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The Study of Efficiency and Influencing Factors in the Chinese Securities Industry Based on Text Mining Technology

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Abstract: In order to explore the relationship between financial technology and the efficiency of China's securities industry, this paper selects 45 listed securities firms from 2018-2021 as the research samples, firstly, using the super-efficient SBM model to measure the input-output operating efficiency of securities firms, next, using text analysis, principal component method analysis, min-max standardization method to quantify the fintech index, and finally, through the panel data model to analyze the impact of the related factors on the operating efficiency of securities firms, and related analysis based on the classification of securities firms by the SEC. It is found that in terms of operating efficiency, the efficiency of AA-grade securities firms has a more obvious advantage over A-grade securities firms and non-A-grade securities firms. In terms of the fintech index, the fintech index in AA-grade firms is basically superior compared with A-grade and non-A-grade firms, while the fintech index of A-grade and non-A-grade securities shows an alternating leading form and a small difference between each other's values. In terms of influencing factors, the development of fintech technology plays a positive role in promoting the efficiency of AA-grade and A-grade firms and a negative role in non-A-grade firms; the improvement of the risk control rate plays a positive role in promoting the efficiency of AA-grade and A-grade securities firms and a negative role in non-A-grade firms; the improvement of the balance sheet ratio plays a negative role in AA-grade and non-A-grade securities firms and a positive role in A-grade securities firms; The increase in the number of business offices has a negative effect on securities firms at all levels; the increase in the annual GDP growth rate has a positive effect on A- and non-A-rated securities firms, while it has a negative effect on AA-rated securities firms.

1. Introduction

With the rapid development of information technology, the rise of emerging technologies such as big data has a subtle impact on the way financial firms operate. Among them, the development of financial technology is particularly rapid, the introduction of financial technology, for financial institutions to improve the efficiency of the service, reduce costs, realize the integration of online and off-line, expand the scope of coverage of financial services, promote the innovation of the

financial business model to help financial institutions to better carry out risk management and monitoring.

According to statistics from the Securities Association, the securities industry invested $33.8 billion in information technology in 2021, a year-on-year increase of 28.7%. In the five years from 2017 to 2021, the securities industry's cumulative investment in information technology is close to 120 billion yuan, which has laid a solid foundation for the industry's digital transformation and high-quality development. However, at the same time, financial technology is like a double-edged sword, helping firms to innovate and invariably increasing the daily burden of firms, resulting in the efficiency of some firms not increasing but decreasing at the time of introduction, so it is of practical significance to explore the impact of financial technology on the efficiency of securities firms. Based on this, this paper measures the operational efficiency of the securities industry based on constructing a system of input-output indexes suitable for the industry and then measures the industry's fintech index through text mining technology to find out the relevant factors affecting the operational efficiency of the securities industry, to provide references for the relevant research.

2. Current status of research

Most of the current measurement of efficiency values are explored by data envelopment analysis (DEA), which was proposed by the famous operations researcher A. Charnes et al. in 1978 as a nonparametric method for measuring the relative effectiveness between decision units with multiple inputs and multiple outputs. At the same time, the traditional DEA has two major shortcomings: one is that the range of the measurement value is between 0 and 1, and when there are more decision-making units, there may be more than 1. Andersen [1] and others introduced super-efficiency DEA to address these issues. Unlike traditional DEA, this method enables comparison of efficiency levels among relatively effective decision units. Li Yankun [2] applied the super-efficiency DEA model to 37 listed securities firms and found a fair overall scale but significant polarization. Productivity in securities firms showed weak correlation with asset size but strong correlation with brokerage firm ratings. However, a drawback is that the model measures inefficiency only by scaling down inputs and outputs equally, neglecting improvements in slack variables.To address this deficiency, Tone [3] proposed the SBM-DEA model, which solves the problem of elemental slack and eliminates the bias due to radial and angular problems. Zhu Chuanjin [4] cited the super-efficiency SBM-DEA model to measure the operational efficiency of various commercial banks and found that the operational efficiency of private banks performs better, and the operational efficiency of agricultural and commercial banks performs worse.

In current research, the fintech index is often quantified using text mining. This technology uses algorithms to extract useful information from text. Liu Saifei [5] used data crawling to calculate the annual keyword frequency for each dimension and synthesized the fintech index using the entropy value method.

