Modern Economy, 2022, 13, 679-714
https://www.scirp.org/journal/me
ISSN Online: 2152-7261
ISSN Print: 2152-7245

Exploring Industry Difference in Using Patent Drawings of Invention Grants for Differentiating Stock Return Rate—A Study on Chinese Listed Companies in Non-Manufacturing Industries

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How to cite this paper: Chen, C.-Y., & Chu, C.-L. (2022). Exploring Industry Difference in Using Patent Drawings of Invention Grants for Differentiating Stock Return Rate—A Study on Chinese Listed Companies in Non-Manufacturing Industries. *Modern Economy, 13,* 679-714.
https://doi.org/10.4236/me.2022.135037

Received: April 6, 2022
Accepted: May 27, 2022
Published: May 30, 2022

Abstract

Chinese listed companies of RMB common stocks (A-shares) in the top ten non-manufacturing industry sectors from 2017 to 2021 were selected as effective samples to explore the industry difference in the applications of using patent indicators. The total drawing counts of invention grant patents, which are regarded as the most valuable China patent species, on differentiating A-share's stock return rate was thoroughly discussed via analysis of variation (ANOVA). There was only one industry sector $V1_{\text{(Information Transmission, Software \& Information Technology Services)}}$ in which the stock return rate variances between different drawing groups were of significance in four years from 2017 to 2021; the A-shares in higher drawing count groups showed higher stock return rate means in these four years. There were three industry sectors $V3_{\text{(Production \& Supply of Electricity, Heat, Gas, Water)}}$, $V6_{\text{(Management of Water Conservancy, Environment \& Public Facilities)}}$ and $V8_{\text{(Transportation, Warehousing \& Postal)}}$ in which the stock return rate variances between different drawing groups were totally free of significance in all years. The total drawing count was rarely capable of differentiating A-share's stock return rate because the stock return rate variances between different drawing groups were of significance in only one or two years from 2017 to 2021. The industry difference was therefore strongly suggested to take into consideration before using any patent indicators to evaluate China A-shares.

Keywords

Invention Grant Patent, ANOVA, Stock Return Rate, Drawing Count,

Industry Difference

1. Introduction

Innovation is an essential driver of economic progress that benefits consumers, businesses and the economy as a whole. The technological innovation is a key driver of economic growth. Patent is the most important outcome of technological innovation. Crespi, Arias-Ortiz and Tacsir et al. (2014) used a wide range of innovation indicators to describe the innovation behavior of manufacturing firms in Latin America and the Caribbean. Malva and Santarelli (2016) using firm-level data for 28 transition countries in Eastern Europe and Central Asia, found that firms closer to the technological frontier were more likely to engage in formal R&D activities and stronger IPR systems were more effective in promoting investment in R&D.

China, the largest PCT patent application country, is also the largest domestic patent application country in the world. China Intellectual Property Administration (CNIPA), the patent office provided with the largest number of examiners in the world, published and/or granted more than six million China patents in the single year of 2021, including 1720 thousand invention publications, 696 thousand invention grants, 3120 thousand utility model grants and 785 thousand design grants. With so huge amount of China patents, CNIPA made some achievements in trying to process more patent applications in a shorter period of time (Liegsalz & Wagner, 2013).

The development of China's innovation capabilities from 1985 to 2005 was examined by using China's invention patents (Motohashi, 2008). A substantial trend of Chinese companies catching up with Western counterparts via patent statistics was found in two high-tech sectors including the pharmaceutical industry and mobile communications technology (Motohashi, 2009). These two high-tech sectors showed contrasting trends, Chinese companies' rapid catching up was found in the mobile communications technology, while Chinese companies were lagging behind in the pharmaceutical industry. Hu and Jefferson (2009) used a company-level data set to explore the factors that account for the rising patent activity in China and found that the patent surge in China was seemingly paradoxical given China's weak record of protecting intellectual property rights.

Lei, Zhao and Zhang et al. (2011) found that China's inventive activities had experienced three developmental phases and had been promoted quickly while the innovation strengths of the three development phases had shifted from government to university and research institute and then industry. China patent statistics were found to be meaningful because China's valid patent count was correlated with R&D input and financial output (Dang & Motohashi, 2015). Hanley, Liu and Vaona (2015) found that regional credit depth had a significantly positive effect on China's innovation performance. Credit depth had more marked impacts on China invention patents than on utility model patents and design patents. Liu and Qiu (2016) used Chinese firm-level patent data from 1998 to 2007 and found that the input tariff cut in 2002, which resulted from China's WTO accession, resulted in less innovation undertaken by Chinese firms.

A patent quality index based on internationally comparable citation data from international search reports (ISR) of PCT patent applications was proposed to consider foreign, domestic, and self citations as economic indicators (Boeing & Mueller, 2019). However, the domestic and self citations suffered from an upward bias in China and were suggested to be employed with caution as a measure of patent quality. 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 were found to have different effects on different types of patents (Chen & Zhang, 2019). R&D investment was found to have a positive and significant impact on patenting activities for all types of patents; the stimulating effect of foreign direct investment on patent applications was only robust for utility model patents and design patents; the patent subsidy only had a positive impact on design patents.

China is now the world's No.2 economy to have a stock market with the world's No.2 transaction volume. Chinese listed companies lead the development of China patents, which the unlisted companies and individuals follow. The stock market usually reflects the economic conditions of an economy. Regarding China stock market and the patent issues involved, He, Tong and Zhang 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 Chinese listed companies and their subsidiaries from 1990 to 2010. Chen, Wei and Che (2018, 2020) used the patent data and stock price data of Chinese listed companies of RMB common stocks (A-shares) in Shanghai main board from 2011 to 2017 and found the patent indicators have leading effect on A-share's stock price. Chiu, Chen and Che (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, return-on-equity, book-value-per-share, earnings-per-share, price-to-book and price-to-earnings. 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 Shanghai main board, Shenzhen main board, Growing-Enterprises board, and Small-and-Medium-Enterprises board. The A-share sizes are quite different in these four stock boards.

The majority of A-shares in Shanghai main board, Shenzhen main board are state-owned companies and big companies; most A-shares in Growing-Enterprises board and Small-and-Medium-Enterprises board are small and medium companies. Chiu, Chen and Che (2020c, 2020d, 2020e, 2020f, 2021), Li, Deng and Che (2020a, 2020b, 2021) further studied the patent leading effect in each of the four stock boards, proposed each stock board's patent prediction equations on the stock price, return-on-asset, return-on-equity, book-value-per-share, earnings-per-share, price-to-book and price-to-earnings, finally proposed patent-based stock selection criteria to build stock portfolios having preferable performance.

COVID-19 has been impacting everything including technology and finance. The World Health Organization (WHO) on March 11, 2020, declared COVID-19 outbreak a global pandemic. The stock markets around the world including China's stock market fluctuated dramatically in 2020 and 2021. However, the time series fluctuation trend would not happen to patent. Is it possible to correlate China's stock market with patent during such fluctuation situation?

Tsai, Che and Bai (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2022a, 2022b) discussed the statistic relationship between various China patent indicators and the performance of China A-shares. The China A-shares with the higher innovation continuity of any patent species of the invention publication, the invention grant, the utility model grant, and the design grant were found to show higher stock return rate mean (Tsai et al., 2021a). The A-shares having patents of higher patent counts of any patent species were found to show higher stock price mean and higher stock return rate mean (Tsai et al., 2021b, 2021f). The A-shares having patents of the higher technology variety were found to show higher stock return rate mean (Tsai et al., 2021c). The A-shares having the invention grants of the longer examination duration were found to show higher stock return rate mean (Tsai et al., 2021d). The A-shares having patents and receiving higher backward citation counts were found to show higher stock price means than the A-shares receiving lower backward citation counts (Tsai et al., 2021e). The A-shares having patents but free of forward citation counts were found to show higher stock price mean than the A-shares receiving higher forward citation counts (Tsai et al., 2022a). The A-shares having invention grant's patent lives above the general level usually showed higher market capitalization means than the A-shares having invention grant's patent lives below the general level whereas the A-shares having longer utility model grant's patent lives and longer design grant's patent lives did not show higher market capitalization means (Tsai et al., 2022b).

The patent drawing is seldom discussed previously and is usually regarded as less important when compared with the patent claim. In fact, according to the patent examination criteria, the claim has to be supported by the drawings and/or the specification. It means that the drawings must clearly and fully reveal the claimed embodiments, and possibly show all alternatives of the claimed embodiments. A patent with more embodiments would result in more drawings while a patent with few embodiments and would result in few drawings.

With regard to the drawing count of patents, Lai and Che (2009a, 2009b, 2009c) focused on US patents and damage awards of infringement lawsuits, and applied the drawing count as an indicator for quantitatively modeling US patent legal values. Though the drawing count of China patents has been applied for quantitatively giving the predictive values of A-share's financial indicators (Chiu et al., 2020a, 2020b, 2020c, 2020d, 2020e, 2020f, 2021; Li et al., 2020a, 2020b, 2021), however, the relationship between the drawing count and A-share's financial performance has not been discussed yet.

