,639.52	21,671,839.61
Investment income	(7,080,536.98)	261,790,189.13	24,244,232.16	39,547,723.76

Note: (1) The data come from China Monetary Network and Yearbook of Chinese Enterprise Group Financial Companies; (2) the unit of value is the US dollar, the exchange rate is RMB 6.9370 in 30 December 2016.

5. Results and Analysis

On the basis of the above, this paper conducts a static analysis of the efficiency of 79 selected sample financial companies from 2011 to 2016 with the use of DEAP2.1 software and VRS model of DEA and then carries out dynamic change analysis through the Malmquist index model.

5.1. Static Analysis

5.1.1. Overall Analysis

From the average efficiency, the average efficiency of enterprise group financial companies has not reached 1, indicating that the overall efficiency of the industry of financial companies is generally not high. The average efficiency of Chinese financial companies from 2011 to 2016 are 0.8737, 0.8862, 0.843, 0.8845, 0.8715 and 0.8922. It indicates that after years of development, although the industry size and the number of companies have achieved tremendous growth, the efficiency of the industry of financial companies still has great room for improvement due to the influence of the size of financial companies, the control ability, regulatory constraints and other factors

In terms of the efficiency, the vast majority of financial companies are inefficient. The number of efficient financial companies from 2011 to 2015 is fewer than 10: There were only seven efficient financial companies in 2011, accounting for 8.86% of the sample financial companies; there were nine efficient financial companies in 2012, accounting for 11.39% of the sample financial companies; there were eight efficient financial companies in 2014, accounting for 10.13% of the sample financial companies; and nine efficient financial companies in 2015, accounting for 11.39% of sample financial companies. The number of efficient financial companies in 2016 increased to 15, accounting for 18.99% of the sample. But more than 80% of financial companies were inefficient.

According to the DEA's theory, the efficiency of financial companies can be decomposed into pure technical efficiency and scale efficiency. The number of financial companies with pure technical efficiency from 2011 to 2016 are respectively 27, 28, 29, 32, 30 and 33; the number of financial companies with scale efficiency from 2011 to 2016 is respectively 8, 9, 7, 8, 9 and 15. During the 6 years, the number of financial companies with pure technical efficiency is generally higher than the number of financial companies with scale efficiency. The average efficiency of Chinese financial companies from 2011 to 2016 are 0.8737, 0.8862, 0.843, 0.8845, 0.8715 and 0.8922, the average pure technical efficiency are 0.9778, 0.981, 0.9802, 0.9877, 0.9825 and 0.9858, and the average scale efficiency are 0.892, 0.9012, 0.8612, 0.8958, 0.887 and 0.9051. The average pure technical efficiency is generally higher than average scale efficiency, indicating that the efficiency of the financial companies is more affected by pure technical efficiency than scale efficiency.

The results show that although the investment scale has been expanded in recent years, the integrated management level and technological renewal speed still need to be improved. In order to improve efficiency, financial companies shall pay more attention to pure technical efficiency while increasing the enterprise scale and improve the technical efficiency by promoting management level, expanding technology input, so as to further increase efficiency.

5.1.2. Industry Analysis

The industry of financial companies is classified according to the industry involved by the group. The number of the industry of financial companies has reached 224 in 2015, 17 sub-industries, including energy, electricity, petrochemical engineering, electronics, coal, building materials, non-ferrous metals, automobile, trade, hotel tourism, investment holding, people's livelihood and consumption, agriculture, forestry, animal husbandry and fishery. In asset size, the asset size of petrochemical engineering, military industry, energy & power, building materials and electronics ranked the top five in the industry. In total profit, the total profit of energy & power, petrochemical engineering, military industry, automobile, and coal ranked in the top five in the industry. Therefore, according to asset size, total profit, distribution quantity and other characteristics of sample financial companies, this paper will divide 79 sample financial companies into eight industry categories, including petrochemical engineering, military industry, energy&power, coal, steel, non-ferrous metals, automobile and electronic appliances.

