The effectiveness of IPO institution reform in China: From the view of pricing efficiency changing and international comparison

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Abstract. Since the application of IPO inquiry system in 2005, the China Securities Regulatory Commission (CSRC) has carried out seven reforms on the inquiry system. In order to study the impact of IPO system reform on pricing efficiency, we select three reforms in 2009, 2013 and 2015 as time nodes to study its impact from the perspective of initial price and cumulative excess return. The result show that, the reform of IPO inquiry system in China is gradual, after several times of reforms, there will be a significant impact on the IPO pricing efficiency. Secondly, although the three reforms have a positive impact on the IPO pricing efficiency of the A-share market, it is still in an inefficient stage. Besides, with the acceleration of the internationalization process of China's securities market, we compare the IPO pricing efficiency between the A-share market and the Hong Kong market in order to study the gap of the pricing efficiency between the both. The results show that the A-share market is still in a state of incompletely valid market from the perspective of the initial price and the cumulative excess return rate, while the relatively mature Hong Kong market is an effective market.

1. Introduction

According to market functions, the stock market can be divided into a primary market and a secondary market, which are also called the issuing market and the circulation market respectively. The supply of stocks in the primary market is mainly through Initial Public Offerings (IPO), which as the first step for a company to obtain funds through the capital market and become a public company. So, IPO pricing efficiency is related to the effective allocation of capital. A reasonable initial price can reflect the company's intrinsic value, so that funds in the capital market can be effectively allocated and promote the development of the real economy; otherwise, it will have a negative impact on the development of the real economy.

Numerous research results show that there is an IPO underpricing phenomenon in the global securities market, that is, the issuance price of new stocks in the primary market is significantly lower than the first-day trading price in the secondary market. This phenomenon is particularly obvious in the Chinese A-share market. According to statistics by Sun C Q [1], before the IPO inquiry system was launched, that is, from 1990 to 2004, the average IPO underpricing rate in the A-share market was
as high as 164.5%, which was significantly higher than that of other developing countries. After the launch of the IPO inquiry system, from 2005 to 2013, the average IPO underpricing rate in the A-share market dropped to 94.58%, which preliminarily proved the effectiveness of the reform of the IPO system. That preliminary proof of the effectiveness of the reform of the IPO system.

With the continuous development of Chinese securities market, even though the inquiry system was launched in 2005 to the end of 2017, the China Securities Regulatory Commission has addressed the “three high” issues of IPOs (high issuance price, high price-earnings ratio, and high raised funds) and other issues. However, there are still many problems in China’s new share issuance. For example, in the third reform in November 2013, although a 44% limit was set on the first day's rise and fall of new shares, it did not essentially solve the problem of high IPO underpricing ratios, and many new shares continued their daily limit for a period of time after the issuance. This also affected the function of the capital market to perform value discovery, which greatly extended the time for new stocks to reach the market equilibrium price. Ultimately, it was not conducive to the healthy development of the stock market.

With the gradual deepening of the reform of China's inquiry system, it is necessary to study the new reform measures in recent years to clarify the measures that have effect on the Chinese securities market. At the same time, this paper will conduct a comparative study of the Chinese securities market and the securities markets of developed countries. With the acceleration of the internationalization of the Chinese securities market, the research on the IPO pricing system and pricing efficiency between the Chinese securities market and the securities markets in developed regions can help us clarify the direction of the reform of the inquiry system to better adapt to the international environment.

The contribution of this paper is to study the pricing efficiency of IPOs in the A-share market at different stages of the development of the inquiry system from the perspective of both the initial price and the post-issuance CAR, and to compare the IPO pricing efficiency differences between the A-share market and the Hong Kong stock market. At the same time, it tries to explore the development direction of China's inquiry system from the internal reform status of China's A-share market and the external development status of Hong Kong market.

2. Literature review
The research on IPO pricing efficiency has always been a research hotspot in academia. In order to study the extreme IPO underpricing rate in China’s stock market, a supply-demand analysis model was used to conduct an empirical analysis of 1377 IPO sample data from 1992 to 2004, and the results were found that the main reason for China’s IPO underpricing was government intervention in IPO pricing regulations and control of IPO stock supply.(see Tian, [2]) Lin et al. [3] studied the relationship between accounting conservatism and the magnitude of IPO underpricing in the context of China's A-share market, and found that the two are negatively correlated, indicating that good accounting conservatism can help improve IPO pricing efficiency. In addition, when information asymmetry is high, the relationship is more significant.