It is therefore the objective of this research to find out the followings:

1) What are the varying trends of China patent drawing counts of China A-share's invention grants with regard to various non-manufacturing industry sectors from 2017 to 2021?

2) Whether China patent drawing counts of China A-share's invention grants in various non-manufacturing industry sectors are significantly different or not?

3) Whether the stock return rates in different invention grant patent's drawing groups of China A-shares are significantly different with regard to various non-manufacturing industry sectors?

4) Whether the invention grant's drawing counts in different stock return rate groups of China A-shares are significantly different with regard to various non-manufacturing industry sectors?

The managerial implication of this research therefore comprises:

1) Enriching the understanding of China A-share's patent drawing count of invention grants in various non-manufacturing industry sectors;

2) Extending the application of China invention grant patent's drawing count to the China stock market;

3) Helping the investment organizations to improve their stock portfolio strategy on China A-shares in non-manufacturing industry sectors by using the factor of invention grant patent's drawing count.

In the following paragraphs, Section 2 presents the data and methodology which includes the delimitation and limitation, population and samples for non-manufacturing industry sectors, and the instrumentation which shows the company integrated patent database used, the calculation of patent drawing count, the stock price selected, and the principal of analysis of variance (ANOVA); Section 3 presents the result and finding; Section 4 presents the conclusion and recommendation.

2. Data and Methodology

2.1. Delimitation and Limitation

The objective of this research is to explore the relationship between China A-share's patent drawing count and China A-share's stock return rate with regard to various non-manufacturing industry sectors. It is therefore only the patents filed by companies are discussed, while the patents filed by the government, the R&D institutes, the academic organizations, or the individuals, are all excluded.

There are two stock exchanges in main land China, i.e. Shanghai stock exchange or Shenzhen stock exchange, wherein the criteria for Initial Public Offerings (IPO) thereof are essentially the same. Though Hong Kong, which being a special administrative region of China, also has a stock exchange, however, the criteria for IPO in Hong Kong is different from those in Shanghai and Shenzhen. It is therefore China companies listed with RMB common stocks in Shanghai or Shenzhen stock exchanges, so called China A-shares, are discussed in this research, whereas Chinese companies listed in Hong Kong or any other overseas regions are excluded.

Regarding the patent, since China is now the world largest patent application country and China patents are less analyzed previously when comparing with US patents and EP patents, therefore only China patents are discussed in this research. Foreign patents other than China patents are excluded even though these foreign patents are filed by China A-shares.

Regarding the patent species, there are four major patent species in China patent system including the invention publication, the invention grant, the utility model grant and the design grant. The design grant is a design application of a product which granted by overcoming the preliminary examination by having a distinct configuration, distinct surface ornamentation or both. The utility model grant is a utility model application of a product which granted by overcoming the preliminary examination. The invention publication is an invention application of a product or a process 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 by having novel and distinct technical features over the prior arts, so as to be regarded as the most valuable patent species. It is therefore the invention grant patents are discussed in this research.

2.2. Instrumentation

2.2.1. Company Integrated Patent Database

It is a common phenomenon that a listed company has a lot of subsidiaries. When a subsidiary's revenue is merged to its parent listed company in the formal financial reports, the subsidiary's patents are therefore inferred to contribute to its parent company's financial performance in this research. In order to collect the correct patents and count the correct forward citations, a company integrated patent database is built in this research by carefully reviewing all China A-share's formal financial reports and integrating all subsidiaries' patents together with their parent A-share's patents. The patent drawing count of each parent A-share is then calculated.

It is also common that a patent is co-owned by plural companies. For avoiding duplicating calculation, if a patent is co-owned by the parent A-share and its subsidiaries, it is regarded as a single one patent of the parent A-share; if a patent is co-owned by several subsidiaries, it is also regarded as a single one patent of the parent A-share. However, if a patent is co-owned by two or more A-shares, it is assumed to contribute equivalently to each parent A-share, so the patent is duplicated and distributed to each of the co-owning A-shares.

2.2.2. Patent Drawing Count and Drawing Groups

In order to discuss whether A-shares in different patent drawing count groups have different stock return rate mean, the total drawing count is applied for setting up the drawing groups in this research, whereas the average drawing count is excluded because of the low significance thereof in differentiating A-share's stock return rate (Tsai et al., 2021d).

The total drawing count is defined as the number of all drawings included in all invention grants over previous one year of an A-share. The time interval of one year is applied for retrieving each A-share's patents. For 2017Q1, invention grants are retrieved by the issue date from 2016/04/01 to 2017/03/31; for 2018Q2, invention grants are retrieved by the issue date from 2017/07/01 to 2018/06/30; for 2019Q3, invention grants are retrieved by the issue date from 2018/10/01 to 2019/09/30; and so forth the other quarters.

When invention grants are retrieved, the total drawing count of each A-share is then calculated. The total drawing counts of all A-shares in each non-manufacturing industry sector are ranked by percentile rank quarterly from 2017Q1 to 2021Q4. For avoiding the survivorship bias, all A-shares in each non-manufacturing industry sector are divided into two drawing groups by percentile rank of the total drawing count respectively in each quarter as below:

Group #B: percentile rank 0 - 50, the group of which the A-share having drawing counts ***below*** the normal level of the industry sector;

Group #A: percentile rank 50 - 100, the group of which the A-shares have drawing counts ***above*** the normal level of the industry sector.

Via the percentile rank, the numbers of effective samples in drawing groups #A and #B are about to similar.

2.2.3. Stock Return Rate and Stock Group

In order to discuss whether A-shares in different drawing groups have different financial performance, the stock return rate is applied in this research.

The stock return rate is a simple but straight-forward indicator for beneficial investment. The time period for calculating the stock return rate is another issue. Considering the reasonable investment behaviour and the earlier patent's effect on later market success, the annual stock return rate is applied for observing A-share's performance in this research.

The stock return rate is calculated by the stock price. The stock price in every trading day is always varying. The opening price, the closing price, the highest price, the lowest price, and the mean price, are extensively used in various analyses according to different purposes. However, it does not matter to use any of the aforementioned stock prices in this research. For simplification and consistency, the closing prices of every China A-share in the last trading day of each quarter from 2016Q1 to 2021Q4 are applied as the stock prices to calculate the annual stock return rates from 2017Q1 to 2021Q4 in this research.

When stock return rates are calculated, all A-shares in each non-manufacturing industry sector are further ranked by percentile rank of the stock return rate quarterly from 2017Q1 to 2021Q4. For each non-manufacturing industry sector, all A-shares in each quarter are divided into two stock groups by percentile rank of the stock return rate respectively as below:

Group #L: percentile rank 0 - 50, the group of which the A-share having ***lower*** stock return rates below the normal level of the industry sector;

Group #H: percentile rank 50 - 100, the group of which the A-shares have ***higher*** stock return rates above the normal level of the industry sector.

Via the percentile rank, the numbers of effective samples in stock groups #L and #H are about to similar.

2.2.4. Analysis of Variance

Analysis of Variance (ANOVA) is applied in this research for hypothesis test to discover the followings:

1) Whether the total drawing counts of China A-share's invention grants significantly different between different years with regard to each non-manufacturing industry sector?

2) Whether the total drawing counts of China A-share's invention grants significantly different between different non-manufacturing industry sectors in every year from 2017 to 2021?

3) Whether the A-shares in different drawing groups of invention grants showing significantly different stock return rate means with regard to each non-manufacturing industry sector?

4) Whether the A-shares in different stock groups showing significantly different total drawing counts of invention grants with regard to each non-manufacturing industry sector?

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

$$F = \frac{MST}{MSE} = \frac{\sum n_j \left(\bar{x}_j - \bar{x}\right)^2 \Big/ (k-1)}{\sum \left(x - \bar{x}_j\right)^2 \Big/ (N-k)} \tag{1}$$

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: $\mu_1 = \mu_2 = \ldots = \mu_k$ is supported or rejected. If there is a significant difference between the groups, the null hypothesis is not supported, the F-ratio will be larger and the corresponding p value should be smaller than 0.05.

2.3. Population and Sample

The population comprises all China A-shares listed in China stock exchanges including Shanghai stock exchange and Shenzhen stock exchange. By the end of 2021, the number of all A-shares is 4686.

When a China company is ready to be listed, it would be categorized by the securities supervision commission to a specific industry sector according to the company's products and services. There are all nineteen principal industry sectors for categorizing A-shares, wherein, the number of A-shares of the manufacturing industry sector is more than two times the number of A-shares of all non-manufacturing industry sectors. The manufacturing industry sector should be considered individually. Therefore, the A-shares in the manufacturing industry sector are excluded in this research. In addition, there are sixteen non-manufacturing industry sectors, wherein top ten non-manufacturing sectors comprise more than 90% A-shares in all sixteen non-manufacturing industry sectors. Hence, the A-shares in top ten non-manufacturing industry sectors are discussed in this research.

There are twenty-four quarters from 2016Q1 to 2021Q4 for collecting effective sample's stock prices for calculating the annual stock return rates from 2017Q1 to 2021Q4. For each quarter from 2017Q1 to 2021Q4, an effective sample must meet the following conditions:

1) The A-share was listed to have definite stock closing prices in the last trading days of the quarters of current year and last year so as to have a definitely annual stock return rate over previous one year;

2) The A-share had at least one new invention grant by the end of the quarter over previous one year for calculating the total drawing count;

3) The A-share was categorized to any of top ten non-manufacturing industry sectors.