In financial analysis, panel models are typically used to examine stock and bond data to identify influencing factors. Yan Yanyang [6] employed the fixed effect model to study the factors affecting commercial banks' profitability. The results indicated that the overall development of China's fintech industry is significantly negatively related to the profitability of commercial banks.

Compared with previous studies, the main contributions of this paper are (1) From the perspective of research methodology, this paper constructs a thesaurus of fintech words that meets the characteristics of the securities industry and further analyzes the efficiency of the securities industry and its influencing factors by using Super-SBM DEA and panel data model. The combination of multiple methods makes the research results more accurate and comprehensive. (2) From the thesaurus selection, this paper calculates the fintech word frequency through the annual

reports released by each securities firm, which can more accurately derive the fintech index of the firm in that year. (3) From the perspective of research, previous studies are often conducted from the perspective of the scale of operation and the nature of operation of securities companies, etc. This paper innovatively discusses the efficiency of firms at all levels and the relevant influencing factors based on the ratings of each securities firm by categorizing them through the rating reports of securities firms released by the Securities and Futures Commission, which increases the reference dimension of the study.

3. Empirical analysis

3.1 Analysis of the grading status of securities firms

The China Securities Regulatory Commission (CSRC) in 2021 based on the economic strength of the country and region, the funding situation of the banks concerned, and the operating ability of the firms. It categorized the 45 securities firms listed in China, with the number of firms at each level being 14 AA-rated, 19 A-rated, and 12 non-A-rated.

3.2 Analysis of operating efficiency of securities companies

In order to analyze the form of year-by-year changes in the efficiency of securities firms at all levels, the use of matlab software on the 45 listed securities firms in 2018-2021 is substituted into the super-efficiency SBM model its efficiency measurement.

The results of comparing the efficiency of securities firms at all levels with the Average FinTech Index index year by year based on the hierarchical classifications issued by the SEC are shown in Figure 1.

As shown in Figure 1, as a whole, it can be seen that securities firms at all levels have improved from 2018 to 2019, and the efficiency value collectively decreases in 2020, which is mainly due to the fact that 2020 is the year of the outbreak of the Corona Virus Disease, and the epidemic factor affects the operation of the overall securities firms, so the efficiency collectively decreases. In 2021, firms' efficiency rebounded compared to 2020. This was likely due to the government's implementation of the registration system reform, allowing securities firms to list more easily without needing approval from the Securities and Futures Commission. This improved external environment promoted firm development and efficiency. AA-rated securities firms consistently had higher efficiency values compared to A-rated and non-A-rated firms. In 2018, A-rated firms were more efficient than non-A-rated ones, but from 2019 to 2021, non-A-rated firms led in efficiency, showing a trend of alternating leadership. Considering that the securities rating is based on a combination of four influencing factors: the political background and economic strength of the country and region, the financial situation of the bank concerned, and the business capacity of the firm. It can be assumed that in 2018 when A-rated firms in the above four influencing factors are better than non-A-rated securities firms, and in the following three years. Due to non-A-rated firms in the economic volume is not as large as the A-rated firms, so in the complexity of the business is also smaller than the A-rated firms. So that the non-A-rated in the later stage of the gradual increase in the efficiency and thus exceeded the A-rated firms, and the non-A-rated firms because of the business type is relatively small. For the non-A-class firms, because of the relatively small number of business types, the degree of focus on key projects is also higher than that of A-class firms, which ultimately leads to a gradual increase in the efficiency value over A-class firms.