Many domestic scholars have also done some research on the impact of the reform of the inquiry system. Liu et al. [4] studied the efficiency of IPO pricing before and after the first-stage reform of the inquiry system in 2009 and found that after the first-stage reform of the inquiry system, the IPO underpricing rate was significantly reduced, and the efficiency of IPO pricing increased significantly. However, after the reform Institutional investors have a significant "stock selection" effect, leading to unfair share of new stock risks. Zhou et al. [5] compared the IPO pricing efficiency under the approval system and the approval system and found that the IPO price under the approval system can only reflect the company’s profitability, solvency, and the supply and demand in the secondary market, while under the approval system, in addition to the above indicators, the issue price of new shares can also reflect the company's size, growth capacity and issuance methods, indicating that the issuance efficiency has improved. Zhang J [6] studied the reform of the three new share issuance systems from June 2009 to May 2012 and found that the “window guidance” of the China Securities Regulatory Commission on the price of new shares would lead to deliberate price reduction in the primary market.
In summary, domestic scholars' research on IPO pricing efficiency mainly focuses on the first A-share market IPO system reform in 2009, as well as earlier studies on approval and approval systems.

3. Model
In the existing econometric methods and efficiency evaluation methods (such as traditional OLS model), Stochastic Frontier Analysis (SFA) divides errors into random effects and invalid effects, namely random error terms and unilateral error terms. In addition, SFA can measure the degree of market inefficiency and its influencing factors at the same time, so this paper uses the SFA method to calculate IPO pricing efficiency.

3.1. Stochastic frontier analysis
SFA was first proposed by Meeusen et al. [7]. It was first applied to the relationship of production functions, and then gradually extended to the economic and financial fields. The specific form is as follows:

\[ Y_i = f(x_i, \beta) \exp(v_i) \exp(u_i), i = 1, \ldots, N \]  

(1)

Among them, \( Y_i \) is the output, \( x_i \) is the input, and \( \beta \) is the model parameter. In this model, the random disturbance term is divided into two parts: one part is used to represent statistical error, represented by \( v_i \); the other part is used to represent technical inefficiency, represented by \( u_i \). When \( f(x_i, \beta) \) in the formula satisfies the Cobb-Douglas production function form, and the logarithm of both sides of the equation is taken, the formula (1) can be written in the following form:

\[ \ln Y_i = \beta_0 + \sum \beta_j \ln x_{ij} + v_i - u_i, i = 1, \ldots, N \]  

(2)

Among them, the random error term \( v_i \sim iid N(0, \sigma_v^2) \), the non-negative error term \( u_i \sim iid N^+(0, \sigma_u^2) \), \( v_i \) and \( u_i \) are independent of each other, and \( v_i, u_i \) and the explanatory variable \( x_i \) are independent of each other. The calculation formula of SFA is:

\[ TE_i = \exp(-U_i) = \frac{y_i}{f(x_i, \beta) \exp(v_i)} \]  

(3)

3.2. Variable selection
Table 1. Variable definition.

| Variable | Symbol | Name | Description |
|----------|--------|------|-------------|
| measure the intrinsic value of the company | age | age of the company | the company's duration from establishment to listing |
| | eps | earnings per share | the company's operating results |
| | bps | net assets per share | the value of assets owned by the company’s shareholders |
| profit | the average growth rate of the company’s net profit in the three years prior to the IPO | the company’s growth |
| plev | the asset-liability ratio | the company’s capital structure |
| ratio | the first shareholding ratio of a large shareholder | the company's shareholding structure |
| measure the characteristics of the IPO issuance | num | the total equity of the company before the issuance | the company already has equity before the listing, the larger the ratio, the greater the impact on the stock price |
| | size | the IPO issuance Quantity | / measure the supply and demand relationship of new shares |
| | lot | the online issuance winning rate | |
| measure market | market | the cumulative income of the market 30 days before the IPO | measure the changes in the market environment during the company’s IPO |