Table 1 shows top ten non-manufacturing industry sectors, the descriptions thereof according to the number of effective sample A-shares from high to low,

Table 1. Top ten non-manufacturing industry sectors for invention grants.

Industry sector	Industry sector description	A-shares proportion
V1	Information Transmission, Software & Information Technology Services	32.80%
V2	Construction	12.12%
V3	Production & Supply of Electricity, Heat, Gas, Water	8.74%
V4	Mining	8.11%
V5	Wholesale & Retail	5.95%
V6	R&D Research Services	5.89%
V7	Management of Water Conservancy, Environment & Public Facilities	5.66%
V8	Transportation, Warehousing & Postal	4.47%
V9	Finance	3.85%
V10	Real Estate	3.09%

Source: This research.

and the A-shares proportion in all sixteen non-manufacturing industry sectors. The industry sector V1 has the largest number of effective samples with the highest A-shares proportion 32.80%, while the industry sector V10 has the least number of effective samples in top ten non-manufacturing industry sectors with the A-shares proportion 3.09%. Table 2 shows the effective samples statistics by quarter from 2017Q1 to 2021Q4. The numbers of effective samples in each non-manufacturing industry sector gradually increased year by year.

3. Result and Finding

3.1. Variance of Invention Grant's Total Drawing Count

In this sub-section, the variance of each non-manufacturing industry sector's total drawing count of invention grants between five years from 2017 to 2021, and the variance of invention grant's total drawing count between ten non-manufacturing industry sectors are discussed.

Table 3 shows the total drawing count mean statistics for ten non-manufacturing industry sectors in every year from 2017 to 2021. The industry sector V4 has the highest total drawing count means in all five years from 2017 to 2021. The industry sector V8 has the lowest total drawing count means in 2017 and 2018, the industry sector V10 has the lowest total drawing count mean in 2019, and the industry sector V7 has the lowest total drawing count means in 2020 and 2021.

The total drawing count mean of every non-manufacturing industry sector in Table 3 seems to show an increasing trend. In order to confirm the increasing trend, ANOVA is applied. Table 4 shows the results of ANOVA on total drawing count between five years from 2017 to 2021 with regard to each non-manufacturing industry sector. The total drawing count variances between five years are of significance for the industry sectors V1, V3, and V8; the total drawing count in different years are significantly different only for these three industry sectors. However, the total drawing count variance between five years are free of significance for the other seven industry sectors V2, V4, V5, V6, V7, V9 and V10, though they seem to show increasing trends in Table 3.

Table 5 further shows the multiple comparisons of ANOVA on invention grant's total drawing count between 2021 and any other years from 2017 to 2020 with regard to aforementioned three industry sectors of which the total drawing count variances between years are of significance. Regarding the industry sectors V1 and V3, the total drawing count variances between 2021 and 2017, between 2021 and 2018, between 2021 and 2019, are of significance; whereas the total drawing count variances between 2021 and 2020 are free of significance. According to the significant mean differences, the total drawing count means in the industry sectors V1 and V3 show significantly increasing trends from 2017 to 2020 though the total drawing count means in 2020 and 2021 do not show significant difference. Regarding the industry sector V8, the total drawing count variances between 2021 and 2017, between 2021 and 2018, are of significance;

Table 2. Effective samples statistics of non-manufacturing industry sectors for invention grants.

Year	Industry sector	Effective sample A-shares				
		Q1	Q2	Q3	Q4	Whole year
2017	V1	111	113	127	140	491
	V2	51	52	53	58	214
	V3	36	36	32	36	140
	V4	36	36	34	36	142
	V5	24	25	26	29	104
	V6	18	17	16	17	68
	V7	20	19	20	21	80
	V8	15	13	14	13	55
	V9	16	17	15	17	65
	V10	10	10	11	11	42
	All Top 10	337	338	348	378	1401
2018	V1	144	134	147	151	576
	V2	60	61	60	59	240
	V3	39	36	36	38	149
	V4	36	35	35	41	147
	V5	28	27	27	27	109
	V6	21	17	25	28	91
	V7	25	26	23	26	100
	V8	15	17	19	23	74
	V9	17	15	14	12	58
	V10	11	12	11	13	47
	All Top 10	396	380	397	418	1591
2019	V1	148	147	143	142	580
	V2	57	58	58	57	230
	V3	41	42	42	41	166
	V4	39	39	42	42	162
	V5	29	27	26	25	107
	V6	28	31	28	28	115
	V7	26	28	26	26	106
	V8	22	20	19	17	78
	V9	12	11	14	15	52
	V10	14	15	16	15	60
	All Top 10	416	418	414	408	1656

Continued

2020	V1	142	153	162	173	630
	V2	55	53	54	58	220
	V3	42	46	47	52	187
	V4	41	40	43	42	166
	V5	25	24	23	29	101
	V6	28	32	33	33	126
	V7	23	25	27	28	103
	V8	21	21	25	26	93
	V9	20	19	20	19	78
	V10	10	11	13	16	50
	All Top 10	407	424	447	476	1754
2021	V1	222	232	259	267	980
	V2	73	76	75	76	300
	V3	56	55	57	58	226
	V4	46	47	46	49	188
	V5	39	39	48	44	170
	V6	41	48	46	50	185
	V7	41	42	44	46	173
	V8	34	35	39	36	144
	V9	30	32	32	35	129
	V10	27	27	27	27	108
	All Top 10	609	633	673	688	2603

Source: This research.

whereas the total drawing count variances between 2021 and 2019, between 2021 and 2020, are free of significance. According to the significant mean differences in the industry sector V8, the total drawing count mean significantly increased only from 2017 to 2019.

In order to verify whether the total drawing counts of invention grants between different non-manufacturing industry sectors are significantly different, Table 6 shows the results of ANOVA on total drawing count between ten non-manufacturing industry sectors. It shows that the total drawing count variances between ten non-manufacturing industry sectors are of significance in every year from 2017 to 2021.

Ten different non-manufacturing industry sectors will generate 45 different pairs of non-manufacturing industry sectors. In order to discover which non-manufacturing industry sector having the significant higher total drawing count and which non-manufacturing industry sector having the significant lower total drawing count, the multiple comparisons of ANOVA on invention grant's total

Table 3. Invention grant's total drawing count statistics for ten non-manufacturing industry sectors.

Industry sector		Total drawing count mean				
		2017	2018	2019	2020	2021
V1	Information Transmission, Software & Information Technology Services	60.91	69.25	82.37	110.41	118.98
V2	Construction	241.88	240.68	249.17	234.72	315.06
V3	Production & Supply of Electricity, Heat, Gas, Water	16.31	19.52	21.26	43.02	73.17
V4	Mining	252.06	305.35	287.27	274.97	327.28
V5	Wholesale & Retail	20.30	21.43	23.95	24.02	30.37
V6	R&D Research Services	38.81	40.13	27.28	31.21	37.46
V7	Management of Water Conservancy, Environment & Public Facilities	17.21	20.48	21.04	19.68	26.52
V8	Transportation, Warehousing & Postal	16.15	13.62	23.72	20.60	29.80
V9	Finance	60.42	127.60	228.19	224.58	220.13
V10	Real Estate	18.79	26.60	19.27	27.88	39.02

Source: This research.

Table 4. ANOVA on invention grant's total drawing count between different years for each non-manufacturing industry sector.

Industry sector		Year	Total drawing count			
			Sum square	Mean square	F	p
V1	Information Transmission, Software & Information Technology Services	between years	1,749,720.3	437,430.1	5.640	0.001***
		within years	252,277,533.3	77,552.3		
V2	Construction	between years	1,236,904.4	309,226.1	0.671	0.612
		within years	552,583,496.9	460,870.3		
V3	Production & Supply of Electricity, Heat, Gas, Water	between years	447,422.8	111,855.7	3.699	0.005**
		within years	26,093,508.4	30,235.8		
V4	Mining	between years	537,988.3	134,497.1	0.116	0.977
		within years	925,634,001.4	1,157,042.5		
V5	Wholesale & Retail	between years	8,752.7	2,188.2	1.477	0.208
		within years	868,370.9	1,481.9		
V6	R&D Research Services	between years	13,106.9	3,276.7	1.788	0.130
		within years	1,062,885.2	1,832.6		
V7	Management of Water Conservancy, Environment & Public Facilities	between years	6,236.5	1,559.1	1.470	0.210
		within years	590,919.8	1,060.9		
V8	Transportation, Warehousing & Postal	between years	16,172.4	4,043.1	2.669	0.032*
		within years	665,063.5	1,515.0		
V9	Finance	between years	1,571,973.4	392,993.4	1.200	0.311
		within years	123,514,777.5	327,625.4		
V10	Real Estate	between years	21,208.1	5,302.0	0.953	0.434
		within years	1,680,359.4	5,564.1		

$p^* < 0.05$, $p^{**} \le 0.01$, $p^{***} \le 0.001$; Source: This research.

