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# Invention Patent's Capability for Differentiating Stock Return Rates - Patent Informatics on Manufacturing Industries

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## Abstract

More than 25 thousand Chinese listed companies in top ten manufacturing industry sectors from 2017 to 2021 were selected to explore the industry differences via the tool of analysis of variation (ANOVA) on China invention grant patents including the patent quantity, the varying trend of patent counts, and the capability for differentiating the stock return rate. The patent count of invention grants well showed the capability of differentiating the stock return rate for one industry sector, preferably showed the capability for two industry sectors, fairly showed the capability for three industry sectors, and partially showed the capability for four industry sectors. The manufacturing industry sectors with significantly increased invention grant's patent count means since 2017 showed higher relevance to the capability. The manufacturing industry sectors of higher patent count means also showed higher relevance to the capability. The manufacturing industry sectors of higher/lower stock return rate means did not show relevance to the capability. However, every manufacturing industry sector had its particularity. The industry difference on the invention grant patents among ten manufacturing industry sectors in China stock market was distinct.

**JEL classification numbers:** C38, C46, G11, G12.
**Keywords:** Invention grant patent, ANOVA, Stock return rate, Manufacturing industry.

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# 1. Introduction

Innovation serves as a fundamental catalyst for economic advancement, yielding advantages for both enterprises and the broader economy. Technological innovation, in particular, plays a pivotal role in fostering economic growth. Patents represent a significant outcome of technological innovation. 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 National 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 a single year of 2021. 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 and Wagner, 2013).

The development of China innovation capabilities from 1985 to 2005 was examined by using China 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 company's 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 accounting 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 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 was found to be meaningful because China valid patent count was correlated with R&D input and financial output (Dang and Motohashi, 2015). Hanley, Liu and Vaona (2015) found that regional credit depth had a significantly positive effect on China 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 resulting 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 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.

Li (2012) found the implementation of patent subsidy programs was an important contributing factor of force to drive the patent surge in China.

Chen and Zhang (2019) found that R&D and non-innovation incentives helped China's extraordinary patent growth while patent subsidy and FDI may disproportionately stimulate low-quality patents.

China is now the world No.2 economy to have a stock market with the world 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 (China 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-2020f, 2021), Li, Deng and Che (2020a-2020c) 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.

Tsai, Che and Bai (2021a-2021f, 2022a-2022c) 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 significantly higher stock return rate mean (Tsai *et al.*, 2021a). Regarding the patent count, the A-shares having higher patent counts of any patent species were found to show significantly higher stock price mean and significantly higher stock return rate mean (Tsai *et al.*, 2021b, 2021c). Regarding the technology variety which representing by the quantity of total international patent classification (IPC) numbers of patents, the A-shares having the higher technology variety were found to show significantly higher stock return rate mean (Tsai *et al.*, 2021d). Regarding the invention grant patents' substantial examination duration average, the A-shares having the longer examination duration were found to show significantly higher stock return rate mean (Tsai *et al.*, 2021e). Regarding the total backward citation count, the A-shares having receiving the higher backward citation counts were found to show significantly higher stock price means than the A-shares receiving lower backward citation counts (Tsai *et al.*, 2021f). Regarding the forward citation count, the A-shares having patents but free of forward citation counts were found to show significantly higher stock price means than the A-shares receiving higher total forward citation counts, the A-shares having higher total forward citation counts showed significantly higher stock price means than the A-shares receiving lower total forward citation counts whereas the average forward citation count did not show the significance (Tsai *et al.*, 2022a). Regarding the patent life representing by the period from patent filing date to data collecting date, the A-shares having invention grant's patent lives above the general level usually showed significantly 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 significantly higher market capitalization means (Tsai *et al.*, 2022b). Regarding the patent drawing count invention publications, the A-shares having higher total drawing counts usually showed significantly higher stock return rate means than the A-shares having lower total drawing counts; however, the average drawing count did not show the significance (Tsai *et al.*, 2022c).

The patent count, as a simple and fundamental patent indicators, has been proved to be useful in differentiating China A-share's stock price and stock return rate when observing the whole stock market or whole stock board (Tsai *et al.*, 2021b, 2021c). However, the patent counts in different industries are supposedly to show different characteristics, but it has not been studied yet for China A-shares. Meanwhile, CNIPA published and/or granted 6,321 thousand China patents in a single year of 2021, including 1,720 thousand invention publications, 696 thousand invention grants, 3,120 thousand utility model grants and 785 thousand design grants. Though the invention grant plays a minor role in view of the patent quantity, however, it should be studied further because it is usually regarded as the most valuable patent species when comparing with the invention publication, the utility model grant and the design grant.

