Tsai, Hong-Wen; Che, Hui-Chung; Bai, Bo

Article

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International Journal of Business and Economic Sciences Applied Research (IJBESAR)

Provided in Cooperation with:
International Hellenic University (IHU), Kavala

Suggested Citation: Tsai, Hong-Wen; Che, Hui-Chung; Bai, Bo (2022) : Patent claim's impact on stock return rate based on China stock market's empirical study, International Journal of Business and Economic Sciences Applied Research (IJBESAR), ISSN 2408-0101, International Hellenic University (IHU), Kavala, Vol. 15, Iss. 1, pp. 27-46, https://doi.org/10.25103/ijbesar.151.03

This Version is available at:
https://hdl.handle.net/10419/280247

International Journal of Business and Economic Sciences Applied Research

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Patent Claim's Impact on Stock Return Rate Based on China Stock Market's Empirical Study

Hong-Wen Tsai[1], Hui-Chung Che[†2], Bo Bai[3]

[1]Ph.D., Associate Professor, Graduate Institute of Patent, National Taiwan University of Science and Technology, Taipei, Taiwan
https://orcid.org/0000-0001-9263-8359
[2]Ph.D., CDO, Shenzhen TekGlory Intellectual Property Data Technologies, Ltd., Guangdong, China
https://orcid.org/0000-0001-7199-7651
[2]EMBA, CEO, Shenzhen TekGlory Intellectual Property Data Technologies, Ltd., Guangdong, China
https://orcid.org/0000-0001-9894-5499

ARTICLE INFO

Article History

Received 8 November 2021
Accepted 3 February 2022

JEL Classifications
C38, C46, G11, G12

Keywords:
China A-share, patent, ANOVA, stock return rate, claim count

ABSTRACT

Purpose:
The main aim of this research was to discuss the relationship between the patents and the performance of listed companies, more particularly, to find out whether China patent's claim impacted on China listed company's stock return rate or not. It was because the claim played the most important role in a patent which being a key driving force for modern business.

Design/methodology/approach:
This research used a company integrated China patent database in which all subsidiary's patents were merged with their parent company's patents. Three China patent species of the invention publication, the invention grant and the utility model grant were all studied and compared. The average claim count per patent of each A-share was calculated for the whole stock market and four stock boards comprised therein. Five claim groups were divided by the percentile rank of all A-shares' claim counts. The annual stock return rates in four quarters of 2020 were observed. The research hypothesis was tested using the analysis variance (ANOVA).

Findings:
This research found that the average claim count per patent had a significant impact on China A-share's stock return rate. Though the stock market fluctuated seriously under COVID-19 pandemic, the average claim count of any patent species was still a good indicator for classifying A-share's stock return rate. The A-shares in the higher claim count groups showed the significantly higher stock return rate means while the A-shares in the lower claim count groups showed the significantly lower stock return rate means.

Research limitations/implications:
China companies listed in Shanghai stock exchange and Shenzhen stock exchange were observed while China companies listed in Hong Kong or overseas were excluded. China patents in which patent claim count being calculated in this research were discussed while other countries' patents were excluded. It was because the amount of China domestic patents played the majority part of China listed companies' patents. Patents with more claims were usually regarded as more valuable. Companies having more valuable patents were usually regarded as more competitive to have better financial performance. This research implicated and proved.

Originality/value:
This research provided a novel and creative analysis of the patent claim's impact on the stock return rate over whole China stock market. The finding of this research would improve the understanding of China patents and the innovation outcome of China A-shares. It would contribute a lot the art of the patent valuation and the listed company evaluation.

† Corresponding Author: Hui-Chung Che
Email: drcharlie918@yeah.net

DOI: 10.25103/ijbesar.151.03

1. Introduction

Innovation is an essential driver of economic progress that benefits individuals, businesses and the economy as a whole. Goniadis & Goniadis (2010) found a significant number of patentees started a new business with most of them being optimistic of new job creation. The technological innovation is a key driver of financial performance for most companies in most economies though the intellectual capital has no significant influence on performance of SMEs in some underdeveloped countries, e.g. Kenya (Murimi *et al.*, 2022).

The stock market principally reflects the economic and innovation conditions of an economy. China has been the largest domestic patent application country in the world for many years. China Intellectual Property Administration (CNIPA) is now the world's largest patent office. In the single year of 2020, there are more than three millions of patent published and/or granted by CNIPA, including 1,517 thousands of invention publications, 53 thousands of invention grants and 2,377 thousands of utility model grants. Meanwhile, China is now the world No.2 economy to have a stock market with the world No.2 transaction volume. China listed companies lead the development of China patents, which the unlisted companies and individuals follow.

With so huge amount of China patents, CNIPA faced the challenges in trying to process more patent applications in a shorter period of time and made some achievements (Liegsalz & Wagner, 2013). Based on patent information, Motohashi (2008) examined China's development of innovation capabilities from 1985 to 2005 by using more than 679 thousands of China invention patent. Motohashi (2009) proposed to see a substantial trend of Chinese firms catching up with Western counterparts via patent statistics in two high-tech sectors: the pharmaceutical industry and mobile communications technology. He found that these two fields show contrasting trends, the rapid catching up can be found in mobile communications technology, while Chinese companies are still lagging behind Western counterparts in the pharmaceutical industry. Hu & Jefferson (2009) used a firm-level data set that spans the population of China's large and medium-size industrial enterprises to explore the factors that account for China's rising patent activity. They found that China's patent surge is seemingly paradoxical given the country's weak record of protecting intellectual property rights. Lei *et al.* (2011) found that the inventive activities of China have experienced three developmental phases and have been promoted quickly in recent years. The innovation strengths of the three development phases have shifted from government to university and research institute and then industry. Liu & Qiu (2016) used Chinese firm-level patent data from 1998 to 2007 which featuring a drastic input tariff cut in 2002 because of China's WTO accession. They found that input tariff cut results in less innovation undertaken by Chinese firms. Boeing & Mueller (2019) proposed a patent quality index based on internationally comparable citation data from international search reports (ISR) to consider foreign, domestic, and self-citations. They found that all three citation types may be used as economic indicators if policy distortion is not a concern. They also suggested that the domestic and self-citations suffer from an upward bias in China and should be employed with caution if they are to be interpreted as a measure of patent quality.

Dang & Motohashi (2015) proposed that China patent statistics are meaningful indicators because China valid patent count is correlated with R&D input and financial output. Chen & Zhang (2019) studied China's patent surge and its driving forces on patent applications filed by Chinese firms and found that R&D investment, foreign direct investment, and patent subsidy have different effects on different types of patents. They found that R&D investment has a positive and significant impact on patenting activities for all types of patents; the stimulating effect of foreign direct investment on patent applications is only robust for utility model patents and design patents; the patent subsidy only has a positive impact on design patents.

He *et al.* (2016) found that it was difficult in integrating Chinese patent data with company data, so they constructed a China patent database of all China listed companies and their subsidiaries from 1990 to 2010. Chen *et al.* (2018, 2020) used the patent data and stock data of China listed companies of RMB common stocks (A-shares) in Shanghai main board (SH main board) from 2011 to 2017 and found the patent indicators have leading effect on A-share's stock price. Chiu *et al.* (2020a, 2020b) focused on the whole China A-shares without distinguishing the stock boards from 2016Q4 to 2018Q3. They found that the patent indicators also have leading effect on the financial indicators including the stock price, return-on-asset (ROA), return-on-equity (ROE), book-value-per-share (BPS), earnings-per-share (EPS), price-to-book (PB) and price-to-earnings (PE). The patent prediction equations for quantitatively giving the predictive values of the aforementioned financial indicators are proposed.

The China A-shares are listed on four stock boards including SH main board, Shenzhen main board (SZ main board), Growing-Enterprises board (GE board) and Small-and-Medium Enterprises board (SME board). Chiu *et al.* (2020c, 2020d, 2020e, 2021), Li *et al.* (2020a, 2020b, 2021) further studied the patent leading effect on each stock board, proposed each stock board's patent prediction equations on the stock price, ROA, ROE, BPS, EPS, PB and PE, finally proposed patent based stock selection criteria to have stock the performance surpassing the market trend.