Table 5. Multiple comparisons of ANOVA on invention grant's total drawing count between different two years for non-manufacturing industry sectors.

	Industry sector	Year (I)	Year (J)	Total drawing count		
				Mean diff. (I-J)	Std. error	p
V1	Information Transmission, Software & Information Technology Services	2021	2017	58.076	15.387	0.001***
		2021	2018	49.735	14.621	0.001***
		2021	2019	36.617	14.589	0.012*
		2021	2020	8.570	14.221	0.547
V3	Production & Supply of Electricity, Heat, Gas, Water	2021	2017	56.861	18.702	0.002**
		2021	2018	53.651	18.350	0.004**
		2021	2019	51.909	17.774	0.004**
		2021	2020	30.147	17.189	0.080
V8	Transportation, Warehousing & Postal	2021	2017	13.653	6.170	0.027*
		2021	2018	16.177	5.567	0.004**
		2021	2019	6.081	5.472	0.267
		2021	2020	9.196	5.178	0.076

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: This research.

Table 6. ANOVA on invention grant's total drawing count between ten non-manufacturing industry sectors.

Year	Industry sector	Total Drawing Count			
		Sum square	Mean square	F	p
2017	between sectors	11495140.1	1277237.8	10.060	0.001***
	within sectors	176611424.8	126967.2		
2018	between sectors	14929106.1	1658789.6	9.474	0.001***
	within sectors	276805385.2	175082.5		
2019	between sectors	15504022.5	1722669.2	9.389	0.001***
	within sectors	301993368.6	183471.1		
2020	between sectors	13181358.3	1464595.4	6.950	0.001***
	within sectors	367540771.9	210745.9		
2021	between sectors	26944966.3	2993885.1	10.188	0.001***
	within sectors	762017760.9	293875.0		

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: This research.

drawing count between every two different non-manufacturing industry sectors is applied. Table 7 shows the pairs of non-manufacturing industry sectors that the total drawing count variances there between are of significance among all 45 pairs of non-manufacturing industry sectors.

Regarding 2017 in Table 7, there are 16 pairs of non-manufacturing industry sectors having significant total drawing count variances there between, whereas

Table 7. Multiple comparisons of ANOVA on invention grant's total drawing count between pairs of non-manufacturing industry sectors in each year.

Year	Industry sector (I)	Industry sector (J)	Total drawing count		
			Mean difference (I-J)	Std. error	*p*
2017	V1	V2	−180.879	29.187	0.001***
	V1	V4	−191.052	33.952	0.007**
	V2	V3	225.576	38.733	0.001***
	V2	V5	221.585	42.593	0.001***
	V2	V6	203.074	49.603	0.001***
	V2	V7	224.671	46.695	0.001***
	V2	V8	225.738	53.868	0.001***
	V2	V9	181.468	50.464	0.001***
	V2	V10	223.097	60.136	0.001***
	V3	V4	−235.749	42.439	0.001***
	V4	V5	231.758	45.989	0.007**
	V4	V6	213.248	52.548	0.001***
	V4	V7	234.844	49.812	0.001***
	V4	V8	235.911	56.592	0.002**
	V4	V9	191.641	53.362	0.005**
	V4	V10	233.271	62.587	0.004**
2018	V1	V2	−171.433	32.148	0.001***
	V1	V4	−236.097	38.665	0.001***
	V2	V3	221.167	43.641	0.001***
	V2	V5	219.252	48.330	0.001***
	V2	V6	200.551	51.512	0.001***
	V2	V7	220.203	49.803	0.001***
	V2	V8	227.062	55.637	0.001***
	V2	V10	214.088	66.743	0.001***
	V3	V4	−285.830	48.642	0.001***
	V4	V5	283.916	52.889	0.001***
	V4	V6	265.215	55.812	0.001***
	V4	V7	284.867	54.239	0.001***
	V4	V8	291.725	59.641	0.001***
	V4	V9	177.743	64.882	0.006**
	V4	V10	278.751	70.116	0.001***
2019	V1	V2	−166.807	33.377	0.001***
	V1	V4	−204.898	38.064	0.001***
	V1	V9	−145.825	62.005	0.019*

Continued

	V2	V3	227.915	43.623	0.001***
	V2	V5	225.221	50.124	0.001***
	V2	V6	221.896	48.919	0.001***
	V2	V7	228.136	50.285	0.001***
	V2	V8	225.456	56.124	0.001***
	V2	V10	229.907	62.093	0.001***
	V3	V4	−266.006	47.305	0.001***
	V3	V9	−206.933	68.070	0.002**
	V4	V5	263.312	53.359	0.001***
	V4	V6	259.987	52.230	0.001***
	V4	V7	266.228	53.511	0.001***
	V4	V8	263.547	59.032	0.001***
	V4	V10	267.999	64.733	0.001***
	V5	V9	−204.239	72.408	0.005**
	V6	V9	−200.914	71.580	0.005**
	V7	V9	−207.155	72.520	0.004**
	V8	V9	−204.474	76.684	0.008**
	V9	V10	208.926	81.155	0.010**
2020	V1	V2	−124.308	35.951	0.001***
	V1	V4	−164.556	40.051	0.001***
	V1	V9	−114.163	55.103	0.038*
	V2	V3	191.701	45.661	0.001***
	V2	V5	210.703	55.177	0.001***
	V2	V6	203.508	51.289	0.001***
	V2	V7	215.043	54.809	0.001***
	V2	V8	214.121	56.780	0.001***
	V2	V10	206.843	71.923	0.004**
	V3	V4	−231.948	48.954	0.001***
	V3	V9	−181.556	61.878	0.003**
	V4	V5	250.950	57.932	0.001***
	V4	V6	243.756	54.241	0.001***
	V4	V7	255.290	57.582	0.001***
	V4	V8	254.368	59.461	0.001***
	V4	V10	247.090	74.057	0.001***
	V5	V9	−200.557	69.199	0.004**
	V6	V9	−193.363	66.140	0.004**
	V7	V9	−204.897	68.905	0.003**
	V8	V9	−203.975	70.484	0.004**
	V9	V10	196.697	83.167	0.018*

Continued

	V1	V2	−196.079	35.769	0.001***
	V1	V4	−208.297	43.163	0.001***
	V1	V5	88.614	45.039	0.049*
	V1	V7	92.464	44.705	0.039*
	V1	V9	−101.147	50.774	0.046*
	V2	V3	241.895	47.748	0.001***
	V2	V5	284.693	52.041	0.001***
	V2	V6	277.604	50.676	0.001***
	V2	V7	288.543	51.752	0.001***
	V2	V8	285.265	54.958	0.001***
	V2	V10	276.045	60.833	0.001***
2021	V3	V4	−254.114	53.512	0.001***
	V3	V9	−146.964	59.820	0.014*
	V4	V5	296.911	57.375	0.001***
	V4	V6	289.822	56.140	0.001***
	V4	V7	300.762	57.113	0.001***
	V4	V8	297.483	60.033	0.001***
	V4	V10	288.263	65.454	0.001***
	V5	V9	−189.761	63.299	0.003**
	V6	V9	−182.672	62.182	0.003**
	V7	V9	−193.612	63.062	0.002**
	V8	V9	−190.333	65.718	0.004**
	V9	V10	181.113	70.705	0.010**

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: This research.

the other 29 pairs of non-manufacturing industry sectors are free of significant total drawing count variances there between. The industry sectors V2 and V4 show significantly higher total drawing count means than any of the other eight industry sectors while the total drawing count variance between industry sectors V2 and V4 is free of significance. Meanwhile, the total drawing count variances between any two industry sectors of V1, V3, V5, V6, V7, V8, V9 and V10 are free of significance. According to the significant mean differences, the industry sector V4 shows the highest total drawing count mean while the industry sector V8 shows the lowest total drawing count mean.

Regarding 2018, there are 15 pairs of non-manufacturing industry sectors having significant total drawing count variances there between, whereas the other 30 pairs of non-manufacturing industry sectors are free of significant total drawing count variances there between. The industry sector V4 shows significantly different total drawing count mean from any of the other eight industry sectors except the industry sector V2. The industry sector V2 shows significantly different total drawing count mean from any of the other seven industry sectors except the industry sectors V4 and V9. The industry sector V9 only shows significantly different total drawing count mean from the industry sector V4. Meanwhile, the total drawing count variances between any two industry sectors of V1, V3, V5, V6, V7, V8 and V10 are free of significance. According to the significant mean differences, the industry sector V4 shows the highest total drawing count mean while the industry sector V8 shows the lowest total drawing count mean.

Regarding each of 2019 and 2020, there are 21 pairs of non-manufacturing industry sectors having significant total drawing count variances there between, whereas the other 24 pairs of non-manufacturing industry sectors are free of significant total drawing count variances there between. The industry sectors V2, V4 and V9 show significantly higher total drawing count means than any of the other seven industry sectors while the total drawing count variances between industry sectors V2 and V4, between industry sectors V4 and V9, between industry sectors V9 and V2, are free of significance. Meanwhile, the total drawing count variances between any two industry sectors of V1, V3, V5, V6, V7, V8 and V10 are free of significance. According to the significant mean differences, the industry sector V4 shows the highest total drawing count means both in 2019 and 2020, while the industry sector V10 shows the lowest total drawing count mean in 2019 and the industry sector V7 shows the lowest total drawing count mean in 2020.