The objectives of this research are delineated as follows:

(1) To analyze the trends in the patent counts of China A-share invention grants from 2017 to 2021 across various industries, with a particular focus on different sectors within the manufacturing industry.

(2) To assess whether there are statistically significant differences in the patent counts of invention grants among various manufacturing industry sectors within the China A-share market.

(3) To investigate whether the stock return rates of China A-shares differ significantly between groups with higher and lower patent counts in the context of invention grants across different manufacturing industry sectors.

The managerial implications of this research aim to establish a systematic framework for analyzing industry-specific variations in patent indicators using data from publicly listed companies. This approach seeks to enhance the understanding of patent counts associated with China invention grants across diverse manufacturing sectors within the Chinese stock market. Furthermore, it aspires to assist investment organizations in optimizing their investment performance in China A-shares by incorporating considerations of industry-specific differences.

In the following paragraphs, section 2 presents the data and methodology which including the delimitation and limitation, population and samples for manufacturing industry sectors, and the instrumentation which showing the company integrated patent database used, the calculation of patent 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 count and China A-share's stock return rate in various 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.

Chinese companies are listed all over the world. In this research, Chinese companies listed with RMB common stocks in Shanghai stock exchange or Shenzhen stock exchange, so called China A-shares, are discussed whereas Chinese companies listed in Hong Kong Special Administrative Region of China or any other overseas regions are excluded.

When comparing with US patents and EP patents, China patents are less analyzed previously, though China is now the world largest patent application country. 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.

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 further granted by overcoming not only the preliminary examination but also the substantial examination to have novel and distinct technical features over the prior arts, so as to 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 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 Count and Patent Groups

In order to discuss whether A-shares in different patent groups have different stock return rate mean, the patent count is applied for setting up the patent groups in this research.

The patent count is defined as the number of all invention grants which issued over previous one year of an A-share. 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 patent count of each A-share is then calculated. For each manufacturing industry sector, the median of patent counts of all A-shares is calculated quarter by quarter from 2017Q1 to 2021Q4. All A-shares in each manufacturing industry sector are divided into two patent groups by the median of the patent count respectively in each quarter.

Patent group #B: the group in which the A-share having patent counts ***below*** and equal to the median in the industry sector;

Patent group #A: the group in which the A-share having patent counts ***above*** the median in the industry sector.

Via the median, the numbers of effective samples in patent groups #A and #B are about to similar; and the survivorship bias is avoided.

### 2.2.3 Stock Return Rate

In order to discuss whether A-shares in different patent 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 prices. 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.

### 2.2.4 Analysis of Variance

Analysis of Variance (ANOVA) is applied in this research for discovering:

(1) Whether the invention grant's patent count significantly different between different years for each manufacturing industry sector?

(2) Whether the invention grant's patent count significantly different between different manufacturing industry sectors in each year?

(3) Whether the A-shares in different patent groups #A and #B of invention grants showing significantly different stock return rate means for each 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".

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

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 $H_0$: $\mu_1 = \mu_2 = .... = \mu_k$ 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 4,686.

When a Chinese company is ready to be listed, it would be categorized by the securities supervision commission to a specific industry attribute according to the company's products and services. There are all nineteen different industry attributes for categorizing China A-shares, including one manufacturing attribute and eighteen non-manufacturing attributes. However, the number of A-shares of the manufacturing industry attribute is more than two times the number of all A-shares of eighteen non-manufacturing industry attributes. The manufacturing industry sector should be considered individually. Therefore, the A-shares in all non-manufacturing industry attributes are excluded in this research.

In addition, there are 29 industry sectors comprised in the manufacturing industry attribute. Based on the preliminary calculation of the A-shares derived from the first stage extraction, the A-shares having invention grants in top ten manufacturing sectors occupy 80.04% of the A-shares in all 29 manufacturing industry sectors, while the other nineteen manufacturing sectors comprises only 19.96% A-shares which are too few to analyze the industry differences. Hence, the A-shares in top ten 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 patent count; and

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

Table 1 shows top ten manufacturing industry sectors, the descriptions thereof, and the A-shares proportion in all 29 manufacturing industry sectors. The industry sector C39 (manufacturing of computer, communication and other electrical devices) has the largest number of effective samples while the industry sector C29 (manufacturing of rubber & plastic products) has the least number of effective samples. Table 2 shows the effective samples statistics in each quarter. There are totally 25,712 effective sample A-shares analyzed from 2017Q1 to 2021Q4. The numbers of effective samples in each manufacturing industry sector seem to gradually increase year by year.