COVID-19 is an impact to everything including technology and finance. The World Health Organization (WHO) on March 11, 2020, has declared COVID-19 outbreak a global pandemic. The stock markets around the world including China stock market fluctuated dramatically in 2020. Figure 1 shows the principal China stock indexes performance from Jan. 2019 to Dec. 2020, wherein, 300317 is the stock index consisting of all China A-shares, 000002 is the stock index consisting of all A-shares in SH main board, 399101 is the stock index consisting of all A-shares in SME board, 399102 is the stock index consisting of all A-shares in GE board. Apparently, stock indexes in 2020 are more volatile than those in 2019.

DOI: 10.25103/ijbesar.151.03

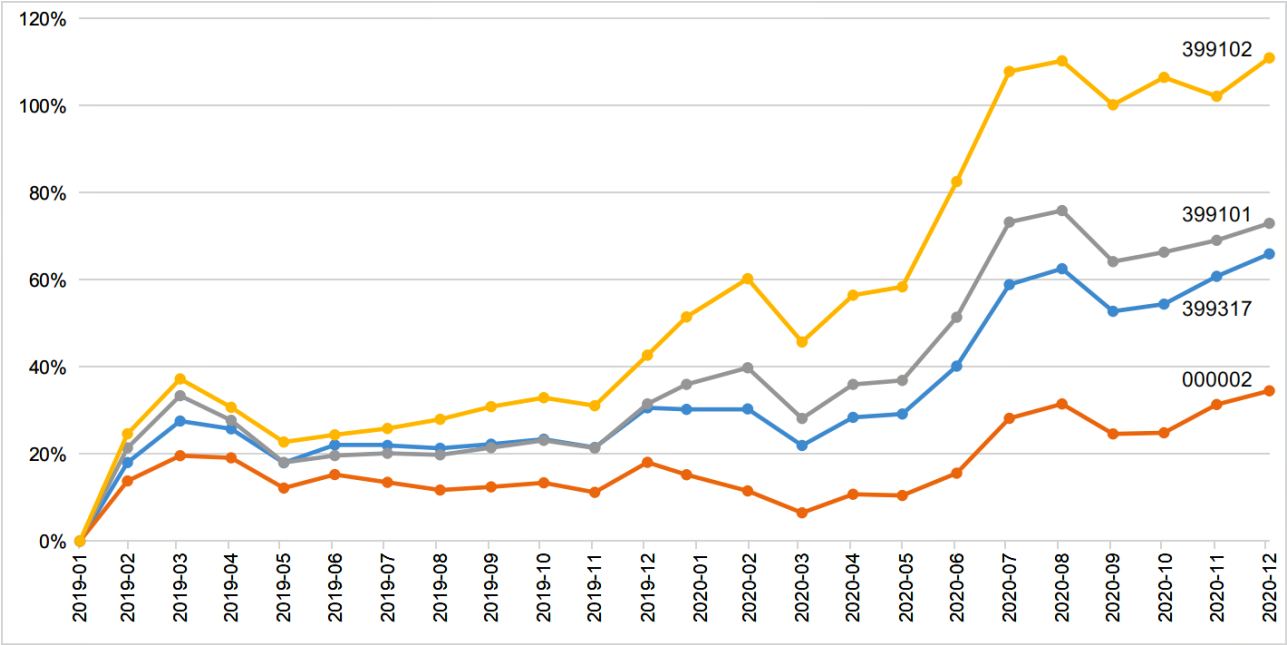

Figure 1: Performance of Principal China Stock Indexes from JAN 2019 to DEC 2020

The fluctuation modes of stock indexes are far beyond any patent indicator's varying trend. Tsai *et al.* (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2022) discussed the relationship between China patents and A-shares' stock performance in recent years. The China A-shares with the higher innovation continuity showed the higher stock return rate mean (Tsai *et al.*, 2021a). The China A-shares with the higher patent count showed the higher stock price mean and the higher stock return rate mean (Tsai *et al.*, 2021b, 2021f). The China A-shares with the higher technology variety showed the higher stock return rate mean (Tsai *et al.*, 2021c). The China A-shares having patents of the longer examination duration showed the higher stock price mean and the higher stock return rate mean (Tsai *et al.*, 2021d). The China A-shares having patents of the higher backward citation count showed the higher stock price mean (Tsai *et al.*, 2021e). The A-shares having patents but receiving no forward citations were proved to show the highest stock price mean whereas the A-shares receiving forward citation counts above the average showed the lowest stock price mean (Tsai *et al.*, 2022).

The claim is usually regarded as the most important part of a patent because it forms the boundary of patent right. The claim of a patent is a list which consisting of a series of numbered statements, each of which comprising a subject matter and the corresponding patentable characteristics. A patent having higher claim counts usually has more stable and stronger patent right and is regarded more valuable when comparing with the patent having less claim counts.

Lai & Che (2009a, 2009b, 2009c) applied US patent claim count as one of indicators for quantitatively modeling patent legal values. Chiu *et al.* (2020a, 2020b, 2020c, 2021) and Li *et al.* (2020a, 2020b, 2021) applied China patent claim count as one of indicators to build the patent prediction equations for giving the predictive values of China A-share's financial indicators. However, the detailed impact of patent claim count on China A-share's stock return rate has not been discussed. It is therefore the objective of this research to solve, more particularly, to see the impact variance between different stock boards under the COVID-19 pandemic.

2. Methodology

2.1 Company Integrated Patent Database

It is a common phenomenon that a listed company has lots subsidiaries. When a subsidiary's revenue is merged to its parent company as shown in the formal financial report, the subsidiary's patents are inferred to contribute to parent company's financial performance. Therefore, a company integrated China patent database is built in this research, wherein, all subsidiaries' patents are merged together with parent company's patents. Furthermore, if a patent is co-owned by parent company and any of the subsidiaries, it is regarded as a single one patent of the parent company for avoiding duplicated calculation. However, if a patent is co-owned by two or more parent A-shares, it is inferred to contribute equivalently to each parent A-share's financial performance, so the patent is duplicately specified to each of the parent A-shares.

2.2 Patent Species and Claim Groups

There are three patent species regarding claim counts of published patents in China including the invention publication, the invention grant, and the utility model grant. The invention publication is an invention application which published by overcoming the preliminary examination. The invention grant is an invention application which granted by overcoming not only the preliminary examination but also the substantial examination. The utility model grant is a utility model application which granted by overcoming the preliminary examination. Since the attorney's

DOI: 10.25103/ijbesar.151.03

service charge and official fees including filing and examination from high to low is the invention grant > the invention publication > the utility model grant, so the invention grant is usually regarded as the most valuable patent species with high level innovation while the utility model grant is usually regarded less valuable and the innovation level is low. In this research, the claim's impact of aforementioned patents of three species are all discussed and compared.

For each of four quarters of 2020, patents of three species are retrieved from the company integrated patent database by the patent publication date and the patent grant date. For 2020Q1, patents are retrieved by the publication date or the grant date from 2019/04/01 to 2020/03/31. For 2020Q2, patents are retrieved by the publication date or the grant date from 2019/07/01 to 2020/06/30. And so forth 2020Q3 and 2020Q4.

When patents are retrieved, the average claim count per patent of each A-share is calculated. By setting the stock return rate as the dependent variable and the average claim count as the independent variable, the R^2 of a modeled linear regression equation is less than 0.01. It is inappropriate to use linear modeling for the stock return rate and the average claim count because of the poor explanatory ability.

The discrete data analysis model is therefore applied. The average claim count per patent of all effective samples of A-shares are ranked by percentile. The effective samples are divided into five claim groups by claim count percentile rank (PR) as below:

Claim group 1: PR 0~20, the lowest claim count;
Claim group 2: PR 20~40;
Claim group 3: PR 40~60;
Claim group 2: PR 60~80;
Claim group 5: PR 80~100, the highest claim count.

2.3 Population and Sample

The population comprises all China A-shares listed in SH main board, SZ main board, GE board and SME board. SH main board and SZ main board comprise mostly the state-owned companies and big size companies. GE board and SME board comprise mostly medium and small size companies. An effective sample for each quarter of 2020 must be an A-share listed in 2019 and 2020 so as to have a definite annual stock return rate and have at least one new patent published or granted in the patent retrieval interval as described in sub-section above.