Regarding 2021, there are 23 pairs of non-manufacturing industry sectors having significant total drawing count variances there between, whereas the other 22 pairs of non-manufacturing industry sectors are free of significant total drawing count variances there between. The industry sectors V2, V4 and V9 show significantly higher total drawing count means than any of the other seven industry sectors while the total drawing count variances between industry sectors V2 and V4, between industry sectors V4 and V9, between industry sectors V9 and V2, are free of significance. The industry sector V1 shows significantly different total drawing count mean from any of the five industry sectors V2, V4, V9, V5 and V7. The industry sectors V5 and V7 show significantly different total drawing count mean from any of the four industry sectors V1, V2, V4, and V9, whereas the total drawing count variance between industry sectors V5 and V7 is free of significance. Meanwhile, the total drawing count variances between any two industry sectors of V3, V6, V8 and V10 are free of significance. According to the significant mean differences, the industry sector V4 shows the highest total drawing count mean while the industry sector V7 shows the lowest total drawing count mean.

In summary, the industry sectors V2, V4 and V9 are classified to a higher total drawing count cluster, wherein, the industry sector V4 always shows the highest total drawing count mean. The industry sectors V1, V3, V5, V6, V7, V8 and V10 are classified to a lower total drawing count cluster, wherein, the total drawing count variances between two industry sectors of the lower total drawing count cluster are mostly free of significance.

3.2. Variance of Stock Return Rate between Invention Grant's Drawing Groups

In this sub-section, the variance of the stock return rate between of invention grant's drawing groups #A and #B in each of ten non-manufacturing industry sectors is discussed, in order to see whether the total drawing count of invention grants is capable of differentiating A-share's stock return rate in non-manufacturing industry sectors.

Table 8 shows the results of ANOVA on the stock return rate between invention grant's drawing groups #A and #B of each non-manufacturing industry sector in every year from 2017 to 2021.

For the industry sector V1, the stock return rate variances between drawing groups #A and #B in 2017, 2018, 2019 and 2020 are of significance, whereas the stock return rate variance between two drawing groups in 2021 is free of significance.

For the industry sector V2, the stock return rate variances between drawing groups #A and #B in 2017 and 2018 are of significance, whereas the stock return rate variances between two drawing groups in the other three years are free of significance.

For the industry sector V3, the stock return rate variances between drawing groups #A and #B in all years from 2017 to 2021 are free of significance.

For the industry sectors V4, the stock return rate variance between drawing groups #A and #B in 2018 is of significance, whereas the stock return rate variances between two drawing groups in the other four years are free of significance.

For the industry sector V5, the stock return rate variance between drawing groups #A and #B in 2021 is of significance, whereas the stock return rate variances between two drawing groups in the other four years are free of significance.

For the industry sector V6, the stock return rate variances between drawing groups #A and #B in all years from 2017 to 2021 are free of significance.

For the industry sector V7, the stock return rate variance between drawing groups #A and #B in 2021 is of significance, whereas the stock return rate variances between two drawing groups in the other four years are free of significance.

For the industry sector V8, the stock return rate variances between drawing groups #A and #B in all years from 2017 to 2021 are free of significance.

For the industry sector V9, the stock return rate variances between drawing groups #A and #B in 2017 and 2018 are of significance, whereas the stock return rate variances between two drawing groups in the other three years are free of

Table 8. ANOVA on stock return rate between invention grant's drawing groups for non-manufacturing industry sectors.

	Industry sector	Year	Drawing group	Stock return rate (%)			
				Sum square	Mean square	F	*p*
V1	Information Transmission, Software & Information Technology Services	2017	between groups	8933.3	8933.3	10.594	0.001***
			within groups	412362.7	843.3		
		2018	between groups	20435.1	20435.1	31.108	0.001***
			within groups	377065.1	656.9		
		2019	between groups	13059.3	13059.3	5.135	0.024*
			within groups	1469893.8	2543.1		
		2020	between groups	11445.3	11445.3	4.630	0.032*
			within groups	1552472.0	2472.1		
		2021	between groups	5881.2	5881.2	3.391	0.066
			within groups	1696370.9	1734.5		
V2	Construction	2017	between groups	4508.6	4508.6	4.128	0.043*
			within groups	231546.3	1092.2		
		2018	between groups	1684.3	1684.3	4.799	0.029*
			within groups	83536.9	351.0		
		2019	between groups	1313.9	1313.9	1.678	0.196
			within groups	178507.0	782.9		
		2020	between groups	3188.0	3188.0	2.047	0.154
			within groups	339553.6	1557.6		
		2021	between groups	925.4	925.4	0.287	0.592
			within groups	960438.7	3222.9		
V3	Production & Supply of Electricity, Heat, Gas, Water	2017	between groups	3481.8	3481.8	3.825	0.053
			within groups	125619.3	910.3		
		2018	between groups	359.0	359.0	0.826	0.365
			within groups	63890.2	434.6		
		2019	between groups	1367.9	1367.9	2.680	0.104
			within groups	83713.5	510.4		
		2020	between groups	32.1	32.1	0.065	0.798
			within groups	90742.8	490.5		
		2021	between groups	0.1	0.1	0.001	0.994
			within groups	580776.9	2592.8		
V4	Mining	2017	between groups	0.3	0.3	0.001	0.986
			within groups	128999.1	921.4		
		2018	between groups	2414.5	2414.5	5.146	0.025*
			within groups	68028.4	469.2		
		2019	between groups	483.0	483.0	0.640	0.425
			within groups	120766.7	754.8		

Continued

		2020	between groups	1.9	1.9	0.001	0.971
			within groups	239363.7	1459.5		
		2021	between groups	8142.7	8142.7	1.781	0.184
			within groups	850339.8	4571.7		
V5	Wholesale & Retail	2017	between groups	467.2	467.2	0.529	0.469
			within groups	90135.3	883.7		
		2018	between groups	702.5	702.5	1.394	0.240
			within groups	53909.1	503.8		
		2019	between groups	294.5	294.5	0.447	0.505
			within groups	69236.9	659.4		
		2020	between groups	1578.8	1578.8	1.569	0.213
			within groups	99622.1	1006.3		
		2021	between groups	27827.2	27827.2	6.029	0.015*
			within groups	775429.5	4615.7		
V6	R&D Research Services	2017	between groups	1108.3	1108.3	1.403	0.240
			within groups	52141.9	790.0		
		2018	between groups	33.5	33.5	0.091	0.764
			within groups	32945.5	370.2		
		2019	between groups	606.8	606.8	0.448	0.505
			within groups	153178.1	1355.6		
		2020	between groups	1595.4	1595.4	0.884	0.349
			within groups	223826.1	1805.0		
		2021	between groups	7524.3	7524.3	2.104	0.149
			within groups	654555.9	3576.8		
V7	Management of Water Conservancy, Environment & Public Facilities	2017	between groups	1090.1	1090.1	1.344	0.250
			within groups	63246.2	810.8		
		2018	between groups	300.7	300.7	0.537	0.465
			within groups	54883.6	560.0		
		2019	between groups	75.4	75.4	0.112	0.739
			within groups	70230.9	675.3		
		2020	between groups	1124.0	1124.0	1.561	0.214
			within groups	72730.3	720.1		
		2021	between groups	14805.4	14805.4	13.633	0.001***
			within groups	185711.2	1086.0		
V8	Transportation, Warehousing & Postal	2017	between groups	930.1	930.1	1.072	0.305
			within groups	45965.8	867.3		
		2018	between groups	27.4	27.4	0.041	0.839
			within groups	47603.6	661.2		

Continued

		2019	between groups	42.0	42.0	0.088	0.768
			within groups	36310.7	477.8		
		2020	between groups	211.7	211.7	0.225	0.637
			within groups	85808.2	942.9		
		2021	between groups	3.4	3.4	0.005	0.943
			within groups	93921.8	661.4		
V9	Finance	2017	between groups	12829.5	12829.5	19.260	0.001***
			within groups	41964.7	666.1		
		2018	between groups	4638.9	4638.9	7.007	0.011*
			within groups	37075.1	662.1		
		2019	between groups	39.0	39.0	0.017	0.898
			within groups	116408.7	2328.2		
		2020	between groups	3389.4	3389.4	2.052	0.156
			within groups	125535.2	1651.8		
		2021	between groups	5.5	5.5	0.009	0.924
			within groups	76801.0	604.7		
V10	Real Estate	2017	between groups	982.0	982.0	1.787	0.189
			within groups	21986.3	549.7		
		2018	between groups	40.7	40.7	0.106	0.746
			within groups	17264.0	383.6		
		2019	between groups	11.7	11.7	0.013	0.910
			within groups	52028.3	897.0		
		2020	between groups	22.0	22.0	0.044	0.835
			within groups	24024.4	500.5		
		2021	between groups	13634.9	13634.9	5.532	0.021*
			within groups	261268.8	2464.8		

$p^* < 0.05$, $p^{**} \le 0.01$, $p^{***} \le 0.001$; Source: This research.

significance.