Referring to research on the pricing efficiency of the primary market (see Huntmccool et al., [8]), this paper adopts the log-linear model based on SFA, and the specific expression is as follows:
\[ \ln(Y_i) = \beta_0 + \beta_1 \ln(\text{age}_i) + \beta_2 \ln(\text{eps}_i) + \beta_3 \ln(\text{bps}_i) + \beta_4 \ln(\text{profit}_i) + \beta_5 \ln(\text{plev}_i) + \beta_6 \ln(\text{ratio}_i) + \beta_7 \ln(\text{num}_i) + \beta_8 \ln(\text{size}_i) + \beta_9 \ln(\text{lot}_i) + \beta_{10} \ln(\text{market}) \]  

(4)

Table 1 shows variables definition. There are two main explanatory variables selected in this paper. The first is the IPO initial price commonly used by scholars. In addition, in order to study the company’s basic valuation factors and the ability of the listing events to explain the company’s market performance within a period of time after listing, this paper introduces the cumulative excess returns (CAR30, CAR60, CAR90) of IPO companies on the 30th, 60th, and 90th days after listing as another type of explained variable. Since there is no estimated window data, when calculating the cumulative excess return in this paper, the normal return is replaced by the market return.

4. Empirical results

4.1. Descriptive statistics

This paper selects the Hong Kong stock market, which is similar to the A-share market in terms of geographic and cultural aspects, but has different IPO pricing and issuance systems as a comparative sample. The data of this paper from Wind Database.

A total of 663 IPO companies since 2000 were selected as the research samples for Hong Kong stocks. And from 2005 to 2017, a total of 2,152 IPO companies were selected as the total A-share research sample.

Table 2. Descriptive statistical in Hong Kong stocks.

| variable        | minimum | maximum | mean  | St.d  |
|-----------------|---------|---------|-------|-------|
| Ipoprice(yuan)  | 0.13    | 84.00   | 4.13  | 7.41  |
| Car30(%)        | -79.09  | 215.23  | 8.94  | 33.17 |
| Car60(%)        | -91.17  | 312.68  | 8.66  | 41.74 |
| Car90(%)        | -120.56 | 363.67  | 9.43  | 49.10 |
| Age(day)        | 7.00    | 12309.00| 1482.33| 2247.08|
| Eps(yuan)       | -1.45   | 89.63   | 0.91  | 5.29  |
| Bps(yuan)       | -0.02   | 51.83   | 1.94  | 3.36  |
| Profit(%)       | -610.66 | 115246.51| 375.48| 5171.18|
| Plev(%)         | 5.09    | 155.87  | 58.30 | 22.91 |
| Ratio(%)        | 3.73    | 89.34   | 51.56 | 19.05 |
| Num(million)    | 24.00   | 295262.21| 2940.09| 16635.47|
| Size(million)   | 8.00    | 325597.72| 652.67| 2005.84|
| Lot(%)          | 0.12    | 100.00  | 29.35 | 35.21 |
| Market(%)       | -26.52  | 28.74   | -0.76 | 5.25  |

Table 2 and Table 3 show the results of descriptive statistical analysis of the samples. It can be seen that there is a big difference in the excess cumulative return and the winning rate between the two markets. The 30-day, 60-day and 90-day excess cumulative return rate in the Hong Kong market is only 8.94%, 8.66% and 9.43%; while in the A-share market, the corresponding excess cumulative returns are 94.96%, 94.58% and 94.68%, which are largely related to the super-high IPO underpricing rate in the A-share market. In addition, the average winning rates of the Hong Kong market and the A-share market are 29.35% and 0.68% respectively, which is a huge difference.
Table 3. Descriptive statistical in A stocks.