Table 1 shows the effective samples statistics of the whole stock market and four stock boards in four quarters of 2020, wherein, the whole market consists of all effective samples of four stock boards. The sampling rate of the effective samples to all A-shares is more than 50%. Table 2 shows the number of effective samples of each claim group for discussing the stock return rate. With regard to the patent species, the number of invention publication's effective samples is close to the number of utility model grant's effective samples; the invention grant is of the least number of effective samples due to the rejection of substantial examination. The numbers of effective samples in different claim groups are not the same but quite close, while the numbers of effective samples in different quarters of 2020 are also close. The analysis in this research should be of no survivorship bias.

Table 1: Effective Samples Statistics

Patent Species	Stock Board	Effective Samples				
		2020Q1	2020Q2	2020Q3	2020Q4	Total
Invention Publication	Whole Stock Market	2,610	2,660	2,644	2,643	10,557
	SH Main Board	976	1,004	1,001	1,004	3,985
	SZ Main Board	280	280	276	282	1,118
	GE Board	624	636	631	623	2,514
	SME Board	730	740	736	734	2,940
Invention Grant	Whole Stock Market	2,046	2,092	2,108	2,182	8,428
	SH Main Board	739	760	788	802	3,089
	SZ Main Board	220	218	221	236	895
	GE Board	500	531	515	528	2,074
	SME Board	587	583	584	616	2,370
Utility Model Grant	Whole Stock Market	2,459	2,541	2,553	2,565	10,118
	SH Main Board	934	961	974	992	3,861
	SZ Main Board	265	279	285	281	1,110
	GE Board	556	579	579	579	2,293
	SME Board	704	722	715	713	2,854

Source: This Research

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Table 2: Effective Samples Statistics for Claim Groups

Patent Species	Stock Board	Effective Samples					
		Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Invention Publication	Whole Stock Market	2,242	1,981	2,139	2,683	1,512	10,557
	SH Main Board	797	817	777	1,067	527	3,985
	SZ Main Board	224	223	226	221	224	1,118
	GE Board	509	501	498	537	469	2,514
	SME Board	588	642	534	763	413	2,940
Invention Grant	Whole Stock Market	1,699	1,872	1,486	1,685	1,686	8,428
	SH Main Board	636	605	673	557	618	3,089
	SZ Main Board	180	226	151	159	179	895
	GE Board	511	326	407	437	393	2,074
	SME Board	496	474	463	533	404	2,370
Utility Model Grant	Whole Stock Market	2,108	1,948	2,015	2,023	2,024	10,118
	SH Main Board	772	772	773	771	773	3,861
	SZ Main Board	224	220	222	222	222	1,110
	GE Board	475	442	462	491	423	2,293
	SME Board	571	571	577	564	571	2,854

Source: This Research

2.4 Analysis of Variance

Analysis of Variance (ANOVA) is applied for discovering:

(1) whether the claim counts are significantly different between different patent species;

(2) whether the claim counts are significantly different between different stock boards; and

(3) whether the claim count significantly impacts the stock return rate or not.

ANOVA is a statistical approach used to compare variances across the means of different data groups. The outcome of ANOVA is the "F-Ratio".

$$F = \frac{MST}{MSE} = \frac{\sum n_j (\overline{x_j} - \overline{x})^2 / (k-1)}{\sum\sum (x - \overline{x_j})^2 / (N-k)} \quad \text{.....(1)}$$

This ratio shows the difference between the within group variance and the between group variance, which ultimately produces a result which allowing a conclusion that the null hypothesis $H_0: \mu_1 = \mu_2 = ... = \mu_k$ is supported or rejected. If there is a significant difference between the groups, the null hypothesis is not supported, and the F-ratio will be larger and the corresponding p value should be smaller than 0.05.

3. Result and Finding

3.1 Patent Species of Invention Publication

Table 3 shows the claim count means of invention publication's claim groups. With regard to claim groups 1, 2 and 4, it seems that SZ main board has the lowest claim count means while GE board has the highest claim count means. With regard to claim group 3, it seems that SH main board has the lowest claim count means while GE board also has the highest claim count means. With regard to claim group 5, it seems that SZ main board has the lowest claim count means while SH board has the highest claim count means. In general, GE board seems to have the highest claim count means in most claim groups while SZ main board has the lowest claim count means in most claim groups.

Table 3: Claim Count Means of Invention Publication's Claim Groups

Stock Market	Claim Count Mean					
	Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Whole Stock Market	5.61	7.75	8.81	9.76	11.85	8.61
SH Main Board	5.36	7.49	8.59	9.66	12.11	8.47
SZ Main Board	5.30	7.46	8.59	9.47	10.90	8.35
GE Board	5.83	8.07	9.10	9.87	11.77	8.90
SME Board	5.63	7.90	8.93	9.78	11.57	8.64

Source: This Research

DOI: 10.25103/ijbesar.151.03

Table 4 shows the results of ANOVA on invention publication's claim count between four stock boards. The claim count variances between different stock boards reach p***≤0.001 significance in all claim groups. Different stock boards have significantly different claim count means.

Table 4: Result of ANOVA on Invention Publication's Claim Count Between Stock Boards

Claim Group	Stock Board	Claim Count			
		Sum Square	Mean Square	F	p
1	Between Stock Boards	102.1	34.0	18.838	0.001***
	Within Stock Boards	3,785.6	1.8		
2	Between Stock Boards	144.3	48.1	326.727	0.001***
	Within Stock Boards	323.5	0.1		
3	Between Stock Boards	97.3	32.4	452.198	0.001***
	Within Stock Boards	145.1	0.1		
4	Between Stock Boards	20.3	6.8	94.402	0.001***
	Within Stock Boards	194.5	0.1		
5	Between Stock Boards	70.5	23.5	3.163	0.001***
	Within Stock Boards	11,201.4	7.4		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Tables 5 further shows the multiple comparisons of ANOVA on invention publication's claim count between every two stock boards, wherein, SH stands for SH main board, SZ stands for SZ main board, GE stands for GE board, SME stands for SME board. With regard to claim groups 1, 2, 3 and 4, the claim count variances between SH main board and SZ main board are free of significance; the other claim count variances are of significance. According to the significant mean differences, GE board is therefore confirmed to have the highest claim count means, SZ main board is therefore confirmed to have lowest claim count means. With regard to claim group 5, the claim count variance between SME board and SH main board is the only one of significance; the other claim count variances are free of significance. SH main board has the higher claim count mean than SME board. Though SH main board seems to have the highest claim count means than the other stock boards in Table 4, but it could not be confirmed because the mean differences between SH main board and other stock boards are free of significance except between SH main board and SME board. In general, GE board has the highest claim count means in most claim groups and SZ main board to has the lowest claim count means in most claim groups.

Table 5: Multiple Comparisons of ANOVA on Invention Publication's Claim Count between Stock Boards

Claim Group	Stock Board		Claim Count		
	Board (I)	Board (J)	Mean Difference (I-J)	Std. Error	p
1	SZ	SH	-0.196	0.105	0.062
	GE	SH	0.468	0.076	0.001***
	GE	SZ	0.664	0.111	0.001***
	SME	SH	0.273	0.073	0.001***
	SME	SZ	0.469	0.109	0.001***
	SME	GE	-0.195	0.081	0.017*
2	SZ	SH	-0.033	0.028	0.248
	GE	SH	0.586	0.022	0.001***
	GE	SZ	0.618	0.030	0.001***
	SME	SH	0.416	0.020	0.001***
	SME	SZ	0.448	0.029	0.001***
	SME	GE	-0.170	0.023	0.001***
3	SZ	SH	-0.002	0.021	0.935
	GE	SH	0.509	0.015	0.001***
	GE	SZ	0.510	0.022	0.001***
	SME	SH	0.339	0.015	0.001***
	SME	SZ	0.340	0.022	0.001***
	SME	GE	-0.170	0.017	0.001***
4	SZ	SH	-0.023	0.016	0.166

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	GE	SH	0.209	0.014	0.001***
	GE	SZ	0.232	0.018	0.001***
	SME	SH	0.116	0.013	0.001***
	SME	SZ	0.139	0.017	0.001***
	SME	GE	-0.093	0.015	0.001***
5	SZ	SH	-0.142	0.294	0.628
	GE	SH	-0.332	0.173	0.055
	GE	SZ	-0.190	0.297	0.523
	SME	SH	-0.534	0.179	0.003**
	SME	SZ	-0.392	0.300	0.192
	SME	GE	-0.202	0.184	0.273

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Table 6 shows the stock return rate means of each stock board's claim groups. With regard to the whole stock market, the stock return rate mean seems to increases as the claim count increases. With regard to SH main board, it seems that claim group 2 has the lowest stock return rate mean while claim group 5 has the highest stock return rate mean. With regard to SZ main board, it seems that claim group 1 has the lowest and the only negative stock return rate mean while claim group 4 has the highest stock return rate mean. With regard to GE board, it seems that claim group 1 has the lowest stock return rate mean while claim group 5 has the highest stock return rate mean. With regard to SME board, it seems that claim group 1 has the lowest stock return rate mean while claim group 5 has the highest stock return rate mean. With regard to claim groups 1, 3, 4 and 5, SZ main board has the lowest stock return rate means while GE board has the highest stock return rate means. With regard to claim group 2, SH main board has the lowest stock return rate mean while GE board also has the highest stock return rate mean. In general, it seems that GE board has the highest stock return rate means in all claim groups while SZ main board has lowest claim count means in most claim groups.