For the industry sector V10, the stock return rate variance between drawing groups #A and #B in 2021 is of significance, whereas the stock return rate variances between two drawing groups in the other four years are free of significance.

There is no any industry sector in which the stock return rate variances between drawing groups #A and #B are of significance in all five years, however, there are three industry sectors, i.e. V3, V6 and V8, in which the stock return rate variances between drawing groups #A and #B are free of significance in all five years. There is one industry sector, i.e. V1, in which the stock return rate variances between drawing groups #A and #B are of significance in four years.

There is no any industry sector in which the stock return rate variances between drawing groups #A and #B are of significance in three years. There are two industry sectors, i.e. V2 and V9, in which the stock return rate variances between drawing groups #A and #B are of significance in two years. There are four industry sectors, i.e. V4, V5, V7 and V10, in which the stock return rate variances between drawing groups #A and #B are of significance in only one year.

Table 9 further shows the stock return rate means of invention grant's drawing groups #A and #B of each non-manufacturing industry sector from 2017 to 2021, wherein, the pairs of values marked with "*" having the significant stock return rate variance there between; the pairs of values colored in red denoting the drawing group #A having higher stock return mean than the drawing group #B.

In 2017, there are three industry sectors, i.e. V1, V2 and V9, having significant stock return rate variances between drawing groups #A and #B, and the drawing groups #A have higher stock return means than the drawing groups #B in all

Table 9. Stock return rate means of invention grant's drawing groups.

Industry sector		Drawing group	Stock return rate mean (%)				
			2017	2018	2019	2020	2021
V1	Information Transmission, Software & Information Technology Services	#B	−30.56***	−36.33***	5.63*	5.26*	−11.36
		#A	−22.03***	−24.41***	15.12*	13.78*	−6.46
V2	Construction	#B	−8.58*	−36.01*	−7.76	−1.83	9.86
		#A	0.60*	−30.48*	−2.98	−9.44	13.37
V3	Production & Supply of Electricity, Heat, Gas, Water	#B	−6.88	−25.51	−4.76	−7.28	35.64
		#A	3.12	−22.41	0.98	−8.11	35.60
V4	Mining	#B	7.54	−26.24*	0.44	−3.77	47.07
		#A	7.45	−18.12*	3.90	−3.56	33.90
V5	Wholesale & Retail	#B	−13.20	−26.74	−4.92	12.60	4.45*
		#A	−8.95	−31.82	−8.24	4.69	30.04*
V6	R&D Research Services	#B	−21.88	−36.31	−12.09	0.13	19.39
		#A	−13.80	−35.10	−7.50	7.26	6.64
V7	Management of Water Conservancy, Environment & Public Facilities	#B	−17.54	−39.42	−15.51	−7.48	−8.80***
		#A	−10.14	−35.95	−17.20	−0.83	9.71***
V8	Transportation, Warehousing & Postal	#B	17.17	−24.24	0.48	−11.22	5.91
		#A	8.91	−25.46	1.95	−8.18	6.22
V9	Finance	#B	−10.19***	−21.02*	21.52	4.16	0.54
		#A	17.94***	−3.12*	19.79	−9.02	0.95
V10	Real Estate	#B	−6.45	−29.67	2.17	−10.45	−12.92*
		#A	−16.54	−31.54	1.26	−9.11	9.58*

$p^* < 0.05$, $p^{**} \le 0.01$, $p^{***} \le 0.001$; Source: This research.

these three industry sectors.

In 2018, there are four industry sectors, i.e. V1, V2, V4 and V9, having significant stock return rate variances between drawing groups #A and #B. The number of the industry sectors which showing significant stock return rate variance is the most. The drawing groups #A have higher stock return means than the drawing groups #B in all these four industry sectors.

In each of 2019 and 2020, there is only one industry sector, i.e. V1, having significant stock return rate variance between drawing groups #A and #B. The number of the industry sectors which showing significant stock return rate variance is the least. The drawing group #A has higher stock return mean than the drawing group #B in the industry sector V1.

In 2021, there are three industry sectors, i.e. V5, V7 and V10, having significant stock return rate variances between drawing groups #A and #B. The drawing groups #A have higher stock return means than the drawing groups #B in all these three industry sectors.

To sum up, the total drawing count of invention grants is not capable of differentiating A-share's stock return rate in the industry sectors V3, V6 and V8. The A-shares in the industry sectors V3, V6 and V8 do not show significantly different stock return rate means between the drawing groups of the higher and the lower total drawing counts.

The total drawing count of invention grants is partially capable of differentiating A-share's stock return rate in the industry sectors V2, V4, V5, V7, V9 and V10. The A-shares in these industry sectors show significantly different stock return rate means between the drawing groups in only one or two years from 2017 to 2021 while the A-shares in the drawing groups of the higher total drawing count show higher stock return rate means than the A-shares in the drawing groups of the lower total drawing count.

The total drawing count is well capable of differentiating A-share's stock return rate in the industry sector V1. The A-shares in the industry sector V1 show significantly different stock return rate means between the drawing groups in four years from 2017 to 2021 while the A-shares in the drawing groups of the higher total drawing count show higher stock return rate means than the A-shares in the drawing groups of the lower total drawing count.

Among ten non-manufacturing industry sectors, there is only one industry sector, i.e. V1, in which the total drawing count of invention grants might be capable of differentiating A-share's stock return rate. The industry difference matters.

3.3. Variance of Invention Grant's Total Drawing Count between Stock Groups

In this sub-section, the variance of invention grant's total drawing count between stock groups #H and #L in each of ten non-manufacturing industry sectors is discussed, in order to see whether the A-shares of higher stock return rates have corresponding higher total drawing counts of invention grants or not.

Table 10 shows the results of ANOVA on invention grant's total drawing count between stock groups #H and #L for each non-manufacturing industry sector in every year from 2017 to 2021.

For the industry sector V1, the total drawing count variances between stock groups #H and #L in 2017 and 2018 are of significance whereas the total drawing count variances between two stock groups in the other three years are free of significance.

For the industry sector V2, the total drawing count variances between stock groups #H and #L in 2017, 2018 and 2021 are of significance, whereas the total drawing count variances between two stock groups in 2019 and 2020 are free of significance.

For the industry sector V3, the total drawing count variances between stock groups #H and #L in 2017 and 2018 are of significance, whereas the total drawing count variances between two stock groups in the other three years are free of significance.

For the industry sectors V4, the total drawing count variances between stock groups #H and #L in 2017, 2018, 2019 and 2020 are of significance, whereas the total drawing count variance between two stock groups in 2021 is free of significance.

For the industry sectors V5 and V6, the total drawing count variances between stock groups #H and #L are free of significance in all five years from 2017 to 2021.

For the industry sectors V7, the total drawing count variance between stock groups #H and #L is of significance in 2020, whereas the total drawing count variances between two stock groups in the other four years are free of significance.

For the industry sector V8, the total drawing count variances between stock groups #H and #L are free of significance in all five years from 2017 to 2021.

For the industry sector V9, the total drawing count variances between stock groups #H and #L in 2017 and 2018 are of significance whereas the total drawing count variances between two stock groups in the other three years are free of significance.

For the industry sector V10, the total drawing count variances between stock groups #H and #L are free of significance in all five years from 2017 to 2021.

In Table 10, there is no any industry sector in which the total drawing count variances between stock groups #H and #L are of significance in all five years. There is one industry sector, i.e. V4, in which the total drawing count variances between stock groups #H and #L are of significance in four years. There is one industry sector, i.e. V2, in which the total drawing count variances between stock groups #H and #L are of significance in three years. There are three industry sectors, i.e. V1, V3 and V9, in which the total drawing count variances between stock groups #H and #L are of significance in two years. There is one industry sector, i.e. V7, in which the total drawing count variance between stock groups #H and #L is of significance in one year.

Table 10. ANOVA on invention grant's total drawing count between stock groups for non-manufacturing industry sectors.