| variable     | minimum | maximum | mean  | St.d  |
|--------------|---------|---------|-------|-------|
| ipoprice(yuan) | 1.26    | 148.00  | 17.33 | 12.82 |
| Car30(%)    | -43.45  | 592.77  | 94.96 | 78.23 |
| Car60(%)    | -49.09  | 608.21  | 94.58 | 77.64 |
| Car90(%)    | -59.50  | 594.82  | 94.68 | 77.78 |
| Age(day)    | 4.00    | 20 440.00 | 4 161.73 | 2 042.11 |
| Eps(yuan)   | 0.03    | 10.97   | 0.81  | 0.56  |
| Bps(yuan)   | 0.28    | 27.07   | 3.67  | 2.04  |
| Profit(%)   | -82.64  | 5 746.88 | 34.34 | 129.24 |
| Plev(%)     | 1.78    | 98.20   | 45.94 | 17.64 |
| Ratio(%)    | 4.36    | 88.55   | 39.08 | 15.14 |
| Num(million)| 26.00   | 270 000.00 | 740.70 | 9 503.55 |
| Size(million)| 8.67  | 25 570.59 | 102.85 | 675.05 |
| Lot(%)      | 0.01    | 65.52   | 0.68  | 1.95  |
| Market(%)   | -21.29  | 26.64   | -0.23 | 5.39  |

4.2. SFA-based pricing efficiency comparison between A shares and Hong Kong shares

Table 4. Hong Kong stocks SFA analysis results.

| variable     | initial price | CAR30 | CAR60 | CAR90 |
|--------------|---------------|-------|-------|-------|
|              | coefficient  | Z value | coefficient | Z value | coefficient | Z value |
| ln(age)      | -0.11        | -0.68  | -0.01 | -0.47 | -0.01 | -0.91 | -0.01 | -0.57 |
| ln(eps)      | 0.4***       | 11.3   | 0.02* | 1.00  | -0.01 | -0.26 | 0.01  | 0.06  |
| ln(bps)      | 0.81***      | 47.48  | 0.03** | 2.00  | 0.00  | 0.03  | -0.01 | -0.15 |
| ln(profit)   | 0.02         | 0.5    | -0.02 | -0.64 | 0.01  | 0.12  | -0.01 | -0.17 |
| ln(plev)     | 0.04         | 1.11   | -0.05** | -1.95 | -0.07** | -1.96 | -0.04 | -1.04 |
| ln(ratio)    | -0.02        | -0.65  | 0.02  | 0.65  | 0.01  | 0.25  | 0.03  | 0.64  |
| ln(num)      | 0.33***      | 7.61   | -0.05* | -1.66 | -0.08* | -1.82 | -0.07 | -1.48 |
| ln(size)     | -0.29***     | -6.53  | 0.07** | 2.02  | 0.09** | 2.05  | 0.09* | 1.67  |
| ln(lot)      | -0.04***     | -4.03  | -0.04*** | -4.46 | -0.02* | -1.71 | -0.01 | -0.87 |
| ln(market)   | -0.15***     | -2.25  | -0.01 | -0.21 | -0.01 | -0.06 | 0.06  | 0.84  |
| cons         | 0.09         | 0.18   | 0.30  | 0.82  | 0.29  | 0.63  | 0.06  | -0.10 |
| Insig2v      | -1.72***     | -31.11 | -2.27*** | -41.26 | -1.77*** | -32.09 | -1.43*** | -26.13 |
| Insig2u      | -10.22       | -12.91 | -0.07 | -12.13 | -0.01 | -12.09 | -0.08 |

L- r test 0.00    Prob>=chibar2 1.00    TE 0.9952    0.9987    0.9981    0.9981

Note: ***,**** represent a significance level of 10%, 5%, and 1%, respectively.

Table 4 shows the SFA analysis results of Hong Kong stocks. The four model results accept the null hypothesis $H_0: \sigma^2 = 0$, and the average efficiencies are 0.9952, 0.9987, 0.9981 and 0.9981, respectively. Therefore, it is believed that the Hong Kong market is an effective market for the four explained variables. Furthermore, bps, eps, and num are all positively correlated with the initial price, indicating that the company’s own basic valuation information has a strong ability to explain the initial price; size and lot, are all related to the initial price. The significant negative correlation indicates that the higher the number of shares issued, the higher the winning rate, and the lower the initial price. This
result is also in line with the basic operating rules of the market; the market characteristic variables have a significant negative correlation with the initial price. For CAR30, except for the significant negative correlation between num and CAR30, plev has a significant negative correlation with CAR30, and the market characteristic variables are not significant, and other results are basically the same as the initial price. The significance of the analysis results of CAR60 and CAR90 has gradually decreased. This may be the cumulative income has become more and more relevant to the company’s development with the development of the company, while the relationship with the company before the issuance has gradually weakened.