As can be seen from Table 2, the average industry efficiency of the petrochemical industry among Chinese financial companies was 0.9208 in 2015, ranked first. Then the average industry efficiency of steel and non-ferrous metals, coal industry, energy and power industry, electronic appliance industry, military industry, automobile industry and other industries in 2015 were respectively 0.9113, 0.883, 0.8808, 0.863, 0.8593, 0.8565 and 0.8491; the average efficiency of military industry was 0.8491 in 2016, an increase of 13.7% compared with 2015, ranked first in the industry of financial companies. Then the average industry efficiency of petrochemical industry, steel and non-ferrous metals, energy and power industry, coal industry, automobile industry, other industries and electronic appliance industry in 2016 were respectively 0.9472, 0.9282, 0.9014, 0.897, 0.8803, 0.8578 and 0.8487. The data showed that the efficiency growth of financial companies in the military industry is more affected by scale efficiency than by pure technical efficiency, which indicates that financial companies in the military industry mainly rely on expanding corporate scale to improve their efficiency in 2016.

Table 2. Statistical Table of Average Efficiency of Financial Companies in Different Industries.

Industry	Sample Size	Average Value in 2015			Average Value in 2016		
		TE	PTE	SE	TE	PTE	SE
Petrochemical industry	5	0.9208	0.978	0.9406	0.9472	0.9926	0.954
Industry	6	0.8593	0.954	0.9007	0.977	0.9983	0.9785
Energy and power industry	15	0.8808	0.9725	0.9064	0.9014	0.9676	0.9325
Coal industry	5	0.883	0.9964	0.8864	0.897	0.9962	0.9004
Steel and non-ferrous metals industry	9	0.9113	0.9972	0.9136	0.9282	0.9927	0.9349
Automobile industry	6	0.8565	0.9708	0.8833	0.8803	0.968	0.9102
Electronic appliance industry	7	0.863	0.9879	0.8731	0.8487	0.9837	0.8617
Other industries	26	0.8491	0.9893	0.8578	0.8578	0.9926	0.964

In terms of industry, the efficiency of petrochemical engineering, steel and non-ferrous metals industries is superior to that in other industries. Among all industries, only the average efficiency of these two industries is above 0.9 and showed an increasing trend in these 2 years. The petrochemical industry grew by 2.87% and the steel and nonferrous metals industry grew by 1.85%. Why? Maybe the industry assets scale, profit growth and cost control ability of the financial companies in the petrochemical industry are better than the industry average level; Although the operation iron and steel industry and the nonferrous metal industry are stagnant due to the depressed industry operation, the business scale has increased drastically and the growth rate of the total profit is large. The average efficiency of the auto industry from 2015 to 2016 is low. The weak domestic economic situation had a great impact on the auto industry, resulting in significant decline of the industry profitability. Therefore, various profit rate indexes declined in different degrees and the cost expense increased, thus reflecting low efficiency.

5.2. Dynamic Change Analysis

5.2.1. Overall Analysis

First, we analyze the dynamic changes of the efficiency of finance companies. The annual average Malmquist index change and decomposition from 2011 to 2016 are shown in Table 3.

Table 3. Annual Average Malmquist Index Change and Decomposition Table from 2011 to 2016.

Number	Year	M	TECH	PTCH	PTECH	SECH
1	2011–2012	0.997	1.014	0.983	1.003	1.011
2	2012–2013	1.032	0.951	1.086	0.997	0.954
3	2013–2014	1.006	1.049	0.959	1.008	1.04
4	2014–2015	1.003	0.984	1.02	0.994	0.989
5	2015–2016	0.979	1.025	0.954	1.004	1.022
Mean value		1.0036	1.004	0.9996	1.0012	1.0029

As shown in Table 3, the mean value of industry efficiency of Chinese finance companies from 2011 to 2016 is 1.004, indicating that the efficiency of the industry of Chinese financial companies has increased slightly in the past 6 years. The number of financial companies whose technical efficiency index is greater than 1 from 2011 to 2016 is 47, accounting for 59.49% of the total sample number. It indicates that 47 financial companies are in the trend of efficiency growth and the efficiency of more than 59% of financial companies has been improved.

From the decomposition of efficiency change index, the effect of pure technical efficiency change index, 1.0012, is less than that of scale efficiency change index 1.0029. It shows that compared with pure technical efficiency change, the efficiency changes of financial companies are more easily affected by the scale efficiency change of financial companies. It is consistent with the research conclusions of Zhu Nan and Tan Debin (2015). They conducted an empirical analysis for the panel data of 67 financial companies from 2007 to 2010 and held that the impact of pure technical efficiency change index is less than that of scale efficiency change index from the decomposition of efficiency change index.