	Industry sector	Year	Stock group	Total drawing count			
				Sum square	Mean square	F	*p*
V1	Information Transmission, Software & Information Technology Services	2017	between groups	268797.1	268797.1	11.109	0.001***
			within groups	11832072.9	24196.5		
		2018	between groups	409098.4	409098.4	12.058	0.001***
			within groups	19474015.6	33926.9		
		2019	between groups	20399.9	20399.9	0.414	0.520
			within groups	28479506.9	49272.5		
		2020	between groups	19243.3	19243.3	0.164	0.686
			within groups	73791291.6	117502.1		
		2021	between groups	20452.5	20452.5	0.170	0.681
			within groups	117960450.3	120614.0		
V2	Construction	2017	between groups	5592355.2	5592355.2	18.890	0.001***
			within groups	62763074.9	296052.2		
		2018	between groups	5887117.7	5887117.7	16.519	0.001***
			within groups	84817216.2	356374.9		
		2019	between groups	100083.5	100083.5	0.263	0.609
			within groups	86776323.5	380597.9		
		2020	between groups	104716.5	104716.5	0.289	0.592
			within groups	79089263.6	362794.8		
		2021	between groups	6127860.6	6127860.6	8.251	0.004**
			within groups	221325485.2	742703.0		
V3	Production & Supply of Electricity, Heat, Gas, Water	2017	between groups	5028.0	5028.0	12.484	0.001***
			within groups	55579.8	402.8		
		2018	between groups	5625.6	5625.6	8.215	0.005**
			within groups	100659.6	684.8		
		2019	between groups	2334.6	2334.6	2.785	0.097
			within groups	137463.3	838.2		
		2020	between groups	96774.6	96774.6	2.474	0.117
			within groups	7237603.3	39122.2		
		2021	between groups	156537.5	156537.5	1.917	0.168
			within groups	18295902.1	81678.1		
V4	Mining	2017	between groups	3448851.4	3448851.4	5.258	0.023*
			within groups	91832714.1	655948.0		
		2018	between groups	11115477.8	11115477.8	10.559	0.001***
			within groups	152641875.5	1052702.6		
		2019	between groups	4942586.6	4942586.6	4.531	0.035*
			within groups	174533339.0	1090833.4		

Continued

		2020	between groups	8935645.0	8935645.0	9.046	0.003**
			within groups	162004593.8	987832.9		
		2021	between groups	5657932.8	5657932.8	3.389	0.067
			within groups	310520985.2	1669467.7		
V5	Wholesale & Retail	2017	between groups	27.6	27.6	0.038	0.845
			within groups	73700.1	722.6		
		2018	between groups	99.9	99.9	0.136	0.713
			within groups	78522.9	733.9		
		2019	between groups	1674.7	1674.7	1.376	0.243
			within groups	127794.1	1217.1		
		2020	between groups	320.9	320.9	0.289	0.592
			within groups	110077.1	1111.9		
		2021	between groups	6865.4	6865.4	2.458	0.119
			within groups	469288.2	2793.4		
V6	R&D Research Services	2017	between groups	1142.6	1142.6	0.485	0.488
			within groups	155373.9	2354.2		
		2018	between groups	757.4	757.4	0.265	0.608
			within groups	254185.0	2856.0		
		2019	between groups	270.2	270.2	0.370	0.544
			within groups	82636.9	731.3		
		2020	between groups	1155.0	1155.0	0.784	0.378
			within groups	182706.3	1473.4		
		2021	between groups	260.3	260.3	0.124	0.725
			within groups	384397.6	2100.5		
V7	Management of Water Conservancy, Environment & Public Facilities	2017	between groups	50.3	50.3	0.118	0.732
			within groups	33137.1	424.8		
		2018	between groups	1163.0	1163.0	0.796	0.374
			within groups	143178.0	1461.0		
		2019	between groups	750.2	750.2	0.950	0.332
			within groups	82155.6	790.0		
		2020	between groups	2709.3	2709.3	4.212	0.043*
			within groups	64971.1	643.3		
		2021	between groups	1530.3	1530.3	1.002	0.318
			within groups	261274.9	1527.9		
V8	Transportation, Warehousing & Postal	2017	between groups	689.4	689.4	1.292	0.261
			within groups	28283.4	533.6		
		2018	between groups	412.6	412.6	1.360	0.247
			within groups	21848.8	303.5		

Continued

		2019	between groups	246.3	246.3	0.135	0.714
			within groups	138379.5	1820.8		
		2020	between groups	1142.6	1142.6	1.193	0.278
			within groups	87131.7	957.5		
		2021	between groups	38.7	38.7	0.014	0.905
			within groups	386890.5	2724.6		
V9	Finance	2017	between groups	78763.4	78763.4	11.640	0.001***
			within groups	426292.4	6766.5		
		2018	between groups	217568.5	217568.5	7.912	0.007**
			within groups	1540001.4	27500.0		
		2019	between groups	80336.8	80336.8	0.623	0.434
			within groups	6449049.3	128981.0		
		2020	between groups	194113.6	194113.6	0.415	0.521
			within groups	35527807.5	467471.2		
		2021	between groups	161969.7	161969.7	0.261	0.610
			within groups	78838875.1	620778.5		
V10	Real Estate	2017	between groups	751.2	751.2	2.039	0.161
			within groups	14739.8	368.5		
		2018	between groups	250.2	250.2	0.117	0.734
			within groups	96311.2	2140.2		
		2019	between groups	502.1	502.1	0.776	0.382
			within groups	37535.7	647.2		
		2020	between groups	1195.0	1195.0	0.650	0.424
			within groups	88310.3	1839.8		
		2021	between groups	35762.1	35762.1	2.698	0.103
			within groups	1405001.9	13254.7		

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: This research.

Table 11 shows invention grant's total drawing count means of stock groups #H and #L of each non-manufacturing industry sector from 2017 to 2021, wherein, the pairs of values marked with "*" having the significant total drawing count variance there between; the pairs of values colored in red denoting that the stock group #H having higher total drawing count mean than the stock group #L; the pairs of values colored in green denoting the stock group #H having lower total drawing count mean than the stock group #L.

In 2017, there are five industry sectors, i.e. V1, V2, V3, V4 and V9, having significant total drawing count variances between stock groups #H and #L, and the stock groups #H have higher stock return means than the stock groups #L in all these five industry sectors.

Table 11. Invention grant's total drawing count means of stock groups for ten non-manufacturing industry sectors.

Industry sector		Stock group	Total drawing count mean				
			2017	2018	2019	2020	2021
V1	Information Transmission, Software & Information Technology Services	#L	37.75***	42.69***	76.46	104.91	114.44
		#H	84.55***	95.99***	88.32	115.96	123.58
V2	Construction	#L	81.73***	85.36***	269.85	256.34	173.09**
		#H	405.06***	398.61***	228.13	212.71	458.94**
V3	Production & Supply of Electricity, Heat, Gas, Water	#L	10.31***	13.41**	24.96	65.65	99.25
		#H	22.30***	25.70**	17.46	20.15	46.62
V4	Mining	#L	96.21*	35.92***	459.79*	504.20**	498.93
		#H	407.90*	586.00***	110.43*	40.15**	151.95
V5	Wholesale & Retail	#L	19.79	20.50	27.80	25.75	36.65
		#H	20.82	22.42	19.88	22.18	23.94
V6	R&D Research Services	#L	34.83	37.34	25.76	28.23	36.28
		#H	43.03	43.11	28.82	34.29	38.65
V7	Management of Water Conservancy, Environment & Public Facilities	#L	16.44	17.14	18.38	14.70*	23.56
		#H	18.03	23.96	23.70	24.96*	29.51
V8	Transportation, Warehousing & Postal	#L	12.79	11.38	25.45	17.21	29.29
		#H	19.88	16.11	21.89	24.22	30.32
V9	Finance	#L	27.18***	68.43**	190.37	273.20	255.29
		#H	96.87***	191.00**	269.04	173.39	184.42
V10	Real Estate	#L	22.82	28.76	22.06	32.58	56.55
		#H	14.35	24.14	16.28	22.79	20.13

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: This research.

In 2018, there are also five industry sectors, i.e. V1, V2, V3, V4 and V9, having significant total drawing count variances between stock groups #H and #L, and the stock groups #H have higher stock return means than the stock groups #L in all these five industry sectors.

In 2019, there is only one industry sector, i.e. V4, having significant total drawing count variance between stock groups #H and #L. The stock group #H has lower total drawing count mean than the stock group #L.

In 2020, there are two industry sectors, i.e. V4 and V7, having significant total drawing count variances between stock groups #H and #L. The stock groups #H have lower total drawing count mean than the stock group #L in the industry sector V4, whereas the stock group #H has higher total drawing count mean than the stock group #L in the industry sector V7.

In 2021, there is only one industry sector, i.e. V2, having significant total drawing count variance between stock groups #H and #L. The stock group #H has higher total drawing count mean than the stock group #L.

To sum up, the A-shares in the industry sectors V5, V6, V8 and V10 do not show significantly different total drawing count means between the stock groups in all years from 2017 to 2021. The A-shares in the industry sectors V7 and V9 partially show significantly different total drawing count means between the stock groups in one or two years from 2017 to 2021. The A-shares in the industry sectors V2 fairly show significantly different total drawing count means between the stock groups in three years from 2017 to 2021.

The A-shares in the industry sectors V4 well show significantly different total drawing count means between the stock groups in four years from 2017 to 2021. However, the A-shares in the stock group #H show higher total drawing count means in two years but show lower total drawing count means in the other two years.

4. Conclusion and Recommendation

Based on the company's integrated patent database of China A-shares and the stock return rate data in twenty quarters from 2017Q1 to 2021Q4, the effect of total drawing count of China invention grant patents for differentiating China A-share's stock return rate in top ten non-manufacturing industry sectors was thoroughly analyzed via ANOVA.