Table 5 shows the SFA analysis results of all samples of A shares. The four model results reject the null hypothesis $H_0: \sigma^2_u = 0$. The average efficiencies are 0.7306, 0.6737, 0.6462 and 0.6121, respectively. Therefore, we noticed that in the descriptive statistical analysis results, there is a significant difference in the winning rate between the A-share market and the Hong Kong stock market. The average winning rate in the A-share market is 0.68%, while in the Hong Kong stock market, this value is as high as 29.35%, which is 43.16 times that of the A-share market.

Table 5. A-share SFA analysis results.

| variable | initial price | CAR30 | CAR60 | CAR90 |
|----------|--------------|-------|-------|-------|
|          | coefficient  | Z value | coefficient | Z value | coefficient | Z value | coefficient | Z value |
| ln(age)  | 0.07***      | 4.67   | -0.05** | -3.27   | -0.06*** | -4.2    | -0.08*** | -3.76   |
| ln(eps)  | 0.69***      | 18.53  | -0.37***| -14.42  | -0.37*** | -13.96  | -0.33*** | -14.13  |
| ln(bps)  | -0.01        | -0.09  | 0.31*** | 10.30   | 0.31***  | 10.07   | 0.28***  | 10.55   |
| ln(profit)| 0.03         | 1.00   | -0.01   | -0.30   | -0.02    | -0.56   | -0.01    | -0.23   |
| ln(plev) | -0.05**      | -2.21  | -0.03   | -1.34   | -0.02    | -0.74   | -0.02    | -0.87   |
| ln(ratio)| -0.05        | -1.98  | 0.02    | 0.81    | 0.02     | 0.97    | 0.02     | 0.98    |
| ln(num)  | 0.28***      | 8.48   | 0.11*** | 3.61    | 0.10***  | 3.31    | 0.10***  | 3.96    |
| ln(size) | -0.55***     | -14.36 | -0.19***| -5.24   | -0.19*** | -5.08   | -0.19*** | -5.97   |
| ln(lot)  | 0.19***      | 19.94  | -0.16***| -23.74  | -0.16*** | -23.21  | -0.13*** | -22.30  |
| ln(market)| 0.34        | 1.01   | -0.20***| -6.12   | -0.16*** | -4.96   | -0.13*** | -4.32   |
| cons     | 6.97***      | 22.1   | 2.33*** | 7.79    | 2.37***  | 7.99    | 2.36***  | 8.86    |
| ln(sig2v)| -2.40***     | -20.73 | -2.10***| -23.49  | -2.23*** | -26.32  | -2.25*** | -28.40  |
| ln(sig2u)| -1.67***     | -9.91  | -1.16***| -10.61  | -0.91*** | -11.62  | -1.49*** | -13.24  |

L-r test 21.32 45.00 46.52 47.43
Prob>=chibar2 0.00 0.00 0.00 0.00
TE 0.7306 0.6737 0.6462 0.6121

Note: *, **, *** represent a significance level of 10%, 5%, and 1%, respectively.

From the results of the SFA analysis, in the Hong Kong stock market, the winning rate is significantly negatively correlated with the initial price and CAR. This indicates that the higher the winning rate, the lower the initial price, and the lower the return. Many investors have shared the proceeds of the issuance of new shares. In the A-share market, the winning rate has a significant positive correlation with the initial price, while it has a significant negative relationship with CAR, indicating that the higher the winning rate, the higher the winning rate, and the lower the return. It has led to the imbalance in the distribution of IPO proceeds in the A-share market, which is not conducive to market stability.

4.3. The Impact of IPO System Reform on IPO Pricing efficiency

Since the Chinese securities market began to adopt the inquiry system with Chinese characteristics in 2005, in order to improve the IPO system, the China Securities Regulatory Commission has been
carrying out gradual reforms to it. As of the end of 2017, there have been seven times before and after the reform of the inquiry system. The most discussed by scholars over the years was the first round of IPO reform in June 2009.