**Table 1: Top Ten Manufacturing Industry Sectors for Invention Grants**

| Industry sector and description | A-shares proportion |
|---|---|
| C39 (manufacturing of computer, communication & other electrical devices) | 16.79% |
| C38 (manufacturing of electrical machinery & equipment) | 11.73% |
| C26 (manufacturing of chemical materials & products) | 10.34% |
| C27 (medical industry & pharmacy) | 8.86% |
| C35 (manufacturing of dedicated equipment) | 6.71% |
| C34 (manufacturing of general equipment) | 6.41% |
| C36 (automotive manufacturing) | 6.32% |
| C30 (manufacturing of non-metallic minerals & products) | 3.70% |
| C32 (nonferrous metal smelting, plating & extrusion) | 3.34% |
| C29 (manufacturing of rubber & plastic products) | 3.09% |
| Whole Top 10 | 80.04% |

Source: the securities supervision commission of China

**Table 2: Effective Samples Statistics of Top Ten Manufacturing Industry Sectors for Invention Grants**

| Year | Industry sector | Effective sample A-shares | | | | |
|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | Whole year |
| 2017 | C26 | 128 | 126 | 127 | 134 | 515 |
| | C27 | 128 | 123 | 121 | 133 | 505 |
| | C29 | 37 | 36 | 40 | 41 | 154 |
| | C30 | 40 | 39 | 37 | 40 | 156 |
| | C32 | 45 | 41 | 43 | 44 | 173 |
| | C34 | 74 | 76 | 76 | 83 | 309 |
| | C35 | 121 | 118 | 120 | 131 | 490 |
| | C36 | 64 | 68 | 68 | 76 | 276 |
| | C38 | 150 | 151 | 146 | 155 | 602 |
| | C39 | 207 | 202 | 199 | 217 | 825 |
| | Whole Top 10 | 994 | 980 | 977 | 1,054 | 4,005 |
| 2018 | C26 | 137 | 144 | 147 | 155 | 583 |
| | C27 | 138 | 142 | 147 | 154 | 581 |
| | C29 | 47 | 47 | 46 | 51 | 191 |
| | C30 | 40 | 38 | 46 | 49 | 173 |
| | C32 | 44 | 45 | 51 | 53 | 193 |
| | C34 | 87 | 91 | 98 | 100 | 376 |
| | C35 | 134 | 141 | 143 | 144 | 562 |
| | C36 | 78 | 80 | 85 | 84 | 327 |
| | C38 | 162 | 171 | 182 | 184 | 699 |
| | C39 | 230 | 250 | 256 | 261 | 997 |
| | Whole Top 10 | 1,097 | 1,149 | 1,201 | 1,235 | 4,682 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2019 | C26 | 165 | 161 | 155 | 150 | 631 |
| | C27 | 158 | 155 | 156 | 160 | 629 |
| | C29 | 52 | 50 | 52 | 48 | 202 |
| | C30 | 51 | 52 | 53 | 55 | 211 |
| | C32 | 54 | 51 | 47 | 49 | 201 |
| | C34 | 99 | 93 | 86 | 76 | 354 |
| | C35 | 144 | 146 | 146 | 138 | 574 |
| | C36 | 91 | 94 | 90 | 89 | 364 |
| | C38 | 181 | 173 | 171 | 176 | 701 |
| | C39 | 262 | 265 | 268 | 268 | 1,063 |
| | Whole Top 10 | 1,257 | 1,240 | 1,224 | 1,209 | 4,930 |
| 2020 | C26 | 152 | 159 | 171 | 171 | 653 |
| | C27 | 156 | 155 | 161 | 163 | 635 |
| | C29 | 45 | 43 | 44 | 46 | 178 |
| | C30 | 52 | 53 | 53 | 54 | 212 |
| | C32 | 47 | 48 | 49 | 51 | 195 |
| | C34 | 78 | 79 | 77 | 80 | 314 |
| | C35 | 130 | 134 | 137 | 136 | 537 |
| | C36 | 91 | 90 | 90 | 89 | 360 |
| | C38 | 169 | 170 | 163 | 168 | 670 |
| | C39 | 261 | 275 | 287 | 297 | 1,120 |
| | Whole Top 10 | 1,181 | 1,206 | 1,232 | 1,255 | 4,874 |
| 2021 | C26 | 205 | 210 | 235 | 241 | 891 |
| | C27 | 189 | 194 | 210 | 207 | 800 |
| | C29 | 59 | 61 | 63 | 68 | 251 |
| | C30 | 60 | 62 | 71 | 70 | 263 |
| | C32 | 53 | 54 | 59 | 60 | 226 |
| | C34 | 92 | 96 | 105 | 108 | 401 |
| | C35 | 172 | 181 | 198 | 202 | 753 |
| | C36 | 105 | 104 | 100 | 98 | 407 |
| | C38 | 195 | 203 | 207 | 203 | 808 |
| | C39 | 322 | 326 | 348 | 362 | 1,358 |
| | Whole Top 10 | 1,452 | 1,491 | 1,596 | 1,619 | 6,158 |