As shown in Figure 1, the efficiency change indexes for the 2011–2012 period, the 2012–2013 period, the 2013–2014 period, the 2014–2015 period and the 2015–2016 period were respectively 1.014, 0.951, 1.049, 0.984 and 1.025. From the dynamic change, the efficiency first decreased, then increased, then decreased and finally increased, showing a fluctuating trend. The changing trend of pure technical efficiency was the same as that of scale efficiency. The pure technical efficiency also first decreased, then increased, then decreased and finally increased.
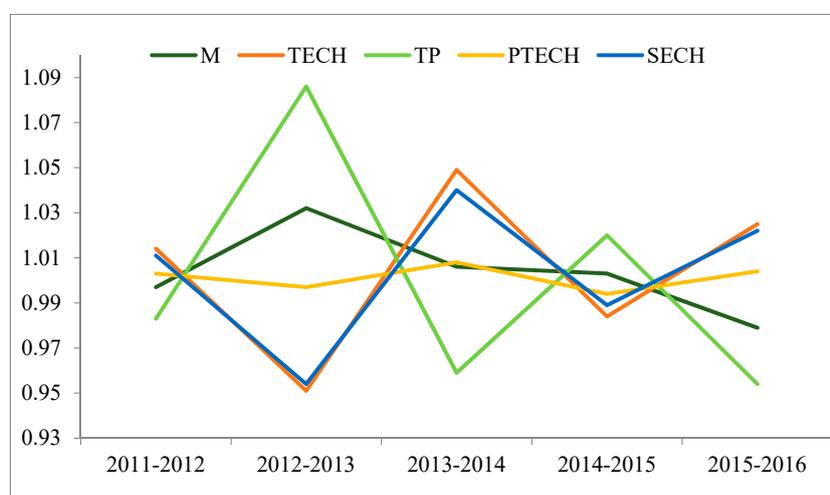

Figure 1. Efficiency Change Trend of 79 Financial Companies from 2011 to 2016.

Next, we analyze the Malmquist index change. From Figure 1, it can be seen that the Malmquist index first rose and then descended from 2011 to 2016. It rose to the highest level in 2013 and then decreased by year, showing a slightly convex trend: The Malmquist index rose by about 3.5% from 2011 to 2013 and decreased by 5% from 2013 to 2016. The change trend of pure technical efficiency is the same as that of scale efficiency. They both first decreased, then increased, then decreased and finally increased. The technological progress first increased, then decreased, then increased and finally decreased, showing a fluctuating trend. Different from the change trend of technical efficiency, their change trend is different from that of the Malmquist index. It indicates that the change trend of the Malmquist index is the result of the comprehensive effect of pure technical efficiency, scale efficiency, and technological progress. Driven by technological progress growth, the Malmquist index rose to its highest point in the 2012–2013 period.

5.2.2. Industry Analysis

According to Table 4, from the efficiency change of the industry of financial companies, the average efficiency of 79 financial companies from 2011 to 2016 is 1.004, indicating that the efficiency of finance companies increased by about 0.4%. The growth rate of the efficiency of financial companies in the military industry is fastest, followed by the petrochemical industry, the energy and power industry, and the steel and non-ferrous metal industry. The average efficiency of these four industries is more than 1; the efficiency change of the coal industry, automobile industry, electronic appliance industry and other industries are less than 1. It shows that the efficiency of these four industries is lower than the average level of 79 financial companies. The efficiency has not been improved but has declined.

Table 4. Results of Efficiency Changes of Different Industries of Financial Companies.

Industry	2011–2016				
	M	TECH	PTCH	PTECH	SECH
All samples	1.0036	1.004	0.9996	1.0012	1.0029
Petrochemical industry	1.0262	1.0134	1.0126	1.0028	1.0108
Military industry	1.0147	1.0212	0.9937	1.0052	1.0158
Energy and power industry	1.0077	1.0079	0.9998	1.0028	1.0053
Coal industry	1.0004	0.9992	1.0012	1.0012	0.9982
Steel and non-ferrous metals industry	1.0063	1.0072	0.9992	0.9994	1.0078
Automobile industry	1.0095	0.9925	1.0170	0.9950	0.9977
Electronic appliance industry	0.9876	0.9907	0.9967	0.9970	0.9936
Other industries	0.9948	0.9997	0.9952	1.0012	0.9985

From the change of scale efficiency, the scale efficiency of the coal industry, automobile industry, electronic appliance industry and other industries among the eight industries from 2011 to 2016 decreased, while the scale efficiency of the other four industries increased. The scale efficiency of financial companies in the military industry is fastest. Its scale efficiency change value reached 1.0158, rising by 1.58%; the next is the petrochemical industry; its scale efficiency increased by 1.08%.