Table 6: Stock Return Rate Means of Invention Publication's Claim Groups

Stock Board	Stock Return Rate Mean (%)					
	Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Whole Stock Market	5.07	6.80	10.56	12.00	22.09	10.71
SH Main Board	5.32	3.15	5.52	9.52	15.29	7.36
SZ Main Board	-6.67	3.94	4.94	9.42	2.66	2.84
GE Board	11.16	14.49	19.82	14.61	34.21	18.58
SME Board	4.92	8.22	15.70	12.08	19.50	11.50

Source: This Research

Table 7 shows the results of ANOVA on the stock return rate between invention publication's claim groups. The stock return rate variances of the whole stock market and each of stock boards reach p***≤0.001 significance. Different invention publication's claim groups have significantly different stock return rate means in the whole stock market and each stock board.

Table 7: Result of ANOVA on Stock Return Rate Between Invention Publication's Claim Groups

Stock Board	Claim Group	Stock Return Rate (%)			
		Sum Square	Mean Square	F	p
Whole Stock Market	Between Groups	301,877.7	75,469.4	29.147	0.001***
	Within Groups	27,321,714.1	2,589.2		
SH Main Board	Between Groups	58,554.3	14,638.6	6.428	0.001***
	Within Groups	9,063,856.4	2,277.4		
SZ Main Board	Between Groups	31,109.1	7,777.3	5.315	0.001***
	Within Groups	1,628,697.6	1,463.3		
GE Board	Between Groups	160,160.0	40,040.0	12.537	0.001***
	Within Groups	8,013,049.9	3,193.7		
SME Board	Between Groups	68,456.6	17,114.1	6.031	0.001***
	Within Groups	8,328,305.6	2,837.6		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

DOI: 10.25103/ijbesar.151.03

Table 8 shows the multiple comparisons of the stock return rate between every two claim groups. With regard to the whole stock market, the stock return rate variances between claim groups 2 and 1, between claim groups 4 and 3, are free of significance; the other stock return rate variances are of significance. According to the significant mean differences, claim group 5 is confirmed to have the highest stock return rate mean while claim group 1 is confirmed to have the lowest stock return rate mean. With regard to SH main board, the stock return rate variances between claim groups 4 and 2, between claim groups 5 and 1, between claim groups 5 and 2, between claim groups 5 and 3, between claim groups 5 and 4, are of significance; the other stock return rate variances are free of significance. According to the significant mean differences, claim group 5 is confirmed to have the highest stock return rate mean while claim group 2 is confirmed to have the lowest stock return rate mean. With regard to SZ main board, the stock return rate variances between claim groups 2 and 1, between claim groups 3 and 1, between claim groups 4 and 1, between claim groups 5 and 1, are of significance; the other stock return rate variances are free of significance. According to the significant mean differences, claim group 4 is confirmed to have the highest stock return rate mean while claim group 1 is confirmed to have the lowest stock return rate mean. With regard to GE board, the stock return rate variances between claim groups 3 and 1, between claim groups 5 and 1, between claim groups 5 and 2, between claim groups 5 and 3, between claim groups 5 and 4, are of significance; the other stock return rate variances are free of significance. According to the significant mean differences, claim group 5 is confirmed to have the highest stock return rate mean while claim group 1 is confirmed to have the lowest stock return rate mean. With regard to SME board, the stock return rate variances between claim groups 2 and 1, between claim groups 4 and 2, between claim groups 4 and 3, between claim groups 5 and 3, are free of significance; the other stock return rate variances are of significance. According to the significant mean differences, claim group 5 is confirmed to have the highest stock return rate mean while claim group 1 is confirmed to have the lowest stock return rate mean. In general, in the whole stock market and most stock boards except SZ main board, claim group 5 has the highest stock return rate means while claim group 1 has the lowest stock return rate means.

Table 8: Multiple Comparisons of ANOVA on Stock Return Rate for Invention Publication's Claim Groups

Stock Market	Claim Group		Stock Return Rate (%)		
	Group (I)	Group (J)	Mean Difference (I-J)	Std. Error	p
Whole Stock Market	2	1	1.730	1.569	0.270
	3	1	5.495	1.538	0.001***
	3	2	3.765	1.587	0.018*
	4	1	6.929	1.456	0.001***
	4	2	5.199	1.507	0.001***
	4	3	1.434	1.475	0.331
	5	1	17.019	1.693	0.001***
	5	2	15.289	1.738	0.001***
	5	3	11.524	1.710	0.001***
	5	4	10.090	1.636	0.001***
SH Main Board	2	1	-2.175	2.376	0.360
	3	1	0.196	2.406	0.935
	3	2	2.370	2.391	0.322
	4	1	4.194	2.234	0.061
	4	2	6.369	2.219	0.004**
	4	3	3.998	2.251	0.076
	5	1	9.969	2.679	0.001***
	5	2	12.144	2.666	0.001***
	5	3	9.773	2.693	0.001***
	5	4	5.775	2.541	0.023*
SZ Main Board	2	1	10.615	3.619	0.003**
	3	1	11.611	3.607	0.001***
	3	2	0.996	3.611	0.783
	4	1	16.092	3.627	0.001***
	4	2	5.477	3.631	0.132
	4	3	4.481	3.619	0.216
	5	1	9.331	3.615	0.010**

DOI: 10.25103/ijbesar.151.03

	5	2	-1.284	3.619	0.723
	5	3	-2.280	3.607	0.527
	5	4	-6.761	3.627	0.063
GE Board	2	1	3.338	3.557	0.348
	3	1	8.658	3.562	0.015*
	3	2	5.321	3.576	0.137
	4	1	3.456	3.496	0.323
	4	2	0.119	3.510	0.973
	4	3	-5.202	3.516	0.139
	5	1	23.051	3.617	0.001***
	5	2	19.713	3.631	0.001***
	5	3	14.392	3.636	0.001***
	5	4	19.594	3.572	0.001***
SME Board	2	1	3.301	3.041	0.278
	3	1	10.778	3.184	0.001***
	3	2	7.477	3.120	0.017*
	4	1	7.168	2.923	0.014*
	4	2	3.867	2.853	0.175
	4	3	-3.610	3.005	0.230
	5	1	14.578	3.420	0.001***
	5	2	11.277	3.360	0.001***
	5	3	3.800	3.491	0.276
	5	4	7.410	3.254	0.023*

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

3.2 Patent Species of Invention Grant

Table 9 shows the claim count means of invention grant's claim groups. With regard to claim groups 1, 2, 3 and 5, it seems that SH main board has the lowest claim count means while GE board has the highest claim count means. With regard to claim group 4, SZ main board has the lowest claim count mean while GE board also has the highest claim count mean. In general, it seems that GE board has the highest claim count means in all claim groups while SH main board has the lowest claim count means in most claim groups.

Table 9: Claim Count Means of Invention Grant's Claim Groups

Stock Market	Claim Count Mean					
	Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Whole Stock Market	3.13	5.42	6.71	7.98	11.47	6.91
SH Main Board	3.02	5.15	6.47	7.81	11.20	6.69
SZ Main Board	3.24	5.44	6.65	7.72	12.09	6.94
GE Board	3.69	5.83	7.05	8.36	12.21	7.28
SME Board	3.16	5.47	6.76	8.21	11.40	6.87

Source: This Research

Table 10 shows the results of ANOVA on invention grant's claim counts between four stock boards. For each of claim count groups, the claim count variances between different stock boards reach p***≤0.001 significance. Different stock boards have significantly different claim count means for each of claim groups.