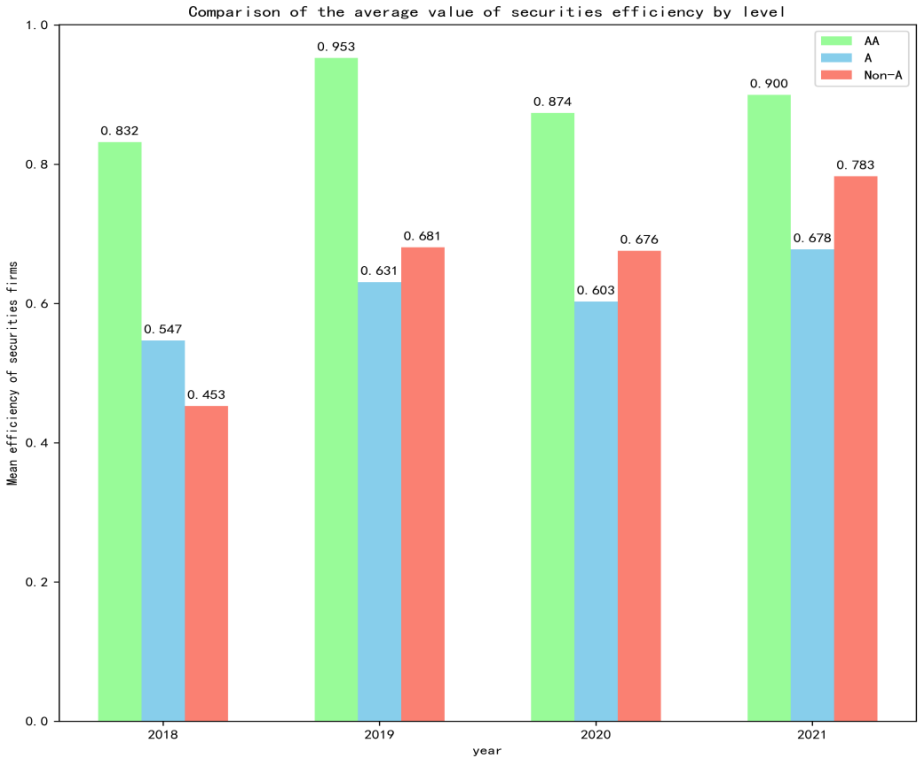

Figure 1: Comparison of the average value of securities efficiency by level

3.3 Fintech Index Measurement

3.3.1 Financial Thesaurus Construction

In this paper, the annual reports (2018-2021) of 45 listed securities firms are first converted into TXT format. These documents undergo text preprocessing, which involves removing spaces, stop words, and noisy information.

Next, the LDA (Latent Dirichlet Allocation) theme model is applied to the annual reports to extract theme words. The top 200 high-frequency fintech words are selected and divided into 10 themes to create a preparatory thesaurus. This thesaurus is then refined, and the fintech vocabulary is reclassified into four categories, comprising a total of 182 words.

The steps to measure the fintech index are as follows: (1) The statistics of word frequency for each category of financial keywords. (2) Conduct principal component analysis on 4 types of keywords, the results show that the KMO test value is 0.782, and the significance degree is less than 0.001 in Barlett's spherical test, which can be regarded as highly significant, indicating that 4 types of fintech word frequency are suitable for principal component analysis. According to the calculation results, this paper chooses two principal component factors, the first principal component factor in the word frequency data of “risk test” with a larger loading factor, the second principal component factor in the word frequency data of “payment function”, “securities trade”, “technical analysis”, “technology analysis”, and the second principal component factor in the word frequency data of “risk test” with a larger loading factor. The second principal component factor has a larger loading factor on the word frequency data of “payment function”, “securities trade” and “technical analysis”. (3) After the selection of principal components, the explained variance of the

above two principal component factors is used as the weight, the weighted average is calculated, and the min-max standardization method is used to standardize the weighted average, to obtain the banking system fintech development index.

To analyze the annual fintech situation of securities firms at each level, the fintech metrics are averaged across firms at each level. Figure 2 displays these mean values over the years. AA-level securities firms lead in fintech in 2018, 2019, and 2021, primarily due to their superior capital strength and broader operational scope compared to A-level and non-A-level firms. Consequently, AA-level firms tend to have higher technological capabilities and invest more in fintech research and development. Secondly, AA-rated firms benefit from abundant talent resources, enabling extensive utilization of fintech within these firms. In 2018, there was a significant gap in fintech index between AA-rated firms and A-rated/non-A-rated firms, which narrowed by 2019. This improvement was largely influenced by the issuance of the "Financial Technology (FinTech) Development Plan (2019-2021)" by the central bank on August 22, 2019. This policy, alongside other external environmental factors, fostered fintech development in A-rated and non-A-rated firms within the securities industry. Economic growth among these firms also indirectly boosted fintech advancement.Over the following two years, A-rated and non-A-rated securities firms alternated in leading fintech development, with their values showing relative stability.