The population for analysis was the China A-share listed in either Shanghai stock exchange or Shenzhen stock exchange whereas China companies listed overseas were excluded. The effective samples, which have an annual stock return rate with at least one new China invention grant issued over the previous one year by the end of any quarter from 2017Q1 to 2021Q4, were categorized by the securities supervision commission as one of top ten non-manufacturing industry sectors $V1_{(\textit{Information Transmission, Software \& Information Technology Services})}$ to $V10_{(\textit{Real Estate})}$. The foreign patents other than China patent were excluded. The total drawing counts of invention grants which are defined as the total drawing numbers of all invention grants of an A-share were applied. According to the percentile rank of total drawing counts and stock return rates, all effective sample A-shares in each non-manufacturing industry sector were divided into two drawings groups of the higher and the lower total drawing counts: #A and #B, and two stock groups of the higher and the lower stock return rates: #H and #L. The following conclusions arrived:

1) There were only three industry sectors, i.e. $V1_{(\textit{Information Transmission, Software \& Information Technology Services})}$, $V3_{(\textit{Production \& Supply of Electricity, Heat, Gas, Water})}$ and $V8_{(\textit{Transportation, Warehousing \& Postal})}$, in which the invention grant's total drawing count variances between five years were of significance. The invention grant's total drawing counts of aforementioned three industry sectors showed significantly increasing trends from 2017 to 2021. However, for the industry sectors $V2_{(\textit{Construction})}$, $V4_{(\textit{Mining})}$, $V5_{(\textit{Wholesale \& Retail})}$, $V6_{(\textit{R\&D Research Services})}$, $V7_{(\textit{Management of Water Conservancy, Environment \& Public Facilities})}$, $V9_{(\textit{Finance})}$ and $V10_{(\textit{Real Estate})}$, the total drawing count variances between five years were free of

significance, there were neither increasing trends nor decreasing trends are shown.

2) Ten non-manufacturing industry sectors were classified into a higher total drawing count cluster which comprising $V2_{(Construction)}$, $V4_{(Mining)}$ and $V9_{(Finance)}$, and a lower total drawing count cluster which comprising $V1_{(Information\ Transmission,\ Software\ \&\ Information\ Technology\ Services)}$, $V3_{(Production\ \&\ Supply\ of\ Electricity,\ Heat,\ Gas,\ Water)}$, $V5_{(Wholesale\ \&\ Retail)}$, $V6_{(R\&D\ Research\ Services)}$, $V7_{(Management\ of\ Water\ Conservancy,\ Environment\ \&\ Public\ Facilities)}$, $V8_{(Transportation,\ Warehousing\ \&\ Postal)}$ and $V10_{(Real\ Estate)}$. The total drawing count variances between some non-manufacturing industry sectors of the higher total drawing count cluster were still of significance while the industry sector $V4_{(Mining)}$ mostly showed the highest total drawing count means from 2017 to 2020. However, the total drawing count variances of invention grants between any two industry sectors of the lower total drawing count cluster were free of significance.

3) Considering applying invention grant's total drawing count in differentiating A-share's stock return rate, the total drawing count only worked in some non-manufacturing industry sectors. The total drawing count of invention grants was not capable of differentiating A-share's stock return rate in the industry sectors $V3_{(Production\ \&\ Supply\ of\ Electricity,\ Heat,\ Gas,\ Water)}$, $V6_{(R\&D\ Research\ Services)}$ and $V8_{(Transportation,\ Warehousing\ \&\ Postal)}$, wherein the stock return rate variances between different drawing groups were free of significance in all five years from 2017 to 2020. The total drawing count of invention grants was partially capable of differentiating A-share's stock return rate in the industry sectors $V2_{(Construction)}$, $V4_{(Mining)}$, $V5_{(Wholesale\ \&\ Retail)}$, $V7_{(Management\ of\ Water\ Conservancy,\ Environment\ \&\ Public\ Facilities)}$ and $V10_{(Real\ Estate)}$, wherein the stock return rate variances between different drawing groups were of significance in only one or two years from 2017 to 2021. The total drawing count of invention grants was well capable of differentiating A-share's stock return rate in the industry sector $V1_{(Information\ Transmission,\ Software\ \&\ Information\ Technology\ Services)}$, wherein the stock return rate variances between different drawing groups were of significance for four years from 2017 to 2021. In addition, the A-shares in drawing group #A of the industry sector $V1_{(Information\ Transmission,\ Software\ \&\ Information\ Technology\ Services)}$ showed higher stock return rate means than the A-shares in the drawing group #B in all four years.

4) Among ten non-manufacturing industry sectors, there was only one industry sector $V1_{(Information\ Transmission,\ Software\ \&\ Information\ Technology\ Services)}$ in which the total drawing count of invention grants well capable of differentiating A-share's stock return rate, because the stock return rate variances between invention grant's drawing groups were of significance in four years from 2017 to 2021. Meanwhile, the A-shares in drawing groups #A showed higher stock return rate means in all four years. There were three industry sectors $V3_{(Production\ \&\ Supply\ of\ Electricity,\ Heat,\ Gas,\ Water)}$, $V6_{(R\&D\ Research\ Services)}$ and $V8_{(Transportation,\ Warehousing\ \&\ Postal)}$ in which the total drawing count of invention grants is not capable of differentiating A-share's stock return rate, because the stock return rate variances between utility model grant's drawing groups were free of

significance in all five years from 2017 to 2021. In addition, for the other six non-manufacturing industry sectors: $V2_{(Construction)}$, $V4_{(Mining)}$, $V5_{(Wholesale\ \&\ Retail)}$, $V7_{(Management\ of\ Water\ Conservancy,\ Environment\ \&\ Public\ Facilities)}$, $V9_{(Finance)}$ and $V10_{(Real\ Estate)}$, the total drawing count of invention grants rarely capable of differentiating A-share's stock return rate, because the stock return rate variances between invention grant's drawing groups were of significance in only one or two years from 2017 to 2021. The industry difference was apparent when using total drawing count of invention grants in differentiating A-share's stock return rate.

5) Considering invention grant's total drawing count means in different A-share's stock groups, the A-shares in the industry sectors $V5_{(Wholesale\ \&\ Retail)}$, $V6_{(R\&D\ Research\ Services)}$, $V8_{(Transportation,\ Warehousing\ \&\ Postal)}$ and $V10_{(Real\ Estate)}$ did not show any significantly different total drawing count means between stock groups in all five from 2017 to 2021. The A-shares in the industry sectors $V1_{(Information\ Transmission,\ Software\ \&\ Information\ Technology\ Services)}$, $V3_{(Production\ \&\ Supply\ of\ Electricity,\ Heat,\ Gas,\ Water)}$, $V7_{(Management\ of\ Water\ Conservancy,\ Environment\ \&\ Public\ Facilities)}$ and $V9_{(Finance)}$ partially showed significantly different total drawing count means between stock groups in only one or two years from 2017 to 2021. The A-shares in the industry sector $V1_{(Information\ Transmission,\ Software\ \&\ Information\ Technology\ Services)}$ well showed significantly different total drawing count means between stock groups for four years from 2017 to 2021. In addition, the A-shares of the industry sector $V4_{(Mining)}$ in the stock groups #H showed higher total drawing count means than the A-shares in the stock groups #L in two years but showed lower total drawing count means in the other two years.

Via the data of China A-shares in ten non-manufacturing industry sectors, this research showed that the industry difference was obvious in the applications of using patent indicators. Different non-manufacturing industry sectors showed different characteristics in using total drawing counts of invention grants in differentiating A-share's stock return rate. The non-manufacturing industry sectors of either more A-shares or fewer A-shares did not guarantee the effectiveness of differentiating A-share's stock return rate by the total drawing count. Meanwhile, either the industry sectors of higher total drawing counts or lower total drawing counts did not guarantee the complete effectiveness of differentiating A-share's stock return rate by the total drawing count. The industry difference was strongly suggested to take into consideration before using any patent indicators.

The innovation of this research was to propose a systematic approach for analyzing the industry differences in view of the patent indicator, i.e. the effect on differentiating stock return rate by invention grant patent's total drawing count, via a fundamental discrete mathematics tool, i.e. ANOVA. The researchers who are interested in this topic are recommended to conduct the followings:

1) To analyze the industry differences of non-manufacturing industry sectors in view of other patent indicators, which have been proved the significance in

differentiating A-share's stock performance such as the innovation continuity (Tsai et al., 2021a), the patent count (Tsai et al., 2021b, 2021f), the International Patent Classification count (Tsai et al., 2021c), the patent examination duration (Tsai et al., 2021d), the backward citation (Tsai et al., 2021e), the forward citation (Tsai et al., 2022a), the patent life (Tsai, et al., 2022b), etc.

2) To apply the proposed approach with the patent indicators to the manufacturing industry sector of China stock market and the various sub-industry sectors comprised in the manufacturing industry sector.

3) To apply the proposed approach to the other country's stock markets with the other country's patent indicators.

The finding of this research would enrich the understanding of China's invention grant patents of China A-shares in different non-manufacturing industry sectors over the previous five years. It would contribute to the state of art in evaluating Chinese listed companies by introducing the patent drawings count as a valuable indicator. The financial organizations might apply the proposed approach with the proposed patent indicator for selecting preferable stocks in portfolios and improving their investment performance.

Acknowledgements

The authors acknowledge the permission of using China A-share's integrated patent data in Tech-Glory® patent database which provided by Shenzhen Tek-Glory Intellectual Property Data Technologies, Ltd.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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