Due to the far-reaching impact of the first IPO system on subsequent reforms, this paper selects the first reform in 2009 as the first time node. Secondly, for the second reform in 2010 and the third reform in 2012, some scholars have done more detailed research, so no time node is set. The interval time between the fourth reform in 2013 and the fifth reform in 2014 is short and the IPO has been suspended for a long time, resulting in insufficient IPO samples during the period. Therefore, the two reforms were merged into one time node. Finally, due to the limited number of IPO samples after the last reform in 2017, the sixth reform in 2015 was taken as the last time node. Therefore, this paper divides China's IPO samples from the above three nodes into four stages since 2005, and compares the changes in IPO pricing efficiency before and after the policy to clarify whether the reform is effective. The time points and policies of each stage are shown in Table 6. Among them, the IPO suspension time is not included.

Table 6. Time points and policies of each stage of A-share IPO.

| stage  | time             | initial policy                                                                 |
|--------|------------------|-------------------------------------------------------------------------------|
| first  | 2005.1—2008.12   | 《Notice on Several Issues Concerning the Trial Implementation of the Inquiry System for Initial Public Offerings》 |
| second | 2009.6—2012.10   | 《Guiding Opinions on Further Reforming and Improving the New Share Issuance System》       |
| third  | 2014.1—2015.7    | "Decision on Revising the Measures for the Administration of Securities Issuance and Underwriting" of March 21, 2014 |
| forth  | 2015.12—2017.12  | "Decision on Amending the Measures for the Administration of Securities Issuance and Underwriting" of December 31, 2015 |

Table 7. A-share SFA analysis results by stages (IPO initial price).

| variable     | first | second | third | forth |
|--------------|-------|--------|-------|-------|
| ln(age)      | 0.03  | 0.07** | 0.01  | -0.01 |
| ln(eps)      | 0.88***| 0.60***| 0.84***| 0.89***|
| ln(bps)      | -0.01 | -0.04  | 0.01  | 0.24  |
| ln(profit)   | 0.08  | 0.07*  | 0.07  | 1.58  |
| ln(plev)     | 0.01  | 0.14   | 0.15  | 1.58  |
| ln(num)      | 0.48***| 0.09†  | 0.18***| 0.19***|
| ln(size)     | -0.56***| -0.35***| -0.29***| -0.18***|
| ln(lot)      | 0.04** | 2.46   | 0.16**| 9.30  |
| ln(market)   | -0.01 | 0.05** | 0.10**| 0.05  |
| cons         | 3.23***| 8.31***| 17.02 | 4.59**|
| Insig2v      | -3.39***| -2.52***| -4.26***| -19.54 |
| Insig2u      | -1.62***| -8.79** | -1.76***| -2.83***|

L-r test: 21.21 15.58 18.38 49.04
Prob>=chibar2: 0.00 0.00 0.00 0.00
TE: 0.7370 0.7405 0.8418 0.8449

Note: *,**,***represent a significance level of 10%, 5%, and 1%, respectively.

When the explained variable is the IPO initial price, the specific analysis results of the SFA are shown in Table 7. On the whole, the average pricing efficiencies of the four stages are 0.7370, 0.7405,
0.8418, and 0.8449, which are in a steadily improving state. However, the unilateral error term $u$ of the four stages is significant, and the null hypothesis $H_0: \sigma_u^2 = 0$ is rejected. Therefore, for the first issue in term of price, the four-stage A-share market is relatively ineffective.