Table 10: Result of ANOVA on Invention Grant's Claim Count Between Stock Boards

Claim Group	Stock Board	Claim Count			
		Sum Square	Mean Square	F	p
1	Between Stock Boards	135.9	45.3	34.812	0.001***
	Within Stock Boards	2,366.4	1.3		
2	Between Stock Boards	101.0	33.7	202.855	0.001***
	Within Stock Boards	269.9	0.2		
3	Between Stock Boards	88.3	29.4	223.055	0.001***

	Within Stock Boards	223.1	0.1		
4	Between Stock Boards	104.2	34.7	173.992	0.001***
	Within Stock Boards	335.8	0.2		
5	Between Stock Boards	305.5	101.8	4.726	0.001***
	Within Stock Boards	34,263.8	21.6		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Tables 11 shows the multiple comparisons of ANOVA on invention grant's claim count between every two stock boards. With regard to claim groups 1 and 2, the claim count variance between SME board and SZ main board is free of significance; while the other claim count variances are of significance. According to the significant mean differences, GE board is therefore confirmed to have the highest claim count mean while SH main board is therefore confirmed to have lowest claim count mean. With regard to claim groups 3 and 4, the claim count variances between every two stock boards are of significance. GE board is confirmed to have the highest claim count mean while SZ main board is confirmed to have lowest claim count mean. With regard to claim group 5, the claim count variances between SZ main board and SH main board, between GE board and SH main board, between SME board and GE board, are of significance; while the other claim count variances are free of significance. GE board is therefore confirmed to have the highest claim count mean while SH main board is confirmed to have lowest claim count mean. In general, GE board has the highest claim count means in all claim groups; SH main board has the lowest claim count means in claim groups 1, 2, and 5 while SZ main board has the lowest claim count means in claim groups 3 and 4.

Table 11: Multiple Comparisons of ANOVA on Invention Grant's Claim Count between Stock Boards

Claim Group	Stock Board		Claim Count		
	Board (I)	Board (J)	Mean Difference (I-J)	Std. Error	p
1	SZ	SH	0.227	0.096	0.019*
	GE	SH	0.670	0.068	0.001***
	GE	SZ	0.443	0.099	0.001***
	SME	SH	0.140	0.068	0.040*
	SME	SZ	-0.086	0.099	0.384
	SME	GE	-0.530	0.072	0.001***
2	SZ	SH	0.293	0.032	0.001***
	GE	SH	0.681	0.028	0.001***
	GE	SZ	0.388	0.035	0.001***
	SME	SH	0.327	0.025	0.001***
	SME	SZ	0.033	0.033	0.310
	SME	GE	-0.355	0.029	0.001***
3	SZ	SH	0.189	0.033	0.001***
	GE	SH	0.583	0.023	0.001***
	GE	SZ	0.395	0.035	0.001***
	SME	SH	0.291	0.022	0.001***
	SME	SZ	0.102	0.034	0.003**
	SME	GE	-0.293	0.025	0.001***
4	SZ	SH	-0.089	0.040	0.027*
	GE	SH	0.550	0.029	0.001***
	GE	SZ	0.639	0.041	0.001***
	SME	SH	0.400	0.027	0.001***
	SME	SZ	0.489	0.040	0.001***
	SME	GE	-0.151	0.029	0.001***
5	SZ	SH	0.897	0.394	0.023*
	GE	SH	1.012	0.300	0.001***
	GE	SZ	0.115	0.419	0.783
	SME	SH	0.204	0.297	0.492
	SME	SZ	-0.692	0.417	0.097
	SME	GE	-0.808	0.329	0.014*

DOI: 10.25103/ijbesar.151.03

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Table 12 shows the stock return rate means of each stock board's claim groups. With regard to SH main board, it seems that claim group 2 has the lowest stock return rate mean while claim group 5 has the highest stock return rate mean. With regard to SZ main board, it seems that claim group 1 has the lowest stock return rate mean while claim group 4 has the highest stock return rate mean. With regard to GE board, it seems that claim group 3 has the lowest stock return rate mean while claim group 5 has the highest stock return rate mean. With regard to SME board, it seems that claim group 4 has the lowest stock return rate mean while claim group 5 has the highest stock return rate mean. Though different stock boards have different distribution types of stock return rates, however in the whole stock market, the stock return rate mean seems to have an increasing trend as the claim count increases. With regard to claim groups 1, 2, 3 and 5, SZ main board seems to have the lowest stock return rate means while GE board seems to have the highest stock return rate means. With regard to claim group 4, SH main board seems to have the lowest stock return rate mean while GE board also seems to have the highest stock return rate mean. In general, GE board seems to have the highest stock return rate means in all claim groups while SZ main board seems to have the lowest stock return rate means in most claim groups.

Table 12: Stock Return Rate Means of Invention Grant's Claim Groups

Stock Board	Stock Return Rate Mean (%)					
	Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Whole Stock Market	9.34	9.30	10.31	13.28	17.03	11.83
SH Main Board	7.05	2.58	6.75	9.74	11.70	7.52
SZ Main Board	-2.63	1.84	-1.21	17.23	8.09	4.41
GE Board	18.57	21.29	14.40	21.38	25.10	20.01
SME Board	11.09	13.34	12.26	10.78	19.14	13.07

Source: This Research

Table 13 shows the results of ANOVA on the stock return rate between invention grant's claim groups. The stock return rate variances between five claim groups of the whole stock market, SH main board, and SZ main board are of significance, wherein, the stock return rate variances of the whole stock market and SZ main board reach p*≤0.001 significance, the stock return rate variance of SH main board reaches p*<0.05 significance. The stock return rate variances of GE board and SME board are free of significance. Different claim groups have significantly different stock return rate means in the whole stock market, SH main board and SZ main board.

Table 13: Result of ANOVA on Stock Return Rate Between Invention Grant's Claim Groups

Stock Board	Claim Group	Stock Return Rate (%)			
		Sum Square	Mean Square	F	p
Whole Stock Market	Between Groups	75167.6	18791.9	7.078	0.001***
	Within Groups	22363469.0	2655.0		
SH Main Board	Between Groups	28799.1	7199.8	3.220	0.012*
	Within Groups	6896200.2	2236.1		
SZ Main Board	Between Groups	43743.8	10936.0	7.731	0.001***
	Within Groups	1258907.5	1414.5		
GE Board	Between Groups	25416.9	6354.2	1.909	0.106
	Within Groups	6885178.8	3327.8		
SME Board	Between Groups	19944.4	4986.1	1.677	0.153
	Within Groups	7031515.7	2973.2		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Different claim groups have significantly different stock return rate means only in the whole stock market, SH main board and SZ main board. Table 14 further shows the multiple comparisons of the stock return rate between every two claim groups in the whole stock market, SH main board and SZ main board. With regard to the whole stock market, the stock return rate variances between claim groups 2 and 1, between claim groups 3 and 1, between claim groups 3 and 2, between claim groups 4 and 3, are free of significance; the other stock return rate variances are of significance. According to the significant mean differences, claim group 5 is confirmed to have the highest stock return rate mean while claim group 2 is confirmed to have the lowest stock return rate mean. With regard to SH main board, the stock return rate variances between claim groups 4 and 2, between claim groups 5 and 2, are of significance; the other stock return rate variances are free of significance. According to the significant mean differences, claim group 5 is confirmed to have the higher stock return rate mean while claim group 2 is confirmed to have the lower stock return rate mean. With regard to SZ main board, the stock return rate variances between claim groups 2 and 1,

between claim groups 3 and 1, between claim groups 4 and 1, between claim groups 5 and 2, are free of significance; the other stock return rate variances are of significance. According to the significant mean differences, claim group 4 is confirmed to have the highest stock return rate mean while claim group 1 is confirmed to have the lowest stock return rate mean. In general, higher claim groups have higher stock return rate means while lower claim groups have lower stock return rate means. Claim group 5 has the highest stock return rate means and claim group 2 has the lowest stock return rate means in most stock boards.