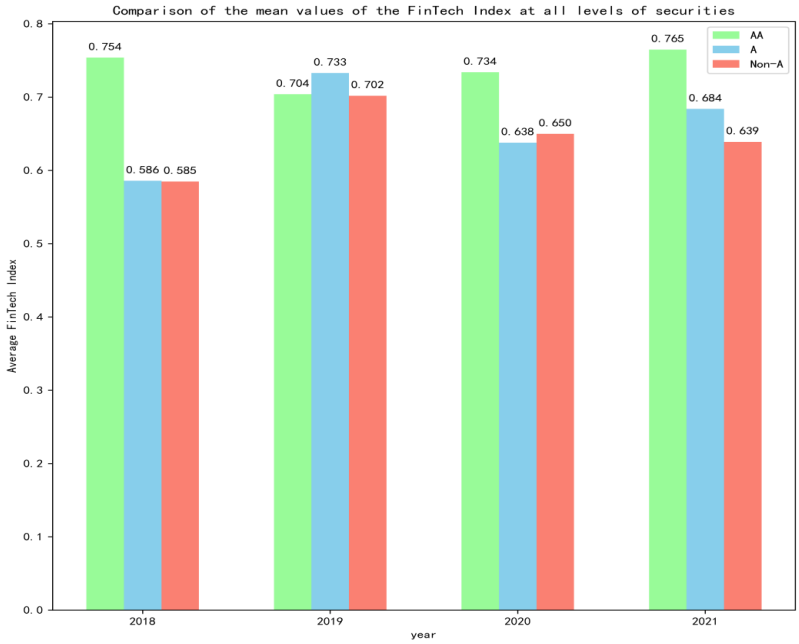

Figure 2: Comparison of the mean values of the FinTech Index at all levels of securities

3.4 Regression analysis

Through the smoothness test for each variable of AA-level firms, A-level, and non-A-level firms, in which A-level firms and non-A-level firms passed the smoothness test after first-order differencing. Finally, for model screening of firms at all levels, data from each level were substituted into the panel model test. According to the results, AA-level and non-A-level firms used a two-factor fixed effects model, while A-level firms used an individual random effects model. The following tables show the P-value relationships of various variables to securities firms at all levels:

Table 1: Impact of the FinTech Index on the efficiency of securities at all levels

security level	regression coefficient	t-statistic	p-value
AA	0.629	1.5	0.143
A	0.361	1.74	0.083*
Non-A	-1.15	-2.24	0.033**
* p<0.1, ** p<0.05, *** p<0.01			

As can be seen from Table 1, fintech in AA grade, A grade securities firms on the efficiency of the value of a positive role, and the A grade firms have a more obvious significance of the positive feedback, indicating that the indicator of the impact of the larger firms is better, the reason is that the A grade securities firms of the various businesses are in the rise of the perfect stage, the introduction of fintech can be better to accelerate the efficiency of the various business firms, to help the firm to further expand the scale of the scale. While the operations of AA-rated securities firms have stabilized, the impact of fintech on the final efficiency value does not play a dominant role. The economic volume of non-A-rated firms is small, and their businesses have not yet matured, so the introduction of too much fintech causes excessive additional expenses for firms, at the same time, the intervention of fintech in the day-to-day work of these firms will also become an operational burden, which results in the reduced efficiency of non-A-rated securities firms.

Table 2: Impact of the risk control ratio on the efficiency of securities at all levels

security level	regression coefficient	t-statistic	p-value
AA	0.642	3.84	0.000***
A	0.216	4.07	0.000***
Non-A	-0.065	-0.27	0.792
* p<0.1, ** p<0.05, *** p<0.01			

As can be seen from Table 2, the risk control rate in AA grade, a grade securities firms on the efficiency value are playing a positive role, and all have a significant impact on it, it can be assumed that this indicator has a better role in promoting the economic volume of the better firms. This indicates that for larger securities firms, the daily business involved in more types and complexity of the content, and the current securities market transaction risk is still high, so China in March 2020 the latest revision of the “Securities Law” began to be implemented, in order to reduce the risk of securities transactions, so for the funds to cope with the risk can help firms to avoid risk and reduce unnecessary operational losses, thereby enhancing efficiency. In contrast, for non-A-rated firms that are the next largest in size, investing too much additional capital in risk can instead affect normal operations and reduce the efficiency value.

Table 3: Impact of gearing on the efficiency of securities at all levels

security level	regression coefficient	t-statistic	p-value
AA	-0.323	-0.42	0.678
A	0.695	2.05	0.04**
Non-A	-0.806	-1.67	0.105
* p<0.1, ** p<0.05, *** p<0.01			

As shown in Table 3, the gearing ratio has a negative, non-significant relationship with the efficiency of AA-rated and non-A-rated firms, but a positive, significant relationship with A-rated firms. This indicates that for AA-rated firms, which already have a well-established operational system, expanding asset size through debt financing has minimal overall impact. However, it can increase the firm's risk, negatively affecting operating income and, consequently, efficiency. As for

the non-A-rated firms with smaller scale system, the economic volume and operation system have not been perfected yet, rashly expanding the asset scale through debt financing, the financial risk and cost of debt will also increase correspondingly, affecting the final overall efficiency. For A-rated firms, a better use of debt financing to expand the scale of the firm and the operating system can increase revenue, and when the return on investment of the debt funds borrowed by the firm is higher than the cost of borrowing, the increase in gearing will bring a higher return on capital, thus improving efficiency.