**Table 8.** A-share phased SFA analysis results (CAR 30 days after listing).

| variable    | first coefficient | first $Z$ value | second coefficient | second $Z$ value | third coefficient | third $Z$ value | forth coefficient | forth $Z$ value |
|-------------|-------------------|-----------------|-------------------|-----------------|------------------|-----------------|------------------|-----------------|
| ln(age)     | -0.02             | -0.39           | -0.06             | -1.63           | -0.09***         | -2.97           | -0.06**          | -2.44           |
| ln(eps)     | -0.23***          | -2.87           | -0.27***          | -5.25           | -0.20***         | -5.73           | -0.31***         | -13.38          |
| ln(bps)     | 0.02              | 0.02            | 0.00              | 0.03            | 0.08*            | 1.81            | 0.06**           | 2.10            |
| ln(profit)  | 0.18**            | 2.22            | 0.08              | 1.46            | 0.07             | 1.41            | 0.09***          | 3.29            |
| ln(plev)    | -0.10             | -1.14           | -0.00             | -0.06           | -0.02            | -0.88           | -0.02            | -1.05           |
| ln(ratio)   | 0.02              | 0.26            | -0.04             | -1.12           | -0.04            | -1.55           | -0.03            | -1.77           |
| ln(num)     | 0.08              | 0.95            | 0.13***           | 2.37            | -0.05            | -1.11           | -0.43            | -1.45           |
| ln(size)    | -0.23**           | -2.22           | -0.24***          | -3.57           | 0.01             | 0.28            | -0.34***         | -7.74           |
| ln(lot)     | -0.01             | 0.17            | -0.16***          | -7.05           | -0.26***         | -15.13          | 0.29***          | 8.03            |
| ln(market)  | -0.09             | -1.08           | -0.35***          | -5.83           | -0.34***         | -9.68           | -0.06            | -1.20           |
| cons        | 3.97***           | 4.14            | 3.44***           | 5.94            | 2.94***          | 6.63            | 9.17***          | 13.24           |
| Insig2v     | -1.77***          | -4.74           | -2.17***          | -15.06          | -3.33***         | -43.01          | -3.02***         | -52.23          |
| Insig2u     | -1.61*            | -1.79           | -1.26***          | -6.99           | 11.18            | -0.12           | -9.98            | -0.19           |

**Table 9.** A-share phased SFA analysis results (CAR 60 days after listing).

| variable    | first coefficient | first $Z$ value | second coefficient | second $Z$ value | third coefficient | third $Z$ value | forth coefficient | forth $Z$ value |
|-------------|-------------------|-----------------|-------------------|-----------------|------------------|-----------------|------------------|-----------------|
| ln(age)     | -0.06             | -1.01           | -0.00             | -1.11           | -0.10***         | -2.79           | -0.07***         | -2.73           |
| ln(eps)     | -0.21***          | -2.61           | -0.06***          | -4.94           | -0.14***         | -3.43           | -0.31***         | -12.89          |
| ln(bps)     | -0.02             | -0.19           | 0.01              | 0.59            | 0.07             | 1.23            | 0.08***          | 2.61            |
| ln(profit)  | 0.20**            | 2.49            | 0.02              | 1.39            | 0.02             | 0.43            | 0.10***          | 3.43            |
| ln(plev)    | -0.14             | -1.60           | 0.01              | 0.95            | 0.00             | 0.10            | -0.01            | -0.58           |
| ln(ratio)   | 0.05              | 0.70            | -0.01             | -1.49           | -0.04            | -1.52           | -0.01            | -0.47           |
| ln(num)     | 0.12              | 1.41            | 0.03**            | 2.05            | -0.06            | -1.27           | -0.05*           | -1.66           |
| ln(size)    | -0.26***          | -2.60           | -0.05***          | -3.27           | 0.06             | 1.02            | -0.36***         | -7.78           |
| ln(lot)     | -0.04             | -1.02           | -0.03***          | -6.47           | -0.33***         | -15.98          | 0.32***          | 8.35            |
| ln(market)  | -0.14*            | -1.77           | -0.06***          | -3.29           | -0.19***         | -4.64           | -0.03            | -0.49           |
| cons        | 4.46***           | 4.74            | 2.16***           | 15.41           | 2.03***          | 4.16            | 9.61***          | 13.47           |
| Insig2v     | -2.11***          | -8.06           | -6.41***          | -34.22          | -3.22***         | -8.71           | -3.36***         | -18.11          |
| Insig2u     | -1.06***          | -3.59           | -2.85***          | -49.34          | -4.17            | -1.61           | -2.99***         | -8.12           |

Note: * *** represent a significance level of 10%, 5%, and 1%, respectively.
From the specific results, in the first stage, only three company characteristic variables including eps, ratio, num and two IPO characteristic variables are significantly related to the initial price; in the second stage, there are age, eps, profit, num and two IPO characteristic variables are significantly related to the initial price; in the third stage, there are four company characteristic variables including eps, plev, ratio, num, two IPO characteristic variables and one market characteristic variable and the initial price significantly correlated; in the fourth stage, there are five company characteristic variables including eps, bps, profit, ratio, num and the IPO characteristic variable of size is significantly correlated with the initial price.