Table 14: Multiple Comparisons of ANOVA on Stock Return Rate between Invention Grant's Claim Groups

Stock Board	Claim Group		Stock Return Rate (%)		
	Group (I)	Group (J)	Mean Difference (I-J)	Std. Error	p
Whole Stock Market	2	1	-0.040	1.727	0.981
	3	1	0.970	1.830	0.596
	3	2	1.010	1.790	0.573
	4	1	3.941	1.772	0.026*
	4	2	3.981	1.730	0.021*
	4	3	2.971	1.834	0.105
	5	1	7.694	1.771	0.001***
	5	2	7.735	1.730	0.001***
	5	3	6.725	1.833	0.001***
	5	4	3.753	1.775	0.034*
SH Main Board	2	1	-4.467	2.686	0.096
	3	1	-0.303	2.615	0.908
	3	2	4.164	2.649	0.116
	4	1	2.685	2.744	0.328
	4	2	7.152	2.777	0.010*
	4	3	2.988	2.709	0.270
	5	1	4.646	2.671	0.082
	5	2	9.113	2.705	0.001***
	5	3	4.949	2.635	0.060
	5	4	1.960	2.763	0.478
SZ Main Board	2	1	4.471	3.757	0.234
	3	1	1.418	4.150	0.733
	3	2	-3.053	3.953	0.440
	4	1	19.862	4.093	0.001***
	4	2	15.391	3.893	0.001***
	4	3	18.444	4.274	0.001***
	5	1	10.715	3.970	0.007**
	5	2	6.243	3.763	0.097
	5	3	9.297	4.156	0.026*
	5	4	-9.148	4.099	0.026*

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

3.3 Patent Species of Utility Model Grant

Table 15 shows the claim count means of utility model's claim groups. With regard to all claim groups, it seems that SZ main board has the lowest claim count means while GE board has the highest claim count means.

Table 15: Claim Count Means of Utility Model Grant's Claim Groups

Stock Board	Claim Count Mean					
	Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Whole Stock Market	6.78	8.23	7.36	8.43	16.44	9.44
SH Main Board	4.32	5.89	6.72	7.72	9.68	6.87
SZ Main Board	4.25	5.86	6.70	7.69	9.41	6.78
GE Board	4.54	6.21	7.21	8.40	10.17	7.26

DOI: 10.25103/ijbesar.151.03

SME Board	4.44	6.01	6.91	8.08	9.85	7.05

Source: This Research

Table 16 shows the results of ANOVA on utility model grant's claim count between four stock boards. The claim count variances between four stock boards reach p***≤0.001 significance in all claim groups. For each of claim groups, different stock boards have significantly different claim count means.

Table 16: Result of ANOVA on Utility Model Grant's Claim Count Between Stock Boards

Claim Group	Stock Board	Claim Count			
		Sum Square	Mean Square	F	p
1	Between Stock Boards	20.2	6.747	6.898	0.001***
	Within Stock Boards	1993.4	0.978		
2	Between Stock Boards	32.9	10.959	159.671	0.001***
	Within Stock Boards	137.3	0.069		
3	Between Stock Boards	76.3	25.450	371.292	0.001***
	Within Stock Boards	139.1	0.069		
4	Between Stock Boards	161.3	53.770	389.405	0.001***
	Within Stock Boards	282.2	0.138		
5	Between Stock Boards	104.7	34.894	17.612	0.001***
	Within Stock Boards	4049.8	1.981		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Tables 17 shows the multiple comparisons of ANOVA on utility model grant's claim count between every two stock boards, wherein, SH, SZ, GE and SME stand for SH main board, SZ main board, GE board and SME board respectively. With regard to claim group 1, the claim count variances between SH main board and SZ main board, between SME board and GE board, are free of significance; while the other claim count variances are of significance. According to the significant mean differences, GE board is therefore confirmed to have the highest claim count mean while SZ main board is therefore confirmed to have lowest claim count mean. Claim groups 2, 3 and 4, the claim count variances between SH main board and SZ main board are free of significance; while the other claim count variances are of significance. GE board is confirmed to have the highest claim count means while SZ main board is confirmed to have lowest claim count means. With regard to claim group 5, the claim count variance between SME board and SH main board is free of significance; while the other claim count variances are of significance. GE board is confirmed to have the highest claim count mean while SZ main board is confirmed to have lowest claim count mean. In General, in the whole stock market and all stock boards, GE board has the highest claim count means while SZ main board has lowest claim count means.

Table 17: Multiple Comparisons of ANOVA on Utility Model Grant's Claim Count between Stock Boards

Claim Group	Stock Board		Claim Count		
	Board (I)	Board (J)	Mean Difference (I-J)	Std. Error	p
1	SZ	SH	-0.074	0.075	0.323
	GE	SH	0.221	0.058	0.001***
	GE	SZ	0.295	0.080	0.001***
	SME	SH	0.113	0.055	0.038*
	SME	SZ	0.187	0.078	0.016*
	SME	GE	-0.108	0.061	0.080
2	SZ	SH	-0.020	0.020	0.309
	GE	SH	0.321	0.016	0.001***
	GE	SZ	0.341	0.022	0.001***
	SME	SH	0.127	0.014	0.001***
	SME	SZ	0.147	0.021	0.001***
	SME	GE	-0.195	0.017	0.001***
3	SZ	SH	-0.021	0.020	0.288
	GE	SH	0.485	0.015	0.001***
	GE	SZ	0.506	0.021	0.001***
	SME	SH	0.189	0.014	0.001***

	SME	SZ	0.210	0.021	0.001***
	SME	GE	-0.296	0.016	0.001***
4	SZ	SH	-0.033	0.028	0.237
	GE	SH	0.676	0.021	0.001***
	GE	SZ	0.710	0.030	0.001***
	SME	SH	0.354	0.021	0.001***
	SME	SZ	0.387	0.029	0.001***
	SME	GE	-0.322	0.023	0.001***
5	SZ	SH	-0.273	0.107	0.011*
	GE	SH	0.481	0.085	0.001***
	GE	SZ	0.754	0.117	0.001***
	SME	SH	-0.002	0.076	0.977
	SME	SZ	0.270	0.110	0.014*
	SME	GE	-0.484	0.088	0.001***

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Table 18 shows the stock return rate means of utility model grant's claim groups. With regard to the whole stock market and all stock boards, it seems that claim group 1 has the lowest stock return rate means while claim group 5 has the highest stock return rate means. With regard to all claim groups, it seems that SZ main board has the lowest stock return rate means while GE board has the highest stock return rate means.

Table 18: Stock Return Rate Means of Utility Model Grant's Claim Groups

Stock Board	Stock Return Rate Mean (%)					
	Group 1	Group 2	Group 3	Group 4	Group 5	All Groups
Whole Stock Market	5.57	7.27	8.35	8.70	20.69	10.10
SH Main Board	2.89	4.14	5.13	3.91	16.02	6.42
SZ Main Board	-1.70	-0.28	1.89	3.68	7.95	2.31
GE Board	15.51	16.43	15.76	18.71	30.72	19.23
SME Board	5.30	7.67	10.82	8.94	21.13	10.78

Source: This Research

Table 19 shows the results of ANOVA on the stock return rate between utility model grant's claim groups. The stock return rate variances between five claim groups of the whole stock market and most stock boards are of significance except SZ main board. Different claim groups have significantly different stock return rate means in the whole stock market, SH main board, GE board and SME board.

Table 19: Result of ANOVA on Stock Return Rate Between Utility Model Grant's Claim Groups

Stock Board	Claim Group	Stock Return Rate (%)			
		Sum Square	Mean Square	F	p
Whole Stock Market	Between Groups	296164.5	74041.1	26.704	0.001***
	Within Groups	28039887.4	2772.7		
SH Main Board	Between Groups	91035.6	22758.9	10.163	0.001***
	Within Groups	8634968.9	2239.4		
SZ Main Board	Between Groups	12600.7	3150.2	2.086	0.081
	Within Groups	1669093.1	1510.5		
GE Board	Between Groups	71516.2	17879.0	4.310	0.002**
	Within Groups	9490672.6	4148.0		
SME Board	Between Groups	85756.7	21439.2	7.665	0.001***
	Within Groups	7968276.9	2796.9		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Since different claim groups have significantly different stock return rate means in the whole stock market and most stock boards except SZ main board, Table 20 shows the multiple comparisons of the stock return rate between every two claim groups. The stock return rate variances between claim groups 5 and 1, between claim groups 5 and 2,

DOI: 10.25103/ijbesar.151.03

between claim groups 5 and 3, between claim groups 5 and 4, are all of significance; the other stock return rate variances are free of significance. According to the significant mean differences, claim group 5 is confirmed to have the highest stock return rate means while claim group 1 is confirmed to have the lowest stock return rate means in the whole stock market, SH main board, GE board and SME board.