Source: Author's calculation

# 3. Result and Finding

## 3.1 Overall Technology

### 3.1.1 Variance of Invention Grant's Patent Count

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

Table 3 shows the patent count statistics of each manufacturing industry sector in each year from 2017 to 2021. The industry sector C39 (manufacturing of computer, communication & other electrical devices) shows the highest patent count mean in each year, while the industry sector C27 (medical industry & pharmacy) shows the lowest patent count mean in each year from 2017 to 2021.

**Table 3: Invention Grant's Patent Count Statistics for Top Ten Manufacturing Industry Sectors**

| Industry sector | Invention grant's patent count mean | | | | |
|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2020 | 2021 |
| C26 (manufacturing of chemical materials & products) | 8.84 | 9.49 | 9.47 | 9.85 | 11.69 |
| C27 (medical industry & pharmacy) | 7.48 | 8.07 | 8.02 | 7.73 | 9.35 |
| C29 (manufacturing of rubber & plastic products) | 9.67 | 9.52 | 8.85 | 8.35 | 11.55 |
| C30 (manufacturing of non-metallic minerals & products) | 10.14 | 10.20 | 9.12 | 9.35 | 13.95 |
| C32 (nonferrous metal smelting, plating & extrusion) | 9.23 | 9.95 | 9.04 | 9.28 | 12.77 |
| C34 (manufacturing of general equipment) | 13.29 | 12.44 | 15.56 | 17.77 | 16.84 |
| C35 (manufacturing of dedicated equipment) | 19.94 | 17.92 | 15.84 | 16.03 | 17.68 |
| C36 (automotive manufacturing) | 38.43 | 37.79 | 34.72 | 36.96 | 45.08 |
| C38 (manufacturing of electrical machinery & equipment) | 38.00 | 42.16 | 45.90 | 51.33 | 61.04 |
| C39 (manufacturing of computer, communication & other electrical devices) | 39.32 | 43.19 | 46.16 | 52.38 | 66.36 |

Source: Author's calculation

The invention grant's patent count means of some of top ten manufacturing industry sectors in Table 3 seem to show increasing trends from 2017 to 2021. In order for verification, ANOVA is applied. Table 4 shows the results of ANOVA on patent count between five years from 2017 to 2021 with regard to each manufacturing industry sector. There are only five manufacturing industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion) and C39 (manufacturing of computer, communication & other electrical devices), in which the patent count variances between five years are of significance; the patent count in different years are significantly different for these five industry sectors. For the other five manufacturing industry sectors including C29 (manufacturing of rubber & plastic products), C34 (manufacturing of general equipment), C35 (manufacturing of dedicated equipment), C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment), the patent count variances between five years are free of significance, so the invention grant's patent count in different years are not significantly different for these manufacturing industry sectors, though they look differently as shown in Table 3.

**Table 4: ANOVA on Invention Grant's Patent Count between Different Years**

| Industry sector | Year | Invention grant's patent count | | | |
|---|---|---|---|---|---|
| | | Sum square | Mean square | F | p |
| C26 | between years | 3,566.3 | 891.6 | 2.589 | 0.035* |
| | within years | 1,125,263.4 | 344.3 | | |
| C27 | between years | 1,480.1 | 370.0 | 3.426 | 0.008** |
| | within years | 339,669.0 | 108.0 | | |
| C29 | between years | 1,329.4 | 332.4 | 0.770 | 0.545 |
| | within years | 419,178.3 | 431.7 | | |
| C30 | between years | 3,769.0 | 942.2 | 2.874 | 0.022* |
| | within years | 331,147.3 | 327.9 | | |
| C32 | between years | 2,104.1 | 526.0 | 3.760 | 0.005** |
| | within years | 137,534.5 | 139.9 | | |
| C34 | between years | 7,171.3 | 1,792.8 | 1.380 | 0.238 |
| | within years | 2,272,204.5 | 1,299.1 | | |
| C35 | between years | 5,782.1 | 1,445.5 | 0.977 | 0.419 |
| | within years | 4,307,430.3 | 1,479.7 | | |
| C36 | between years | 23,712.9 | 5,928.2 | 0.451 | 0.771 |
| | within years | 22,705,644.2 | 13,132.2 | | |
| C38 | between years | 231,660.0 | 57,915.0 | 0.926 | 0.448 |
| | within years | 217,305,493.3 | 62,534.0 | | |
| C39 | between years | 520,945.4 | 130,236.4 | 2.732 | 0.027* |
| | within years | 255,404,469.3 | 47,667.9 | | |

p*<0.05, p**≤0.01, p***≤0.001; Source: Author's calculation

Table 5 further shows the multiple comparisons of ANOVA on invention grant's patent count between 2021 and any other years from 2017 to 2020 with regard to aforementioned five manufacturing industry sectors of significant invention grant's patent count variances between five years.