As shown in Table 4, the number of business departments at various levels of securities firms has a negative, non-significant impact on efficiency. This indicates that an increase in the number of business departments does not substantially enhance efficiency. According to Huang Yuting [7], this can be attributed to the Internet era, where most people prefer online transactions over offline ones. Consequently, most securities transactions can now be conducted online, minimizing the impact of the number of business departments on overall efficiency. With the growth in the number of business offices, securities firms are bound to invest a corresponding amount of capital and manpower, the result of which will also lead to a decline in efficiency.

Table 4: Impact of the number of business offices on the efficiency of securities at all levels

security level	regression coefficient	t-statistic	p-value
AA	-0.157	0.168	0.356
A	-0.133	-1.3	0.195
Non-A	-0.162	-1.11	0.275
* p<0.1, ** p<0.05, *** p<0.01			

Table 5: Impact of annual GDP growth rate on the efficiency of securities at all levels

security level	regression coefficient	t-statistic	p-value
AA	-18.491	-2.29	0.028**
A	0.808	1.04	0.3
Non-A	16.743	3.26	0.003***
* p<0.1, ** p<0.05, *** p<0.01			

As can be seen from Table 5, the annual GDP growth rate has a negative and significant effect on the efficiency of AA-rated companies, and plays a positive role in A-rated, non-A-rated, and has a significant impact on non-A-rated companies. Referring to Zhao Su [8]Xie Yu [9] in the case of good external economic dynamics, the desire for securities investment declines, the reason is that investors in the case of social and economic upturns, compared to investing in the price of higher AA level securities market, more inclined to invest in the real economy can often be a more stable income and returns. In a favorable economic situation, stock prices in the securities market will also be valued higher, making it difficult for investors to find better investment opportunities, therefore leading to a decline in the amount of AA-rated operations and lower efficiency. As for the firms whose scale is not as good as that of AA grade, the influence of the change of securities trading on the final efficiency is lighter compared with the influence of external economic environment, and their stock price is easier to get investment opportunities compared with that of AA grade firms, which laterally reflects that when the external economic conditions are good, the business of securities trading and securities investment is easier to get the favor of the market in both A grade and non-A grade firms, and the market is more favorable. In particular, non-A-rated firms have seen trading volumes and investment demand strengthen much more than usual in the face of increased market dynamism, with a significant boost to firm efficiency.

4. Conclusion

After the above research, the main conclusions of this paper can be obtained as follows:(1) In terms of operational efficiency, AA-grade firms occupy the leading position in year-by-year efficiency, while A-grade firms and non-A-grade firms show the form of alternating leadership, indicating that China's securities industry presents a trend of polarized development in terms of efficiency. (2) In terms of the FinTech index, the FinTech citation of AA-grade firms occupies the leading position most of the time, and the FinTech indexes of A-grade and non-A-grade firms show the form of leading alternately, and there is not a big difference between each other's values, and after the implementation of the state's policy on the promotion of FinTech, the FinTech indexes of A-grade and non-A-grade firms show the form of increasing and then decreasing, which indicates that firms are also looking for the balance between FinTech and the day-to-day operation of the firms. (3) After the introduction of the panel model to analyze the influence of each relevant factor, a comprehensive analysis can be concluded: Fintech technology plays a positive role in promoting the efficiency of AA-rated and A-rated firms, while non-A-rated firms play a negative role; for AA-rated and A-rated securities firms, improving the risk control rate plays a positive role in promoting the efficiency of the firms, while non-A-rated firms play a negative role; increasing the balance sheet ratio plays a negative role for AA-rated and non-A-rated securities firms, while A-rated securities firms play a positive role; the growth in the number of business offices plays a negative role for all levels of securities firms; and the increase in the annual GDP growth rate plays a positive role in promoting the efficiency of A-rated and non-A-rated securities firms, while AA-rated securities firms play a negative role.

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