Table 20: Multiple Comparisons of ANOVA on Stock Return Rate between Utility Model Grant's Claim Groups

Stock Board	Claim Group		Stock Return Rate (%)		
	Group (I)	Group (J)	Mean Difference (I-J)	Std. Error	p
Whole Stock Market	2	1	1.700	1.655	0.304
	3	1	2.775	1.641	0.091
	3	2	1.075	1.673	0.521
	4	1	3.129	1.639	0.056
	4	2	1.428	1.671	0.393
	4	3	0.354	1.657	0.831
	5	1	15.123	1.639	0.001***
	5	2	13.423	1.671	0.001***
	5	3	12.348	1.657	0.001***
	5	4	11.995	1.655	0.001***
SH Main Board	2	1	1.253	2.409	0.603
	3	1	2.244	2.408	0.351
	3	2	0.991	2.408	0.681
	4	1	1.024	2.409	0.671
	4	2	-0.229	2.409	0.924
	4	3	-1.220	2.409	0.612
	5	1	13.134	2.408	0.001***
	5	2	11.880	2.408	0.001***
	5	3	10.889	2.407	0.001***
	5	4	12.110	2.409	0.001***
GE Board	2	1	0.918	4.256	0.829
	3	1	0.245	4.208	0.954
	3	2	-0.673	4.285	0.875
	4	1	3.201	4.145	0.440
	4	2	2.283	4.223	0.589
	4	3	2.956	4.175	0.479
	5	1	15.201	4.306	0.001***
	5	2	14.284	4.381	0.001***
	5	3	14.956	4.334	0.001***
	5	4	12.001	4.273	0.005**
SME Board	2	1	2.369	3.130	0.449
	3	1	5.519	3.122	0.077
	3	2	3.150	3.122	0.313
	4	1	3.639	3.140	0.247
	4	2	1.270	3.140	0.686
	4	3	-1.880	3.131	0.548
	5	1	15.830	3.130	0.001***
	5	2	13.461	3.130	0.001***
	5	3	10.311	3.122	0.001***
	5	4	12.191	3.140	0.001***

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

DOI: 10.25103/ijbesar.151.03

3.4 Cross Analysis of Patent Species

With regard to the whole stock market, Table 21 shows the results of ANOVA on the stock return rate between three patent species. The stock return rate variances between different patent species in claim groups 1, 4 and 5 are of significance; the stock return rate variances in claim groups 2 and 3 are not. Different patent species have significantly different stock return rate means only in claim groups 1, 4 and 5.

Table 21: Result of ANOVA on Stock Return Rate Between Patent Species in Whole Stock Market

Claim Group	Patent Species	Stock Return Rate (%)			
		Sum Square	Mean Square	F	p
1	Between Patent Species	27765.2	13882.6	5.442	0.004**
	Within Patent Species	15208479.4	2550.9		
2	Between Patent Species	5234.6	2617.3	1.144	0.319
	Within Patent Species	13351204.9	2288.5		
3	Between Patent Species	8776.6	4388.3	1.917	0.147
	Within Patent Species	13167804.4	2289.3		
4	Between Patent Species	23206.9	11603.4	4.839	0.008**
	Within Patent Species	15460852.7	2397.8		
5	Between Patent Species	24684.7	12342.4	3.047	0.048*
	Within Patent Species	20623286.9	4050.1		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Since different patent species have significantly different stock return rate means in claim groups 1, 4 and 5, Table 22 shows the multiple comparisons of ANOVA on the stock return rate between every two patent species in aforementioned claim groups. With regard to claim groups 1 and 4, the stock return rate variances between invention publications and invention grants, between invention grants and utility model grants, are of significance; the other stock return rate variance is not. According to the significant mean differences, invention grants have the highest stock return rate means while invention publications have the lowest stock return rate mean in claim group 1 and utility model grants have the lowest stock return rate mean in claim group 4. With regard to claim group 5, the stock return rate variance between invention publications and invention grants is of significance; the other stock return rate variances are not. According to the significant mean difference, invention publications have the higher stock return rate mean than the other two patent species.

Table 22: Multiple Comparisons of ANOVA on Stock Return Rate between Patent Species in Whole Stock Market

Claim Group	Patent Species		Stock Return Rate (%)		
	Species (I)	Species (J)	Mean Difference (I-J)	Std. Error	p
1	Invention Publication	Invention Grant	-4.895	1.617	0.002**
	Invention Publication	Utility Model Grant	-0.468	1.570	0.765
	Invention Grant	Utility Model Grant	4.427	1.627	0.007**
4	Invention Publication	Invention Grant	-3.198	1.518	0.035*
	Invention Publication	Utility Model Grant	1.773	1.433	0.216
	Invention Grant	Utility Model Grant	4.972	1.610	0.002**
5	Invention Publication	Invention Grant	5.605	2.285	0.014*
	Invention Publication	Utility Model Grant	2.374	2.171	0.274
	Invention Grant	Utility Model Grant	-3.231	2.139	0.131

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

With regard to SH main board, Table 23 shows the results of ANOVA on the stock return rate between three patent species. The stock return rate variance between different patent species is of significance only in claim group 4; the stock return rate variances in the other claim groups are free of significance. Different patent species have significantly different stock return rate means only in claim group 4 of SH main board.

Table 23: Result of ANOVA on Stock Return Rate Between Patent Species in SH Main Board

Claim Group	Patent Species	Stock Return Rate (%)			
		Sum Square	Mean Square	F	p

DOI: 10.25103/ijbesar.151.03

1	Between Patent Species	6,204.4	3,102.2	1.329	0.265
	Within Patent Species	5,140,351.8	2,334.4		
2	Between Patent Species	869.6	434.8	0.229	0.795
	Within Patent Species	4,152,684.2	1,895.3		
3	Between Patent Species	1,007.8	503.9	0.267	0.766
	Within Patent Species	4,192,890.9	1,888.7		
4	Between Patent Species	16,899.4	8,449.7	3.952	0.019*
	Within Patent Species	5,114,875.3	2,138.3		
5	Between Patent Species	6,964.9	3,482.5	1.113	0.329
	Within Patent Species	5,994,223.4	3,130.1		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Table 24 further shows the multiple comparisons of ANOVA on the stock return rate between every two patent species in claim group 4. The stock return rate variances between invention publications and utility model grants, between invention grants and utility model grants, are of significance; the other stock return rate variance is not. According to the significant mean differences, invention grants have the highest stock return rate mean while utility model grants have the lowest stock return rate mean.

Table 24: Multiple Comparisons of ANOVA on Stock Return Rate between Patent Species in SH Main Board

Claim Group	Patent Species		Stock Return Rate (%)		
	Species (I)	Species (J)	Mean Difference (I-J)	Std. Error	p
4	Invention Publication	Invention Grant	-0.218	2.417	0.928
	Invention Publication	Utility Model Grant	5.608	2.186	0.010**
	Invention Grant	Utility Model Grant	5.826	2.571	0.024*

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

With regard to SZ main board, Table 25 shows the results of ANOVA on the stock return rate between three patent species. The stock return rate variance between different patent species is of significance only in claim group 4; the stock return rate variances in the other claim groups are free of significance. Different patent species have significantly different stock return rate means only in claim group 4 of SZ main board.