Observing the industry sectors C26 (manufacturing of chemical materials & products) and C39 (manufacturing of computer, communication & other electrical devices), the patent count variances between 2021 and 2017, between 2021 and 2018, between 2021 and 2019, are of significance; whereas the patent count variances between 2021 and 2020 are free of significance.

Observing the industry sectors C27 (medical industry & pharmacy), C30 (manufacturing of non-metallic minerals & products) and C32 (nonferrous metal smelting, plating & extrusion), the patent count variances between 2021 and any other years from 2017 to 2020 are of significance.

According to the significant patent count variances in Table 4 and the significant mean differences in Table 5, the invention grant's patent count means of aforementioned five manufacturing industry sectors significantly increased since 2017, wherein, three industry sectors including C27 (medical industry & pharmacy), C30 (manufacturing of non-metallic minerals & products) and C32 (nonferrous metal smelting, plating & extrusion) show significantly yearly increasing trends from 2017 to 2021.

**Table 5: Multiple Comparisons of ANOVA on Invention Grant's Patent Count between Different Two Years**

| Industry sector | Year (I) | Year (J) | Invention grant's patent count | | |
|---|---|---|---|---|---|
| | | | Mean difference (I-J) | Std. error | p |
| C26 (manufacturing of chemical materials & products) | 2021 | 2017 | 2.847 | 1.027 | 0.006** |
| | 2021 | 2018 | 2.197 | 0.988 | 0.026* |
| | 2021 | 2019 | 2.219 | 0.965 | 0.022* |
| | 2021 | 2020 | 1.844 | 0.956 | 0.054 |
| C27 (medical industry & pharmacy) | 2021 | 2017 | 1.866 | 0.591 | 0.002** |
| | 2021 | 2018 | 1.280 | 0.566 | 0.024* |
| | 2021 | 2019 | 1.323 | 0.554 | 0.017* |
| | 2021 | 2020 | 1.614 | 0.552 | 0.003** |
| C30 (manufacturing of non-metallic minerals & products) | 2021 | 2017 | 3.806 | 1.830 | 0.038* |
| | 2021 | 2018 | 3.744 | 1.773 | 0.035* |
| | 2021 | 2019 | 4.824 | 1.673 | 0.004** |
| | 2021 | 2020 | 4.593 | 1.671 | 0.006** |
| C32 (nonferrous metal smelting, plating & extrusion) | 2021 | 2017 | 3.543 | 1.195 | 0.003** |
| | 2021 | 2018 | 2.821 | 1.159 | 0.015* |
| | 2021 | 2019 | 3.730 | 1.147 | 0.001*** |
| | 2021 | 2020 | 3.497 | 1.156 | 0.003** |
| C39 (manufacturing of computer, communication & other electrical devices) | 2021 | 2017 | 27.046 | 9.637 | 0.005** |
| | 2021 | 2018 | 23.170 | 9.106 | 0.011* |
| | 2021 | 2019 | 20.205 | 8.941 | 0.024* |
| | 2021 | 2020 | 13.980 | 8.813 | 0.113 |

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: Author's calculation

In order to verify whether the invention grant's patent count between different manufacturing industry sectors are significantly different or not, Table 6 shows the results of ANOVA on invention grant's patent count between top ten manufacturing industry sectors. It shows that the invention grant's patent count variances between top ten manufacturing industry sectors are of significance in each year from 2017 to 2021. The invention grant's patent count means of some manufacturing industry sectors are significantly different from those of the other manufacturing industry sectors.