Table 8, Table 9 and Table 10 are the SFA analysis results when the explained variables are 30 days, 60 days and 90 days after listing, respectively. In the first model, the one-sided error terms of the first two stages are more significant, while the one-sided error terms of the latter two stages are not significant. Therefore, for the 30-day cumulative excess return, after the third IPO system reform, the A-share market has always been in an effective state.

**Table 10. A-share phased SFA analysis results (CAR 90 days after listing).**

| variable | first | second | third | forth |
|----------|-------|--------|-------|-------|
| ln(age)  | -0.07 | -1.21  | -0.02 | -0.61 |
| ln(eps)  | -0.22*** | -2.81** | 0.001 | 0.036 |
| ln(bps)  | 0.04** | 0.44   | -0.01 | -0.18 |
| ln(profit) | 0.17**  | 2.35   | 0.03  | 0.67  |
| ln(plev) | -0.11  | -1.37  | 0.01  | 0.42  |
| ln(ratio) | 0.06   | 0.86   | -0.04 | -1.22 |
| ln(num)  | 0.12** | 1.52   | 0.12**| 2.58  |
| ln(size) | -0.26*** | -2.74*** | -3.83 | 0.01  |
| ln(lot)  | -0.03  | -0.78  | -0.14*** | -7.18 |
| ln(market)| -0.07 | -0.95  | -0.24*** | -4.69 |
| cons     | 4.16*** | 4.72   | 2.79***| 5.54  |
| Insig2v  | -2.28*** | -8.94** | -19.39| -3.47***|
| Insig2u  | -1.11*** | -4.21  | -1.30***| -10.30|

| L-r test | 8.21   | 44.22  | 0.81   | 0.00   |
| Prob>chibar2 | 0.002  | 0.00   | 0.184  | 1.00   |
| TE       | 0.6691 | 0.6916 | 0.8763 | 0.9951 |

Note: ***represent a significance level of 1%, respectively.

In the second model, only the A-share market in the third stage is effective, while in the third model, only the A-share market in the fourth stage is effective. In general, similar to the SFA analysis results of the initial price. Among the analysis results of the above three models, the IPO pricing efficiency of the first two stages is quite different from the latter two stages.

5. Conclusions

Based on the IPO data of the A-share market from 2005 to the present, this paper studies the first IPO system reform in June 2009 from the perspectives of the initial IPO price and the 30, 60 and 90 days after the issuance of the CAR. Changes in IPO pricing efficiency in the A-share market before and after the four reforms and the sixth reform in December 2015. The results show that in terms of initial price, the IPO pricing efficiency of the first two stages is significantly different from the latter two stages, while the differences between the first and second stages and the third and fourth stages are not obvious, this paper believes that this may be caused by the gradual reform of China's IPO system.
Overall, although the pricing efficiency of the A-share market has always been in an incompletely efficient market, with the gradual advancement of reforms, its average pricing efficiency is also steadily improving, and the ability of the company's characteristics and IPO characteristics to explain the initial price has gradually increased.

As far as the CAR after the issuance is concerned, the change in IPO pricing efficiency is similar to the initial price, and the pricing efficiency in the first two stages is significantly different from the latter two stages.

In summary, the reform of China's new share issuance policy has a positive impact on the improvement of pricing efficiency in the A-share market. Secondly, this paper compares the pricing efficiency of the relatively mature Hong Kong market and the A-share market. The results show that the IPO pricing efficiency of the Hong Kong market is better than that of the A-share market from the perspective of the initial price and the post-issue CAR. In addition, the winning rate of new shares in the Hong Kong market is much higher than that in the A-share market. The model results also indicate that the online allotment mechanism in the A-share market may cause an imbalance in the distribution of benefits from the issuance of new shares.

Based on the above research results, this paper proposes the following three policy suggests for the reform direction of China's IPO issuance system: First, accelerate the internationalization of China's securities market and expand the scope of inquiry. Second, continue to promote the marketization of IPO pricing, and gradually transfer the rights of allotment to underwriters. Third, choose a more reasonable online distribution method. We have noticed that there is a big difference in the IPO winning rate between the A-share market and the Hong Kong market.

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