From the change of pure technical efficiency, the pure technical efficiency of financial companies in the military industry, petrochemical industry, energy and power industry, coal industry and other industries have been improved at different levels; the pure technical efficiency of financial companies in steel and non-ferrous metals industry, automobile industry and electronic appliance industry. Therefore, in order to improve the efficiency and Malmquist index of financial companies in the steel and non-ferrous metals industry, and the automobile industry and electronic appliance industry, the companies shall improve the scientificity of decisions and improve the capacity to obtain investment by strengthening management and techniques, so as to improve the pure technical efficiency as far as possible.

From the change of technological progress, the technological progress coefficient of all sample financial companies is 0.9996, which indicates that the industry of financial companies is still in the state

of regression. The technological progress of financial companies in the automobile industry is optimal. Except for the financial companies in the automobile industry, the petrochemical industry and the coal industry, the financial companies in the other five industries are in a state of technological regression.

6. Conclusions and Enlightenment

In order to be more intuitive and comparative, this paper will present the conclusions and recommendations in tabular form, as shown in Table 5.

Table 5. Conclusions and recommendations.

Number	Conclusions	Proposal
1	Based on the descriptive statistics of input and output indicators, this paper finds that there are great differences among the financial companies of enterprise groups in China, and there are obvious differences among the financial companies of different industries.	It is suggested that the supervisory department consider some factors such as the differences of the operation scale, the industrial structure and capital operation of the financial companies of enterprise groups to realize the differential management of the financial companies in different industries.
2	This paper uses DEA's VRS model to analyze the efficiency of sample companies in 2011–2016 from a static point of view. The empirical results show that the overall efficiency of China's financial companies is low; the efficiency of financial companies is less affected by scale efficiency than by pure technical efficiency.	It is suggested that financial companies speed up technological progress, optimize their own technology and services, and effectively improve the pure technical efficiency. At present, the financial company has become an important node in the enterprise group information chain, with a wealth of large data, and has become the main channel of group fund receipt and payment and fund management and control. Therefore, it is suggested that financial companies should make a deeper and wider radiation to the function of settlement services, so as to give full play to the energy of their payment licences, reduce the waste of resources, and effectively improve operational efficiency.
3	In this paper, the Malmquist index model was used to analyze and study the change of efficiency of sample companies in 2011–2016 from a dynamic perspective. Compared with the change of pure technical efficiency, the change of financial company's efficiency is more easily affected by the change of financial company's scale efficiency. From 2011 to 2016, the change of Malmquist index experienced the process of first rising and then falling. In 2013, it rose to the highest level and then decreased year by year, showing a convex trend.	It is recommended that the enterprise group strongly support the fund collection management of the financial company. On the one hand, it clearly stipulates from the administrative means that the obligations of the member units are to collect the funds into the finance company, and on the other hand, to increase the assessment of the fund collection management. Expand the scale of fund management of the whole group and use scale benefits to further improve operational efficiency.
4	This paper analyzes the static efficiency and decomposition of financial companies from the perspective of industry classification. The empirical results show that the financial companies in the petrochemical, steel and non-ferrous metals industries are more efficient, while the finance companies in the automotive industry are less efficient.	It is recommended that the auto industry finance company should carry out advanced management methods and operation mechanisms for the financial companies in the petrochemical, steel and non-ferrous metals industries, and proceed from the characteristics of their own industries and customer needs, and strive to develop external cooperation, deepen and research customer needs, and integrate utilization. With information technology platform, while optimizing and transforming the original financial service means, channels and products, we will continue to explore new markets and continuously improve execution and management.

Table 5. *Cont.*

Number	Conclusions	Proposal
5	This paper analyzes the dynamics of financial company efficiency and the Malmquist index from the perspective of industry classification. The empirical results show that the efficiency, scale efficiency and pure technical efficiency of military industry finance companies are the fastest growing; the financial industry of automobile industry is doing the best. The financial industry is in a slightly backward state of technology.	It is suggested that the entire financial company industry should take the military enterprise financial company as the benchmark, organize research and analysis on the advanced management methods and operation mechanisms of the military financial company, find out the common features, and then promote them in the industry. At the same time, it is recommended that the regulatory authorities in the process of financial companies explore and develop innovative business, clear business compliance boundaries, improve off-site supervision mechanisms, build risk early warning systems, establish risk red line and bottom line control, encourage financial innovation services, and help financial companies' industry Realize technological progress.

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