**Table 6: ANOVA on Invention Grant's Patent Count between Top Ten Manufacturing Industry Sectors**

| Year | Industry sector | Invention grant's patent count | | | |
|---|---|---|---|---|---|
| | | Sum square | Mean square | F | p |
| 2017 | between sectors | 765,174.2 | 85,019.4 | 7.434 | 0.001*** |
| | within sectors | 45,686,509.0 | 11,435.9 | | |
| 2018 | between sectors | 1,110,153.9 | 123,350.4 | 7.945 | 0.001*** |
| | within sectors | 72,530,915.8 | 15,524.6 | | |
| 2019 | between sectors | 1,385,880.2 | 153,986.7 | 9.646 | 0.001*** |
| | within sectors | 78,542,998.3 | 15,964.0 | | |
| 2020 | between sectors | 1,856,059.3 | 206,228.8 | 9.669 | 0.001*** |
| | within sectors | 103,745,478.2 | 21,329.3 | | |
| 2021 | between sectors | 3,642,772.0 | 404,752.4 | 12.208 | 0.001*** |
| | within sectors | 203,842,132.6 | 33,155.8 | | |

p*<0.05, p**≤0.01, p***≤0.001; Source: Author's calculation

Ten different manufacturing industry sectors will generate 45 pairs consisting of different manufacturing industry sectors. In order to discover which manufacturing industry sector having the significantly higher or lower patent count, the multiple comparison of ANOVA on invention grant's patent count between every two different manufacturing industry sectors is applied. Table 7 shows the pairs of manufacturing industry sectors in which the invention grant's patent count variances therebetween are of significance; meanwhile, the pairs are ranked from high to low according to the mean difference of the invention grant's patent count for clearly observing the industry sectors of higher/lower patent counts.

**Table 7: Multiple Comparisons of ANOVA on Invention Grant's Patent Count between Pairs of Manufacturing Industry Sectors in Each Year**

| Year | Industry sector (I) | Industry sector (J) | Invention grant's patent count | | |
|---|---|---|---|---|---|
| | | | Mean difference (I-J) | Std. error | p |
| 2017 | C39 | C27 | 31.836 | 6.042 | 0.001*** |
| | C36 | C27 | 30.948 | 8.005 | 0.001*** |
| | C38 | C27 | 30.522 | 6.453 | 0.001*** |
| | C39 | C26 | 30.470 | 6.006 | 0.001*** |
| | C39 | C32 | 30.084 | 8.942 | 0.001*** |
| | C39 | C29 | 29.646 | 9.387 | 0.002** |
| | C36 | C26 | 29.583 | 7.977 | 0.001*** |
| | C36 | C32 | 29.196 | 10.370 | 0.005** |
| | C39 | C30 | 29.174 | 9.336 | 0.002** |
| | C38 | C26 | 29.157 | 6.419 | 0.001*** |
| | C38 | C32 | 28.770 | 9.225 | 0.002** |
| | C36 | C29 | 28.759 | 10.756 | 0.008** |
| | C38 | C29 | 28.333 | 9.657 | 0.003** |
| | C36 | C30 | 28.287 | 10.712 | 0.008** |
| | C38 | C30 | 27.861 | 9.607 | 0.004** |

| | | | | | |
|---|---|---|---|---|---|
| | C39 | C34 | 26.024 | 7.132 | 0.001*** |
| | C36 | C34 | 25.136 | 8.857 | 0.005** |
| | C38 | C34 | 24.710 | 7.484 | 0.001*** |
| | C39 | C35 | 19.374 | 6.099 | 0.002** |
| | C36 | C35 | 18.487 | 8.048 | 0.022* |
| | C38 | C35 | 18.061 | 6.507 | 0.006** |
| 2018 | C39 | C27 | 35.125 | 6.503 | 0.001*** |
| | C38 | C27 | 34.093 | 6.995 | 0.001*** |
| | C39 | C26 | 33.697 | 6.496 | 0.001*** |
| | C39 | C29 | 33.672 | 9.841 | 0.001*** |
| | C39 | C32 | 33.237 | 9.798 | 0.001*** |
| | C39 | C30 | 32.988 | 10.262 | 0.001*** |
| | C38 | C26 | 32.665 | 6.988 | 0.001*** |
| | C38 | C29 | 32.640 | 10.173 | 0.001*** |
| | C38 | C32 | 32.205 | 10.132 | 0.001*** |
| | C38 | C30 | 31.956 | 10.581 | 0.003** |
| | C39 | C34 | 30.746 | 7.541 | 0.001*** |
| | C36 | C27 | 29.721 | 8.614 | 0.001*** |
| | C38 | C34 | 29.715 | 7.969 | 0.001*** |
| | C36 | C26 | 28.292 | 8.608 | 0.001*** |
| | C36 | C29 | 28.268 | 11.347 | 0.013* |
| | C36 | C32 | 27.833 | 11.310 | 0.014* |
| | C36 | C30 | 27.584 | 11.714 | 0.019* |
| | C36 | C34 | 25.342 | 9.421 | 0.007** |
| | C39 | C35 | 25.271 | 6.572 | 0.001*** |
| | C38 | C35 | 24.239 | 7.059 | 0.001*** |
| | C36 | C35 | 19.866 | 8.666 | 0.022 |
| 2019 | C39 | C27 | 38.134 | 6.356 | 0.001*** |
| | C38 | C27 | 37.874 | 6.939 | 0.001*** |
| | C39 | C29 | 37.305 | 9.698 | 0.001*** |
| | C39 | C32 | 37.111 | 9.718 | 0.001*** |
| | C38 | C29 | 37.044 | 10.090 | 0.001*** |
| | C39 | C30 | 37.033 | 9.522 | 0.001*** |
| | C38 | C32 | 36.851 | 10.109 | 0.001*** |
| | C38 | C30 | 36.773 | 9.921 | 0.001*** |
| | C39 | C26 | 36.684 | 6.350 | 0.001*** |
| | C38 | C26 | 36.424 | 6.933 | 0.001*** |
| | C39 | C34 | 30.600 | 7.753 | 0.001*** |
| | C38 | C34 | 30.339 | 8.238 | 0.001*** |
| | C39 | C35 | 30.320 | 6.544 | 0.001*** |
| | C38 | C35 | 30.060 | 7.112 | 0.001*** |
| | C36 | C27 | 26.700 | 8.321 | 0.001*** |
| | C36 | C29 | 25.871 | 11.085 | 0.020* |
| | C36 | C32 | 25.678 | 11.103 | 0.021* |
| | C36 | C30 | 25.599 | 10.932 | 0.019* |
| | C36 | C26 | 25.250 | 8.316 | 0.002** |