Table 25: Result of ANOVA on Stock Return Rate Between Patent Species in SZ Main Board

Claim Group	Patent Species	Stock Return Rate (%)			
		Sum Square	Mean Square	F	p
1	Between Patent Species	1,984.5	992.2	1.013	0.364
	Within Patent Species	594,387.7	979.2		
2	Between Patent Species	923.1	461.6	0.349	0.705
	Within Patent Species	904,233.9	1,322.0		
3	Between Patent Species	2,969.7	1,484.8	1.010	0.365
	Within Patent Species	864,107.1	1,469.6		
4	Between Patent Species	21,373.2	10,686.6	6.304	0.002**
	Within Patent Species	1,234,012.9	1,695.1		
5	Between Patent Species	1,343.2	671.6	0.349	0.706
	Within Patent Species	965,194.4	1,926.5		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

Table 26 further shows the multiple comparisons of ANOVA on the stock return rate between every two patent species in claim group 4. The stock return rate variances between invention publications and invention grants, between invention grants and utility model grants, are of significance; the other stock return rate variance is not. According to the significant mean differences, invention grants have the highest stock return rate mean while utility model grants have the lowest stock return rate mean.

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Table 26: Multiple Comparisons of ANOVA on Stock Return Rate between Patent Species in SZ Main Board

Claim Group	Patent Species		Stock Return Rate (%)		
	Species (I)	Species (J)	Mean Difference (I-J)	Std. Error	p
4	Invention Publication	Invention Grant	-12.781	3.937	0.001**
	Invention Publication	Utility Model Grant	0.776	3.532	0.826
	Invention Grant	Utility Model Grant	13.5561	4.277	0.002**

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

With regard to GE board and SME board, Table 27 shows the results of ANOVA on the stock return rate between three patent species. The stock return rate variances between different patent species is free of significance in all claim groups. Different patent species do not have significantly different stock return rate means in GE board and SME board.

Table 27: Result of ANOVA on Stock Return Rate Between Patent Species in GE Board

Stock Board	Claim Group	Stock Return Rate (%)				
		Patent Species	Sum Square	Mean Square	F	p
GE Board	1	Between Patent Species	14,154.4	7,077.2	2.120	0.120
		Within Patent Species	4,981,579.0	3,338.9		
	2	Between Patent Species	9,271.2	4,635.6	1.610	0.200
		Within Patent Species	3,645,849.0	2,879.8		
	3	Between Patent Species	7,373.6	3,686.8	1.327	0.266
		Within Patent Species	3,789,820.1	2,778.5		
	4	Between Patent Species	11,400.8	5,700.4	2.123	0.120
		Within Patent Species	3,925,164.1	2,684.8		
	5	Between Patent Species	17,847.1	8,923.5	1.422	0.242
		Within Patent Species	8,046,489.1	6,276.5		
SME Board	1	Between Patent Species	12,474.9	6,237.4	2.389	0.092
		Within Patent Species	4,313,067.4	2,610.8		
	2	Between Patent Species	9,936.8	4,968.4	1.880	0.153
		Within Patent Species	4,450,557.9	2,642.8		
	3	Between Patent Species	6,852.7	3,426.3	1.295	0.274
		Within Patent Species	4,157,433.4	2,646.4		
	4	Between Patent Species	3,203.0	1,601.5	0.589	0.555
		Within Patent Species	5,048,436.5	2,718.6		
	5	Between Patent Species	1,133.8	566.9	0.147	0.864
		Within Patent Species	5,358,603.0	3,869.0		

Source: This Research; p*<0.05, p**≤0.01, p***≤0.001

4. Conclusion and Recommendations

Based on the company integrated China patent database and the stock information revealed by Shanghai stock exchange and Shenzhen stock exchange in China, the impact of patent claim counts on the stock return rates under COVID-19 pandemic was thoroughly analyzed via ANOVA. The annual stock return rates of China A-shares in four quarters of 2020 were calculated. An effective sample A-share for each quarter of 2020 was listed in 2019 and 2020 so as to have a definite annual stock return rate, and must have at least one new China patent published or granted in the patent retrieval interval of one year. The China company listed overseas were excluded. Any patents other than China patents were also regardless.

The average claim count of A-share's China patents which published or granted over previous one years by the end of each quarter of 2020 was calculated. Thousands of effective sample A-shares listed in the whole China stock market and four stock boards including SH main board, SZ main board, GE board and SME board, were divided into five claim groups according to their average claim count percentile rake from low to high. The following conclusions were arrived:

(1) In general, the average claim count per patent had a significant impact on A-share's stock return rate. Though the stock market fluctuated seriously under COVID-19 pandemic, the average claim count of any patent species was still a good indicator for classifying A-share's stock return rate. The A-shares in the higher claim groups showed the significantly higher stock return rate means while the A-shares in the lower claim groups showed the significantly lower stock return rate means.

DOI: 10.25103/ijbesar.151.03

(2) With regard to patent species of the invention publication, the claim count variances between four stock boards were of significance. GE board had the highest claim count means in most claim groups while SZ main board had the lowest stock price return rate means in most claim groups. The stock return rate variances between five claim groups in the whole stock market and all four stock boards were of significance. Claim groups 5 had the highest stock return rate means in the whole stock market, SH main board, GE board and SME board; claim group 4 had the highest stock return rate mean in SZ main board. Claim groups 1 had the lowest stock return rate means in the whole stock market, SZ main board, GE board and SME board; claim group 2 had the lowest stock return rate mean in SH main board.

(3) With regard to patent species of the invention grant, the claim count variances between four stock boards were of significance. GE board also had the highest claim count means in all claim groups while SH main board had the lowest stock price return rate means in most claim groups. The stock return rate variances between five claim groups in the whole stock market, SH main board and SZ main board were of significance. Claim groups 5 had the highest stock return rate means in the whole stock market and SH main board; claim group 4 had the highest stock return rate mean in SZ main board. Claim groups 2 had the lowest stock return rate means in the whole stock market and SH main board; claim group 1 had the lowest stock return rate mean in SZ main board. However, the stock return rate variances between five claim groups in GE board and SME board were free of significance.

(4) With regard to patent species of the utility model grant, the claim count variances between four stock boards were of significance. GE board also had the highest claim count means in all claim groups while SZ main board had the lowest stock price return rate means in all claim groups. The stock return rate variances between five claim groups in the whole stock market, SH main board, GE board and SME board were of significance. Claim groups 5 had the highest stock return rate means and claim groups 1 had the lowest stock return rate means in aforementioned stock boards. However, the stock return rate variance between five claim groups in SZ main board was free of significance.

(5) With regard to the stock return rate variance between three patent species, not the variances in all claim groups are of significance. The variances between patent species in all claim groups of GE board and SME board were free of significance; the variances in claim groups 4 of SH main board and SZ main board were of significance while the variances in the other claim groups were free of significance; the variances in claim groups 1, 4 and 5 of the whole stock market were of significance while the other variances were free of significance. Different patent species' claim count did not show significantly different stock return rates in most claim groups. However, in claim groups 4 of the whole stock market, SH main board and SZ main board, invention grants had higher stock return rate means while utility model grants had lower stock return rate means; in claim group 5 of the whole stock market, invention publications had the higher stock return rate while utility model grants had the lower stock return rate.

(6) When considering the patent claim count as a indicator, the invention publication was a more appropriate patent species than the invention grant and the utility model grant, because the claim count of the invention publication could be applied in the whole stock market and each stock board for significantly classifying the stock return rate. The claim count of the utility model grant was not a significant indicator in SZ main board; while The claim count of the invention grant was not a significant indicator in GE board and SME board. However, since the utility model grants usually had shorter examination duration and earlier grant dates than the invention publications and the invention grants, it might be more convenient to apply the utility model grant's claim count for classifying stock return rates and finding valuable stocks of the potential of the higher stock return rate.

The finding of this research would improve the understanding of China patents and the innovation outcome of China A-shares. It would also contribute the art of the patent valuation and the listed company evaluation. Based on the results, there might be some issues for future research. For example, the independent claims are usually regarded as more important than the dependent claims, does the independent claim count play more significance than the dependent claim count in classifying China A-share's stock return rate? In addition, does the results come out from this research also applicable for other patent systems? It is because the claim count of a patent is strongly affected by the law and rules of the patent systems. For China patent system, the extra official fee will be charged when a patent has more than ten claims. For US patent system, the extra official fee will be charged when a patent has more than twenty claims. For European patent system, the extra official fee will be charged when a patent has more than fifteen claims. A company's patent policy and innovation behavior might also be affected by different patent systems.

Acknowledgement

The authors would like to acknowledge the financial support from Ministry of Science and Technology, Taiwan, R.O.C. under Grant no. MOST 109-2410-H-011-021-MY3.

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DOI: 10.25103/ijbesar.151.03