| | | | | | |
|---|---|---|---|---|---|
| | C36 | C34 | 19.166 | 9.432 | 0.042* |
| | C36 | C35 | 18.886 | 8.466 | 0.026* |
| 2020 | C39 | C27 | 44.651 | 7.255 | 0.001*** |
| | C39 | C29 | 44.027 | 11.784 | 0.001*** |
| | C38 | C27 | 43.604 | 8.089 | 0.001*** |
| | C39 | C32 | 43.104 | 11.332 | 0.001*** |
| | C39 | C30 | 43.027 | 10.939 | 0.001*** |
| | C38 | C29 | 42.980 | 12.315 | 0.001*** |
| | C39 | C26 | 42.534 | 7.191 | 0.001*** |
| | C38 | C32 | 42.057 | 11.883 | 0.001*** |
| | C38 | C30 | 41.981 | 11.508 | 0.001*** |
| | C38 | C26 | 41.487 | 8.031 | 0.001*** |
| | C39 | C35 | 36.351 | 7.666 | 0.001*** |
| | C38 | C35 | 35.305 | 8.459 | 0.001*** |
| | C39 | C34 | 34.614 | 9.326 | 0.001*** |
| | C38 | C34 | 33.567 | 9.988 | 0.001*** |
| | C36 | C27 | 29.230 | 9.635 | 0.002** |
| | C36 | C29 | 28.607 | 13.382 | 0.033* |
| | C36 | C32 | 27.684 | 12.986 | 0.033* |
| | C36 | C30 | 27.607 | 12.643 | 0.029* |
| | C36 | C26 | 27.114 | 9.587 | 0.005** |
| | C36 | C35 | 20.931 | 9.948 | 0.035* |
| 2021 | C39 | C27 | 57.016 | 8.115 | 0.001*** |
| | C39 | C29 | 54.815 | 12.510 | 0.001*** |
| | C39 | C26 | 54.669 | 7.850 | 0.001*** |
| | C39 | C32 | 53.586 | 13.081 | 0.001*** |
| | C39 | C30 | 52.414 | 12.267 | 0.001*** |
| | C38 | C27 | 51.700 | 9.082 | 0.001*** |
| | C39 | C34 | 49.523 | 10.349 | 0.001*** |
| | C38 | C29 | 49.499 | 13.158 | 0.001*** |
| | C38 | C26 | 49.353 | 8.846 | 0.001*** |
| | C39 | C35 | 48.680 | 8.273 | 0.001*** |
| | C38 | C32 | 48.270 | 13.702 | 0.001*** |
| | C38 | C30 | 47.098 | 12.927 | 0.001*** |
| | C38 | C34 | 44.207 | 11.123 | 0.001*** |
| | C38 | C35 | 43.363 | 9.223 | 0.001*** |
| | C36 | C27 | 35.739 | 11.086 | 0.001*** |
| | C36 | C29 | 33.538 | 14.614 | 0.022* |
| | C36 | C26 | 33.392 | 10.894 | 0.002** |
| | C36 | C32 | 32.309 | 15.105 | 0.032* |
| | C36 | C30 | 31.137 | 14.406 | 0.031* |
| | C36 | C34 | 28.246 | 12.812 | 0.028* |
| | C36 | C35 | 27.402 | 11.202 | 0.014* |
| | C39 | C36 | 21.277 | 10.290 | 0.039* |

$p^* < 0.05$, $p^{**} \leq 0.01$, $p^{***} \leq 0.001$; Source: Author's calculation

Figures 1 to 3 respectively show the invention grant's patent count mean relationship diagrams of top ten manufacturing industry sectors from 2017 to 2021, wherein, any line which connecting two industry sectors denotes the patent count variance therebetween is of significance, and the arrow denotes the industry sector having significantly lower patent count mean.

As shown in Table 7 and Figure 1, there are 21 pairs of manufacturing industry sectors having significant invention grant's patent count variances therebetween in 2017, 2018 and 2019 respectively, whereas the other 24 pairs of manufacturing industry sectors are free of significant patent count variances. Though the mean differences between manufacturing industry sectors are different in 2017, 2018 and 2019, the patent count mean relationship diagrams are the same. Three industry sectors including C36 (automotive manufacturing), C38 (manufacturing of electrical machinery & equipment) and C39 (manufacturing of computer, communication & other electrical devices) show significantly higher patent count means; while there is no significant patent count variances therebetween. The other seven industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion), C34 (manufacturing of general equipment), C35 (manufacturing of dedicated equipment), show significantly lower patent count means; while there is no significant patent count variances between any two industry sectors. According to the significant mean differences, C39 (manufacturing of computer, communication & other electrical devices) shows the significantly highest patent count mean while C27 (medical industry & pharmacy) shows the significantly lowest patent count mean in each year of 2017, 2018 and 2019.

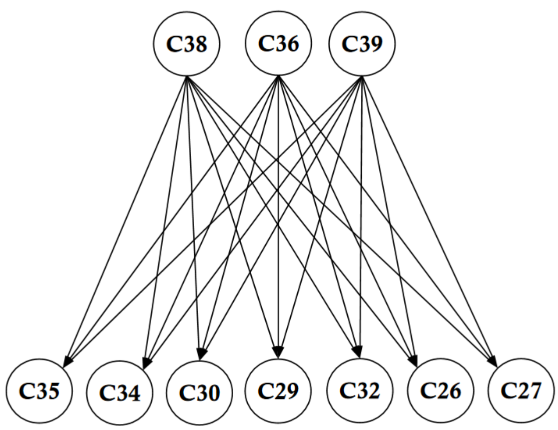


**Figure 1: Patent Count Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2017, 2018 and 2019**

Source: Author's calculation

In 2020, there are 20 pairs of manufacturing industry sectors having significant invention grant's patent count variances therebetween as shown in Table 7 and Figure 2, whereas the other 25 pairs of manufacturing industry sectors are free of significant patent count variances. The high/low relationship of patent count means is not the same as but very similar to those of 2017, 2018 and 2019. Three industry sectors including C36 (automotive manufacturing), C38 (manufacturing of electrical machinery & equipment) and C39 (manufacturing of computer, communication & other electrical devices) show significantly higher patent count means; while there is no significant patent count variances therebetween. The other seven industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion), C34 (manufacturing of general equipment), C35 (manufacturing of dedicated equipment), show significantly lower patent count means; while there is no significant patent count variances between any two industry sectors. According to the significant mean differences, C39 (manufacturing of computer, communication & other electrical devices) shows the significantly highest patent count mean while C27 (medical industry & pharmacy) shows the significantly lowest patent count mean.

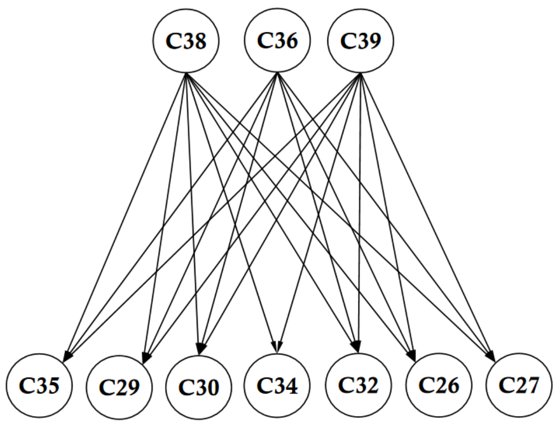


**Figure 2: Patent Count Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2020**

Source: Author's calculation

In 2021, there are 22 pairs of manufacturing industry sectors having significant invention grant's patent count variances therebetween as shown in Table 7 and Figure 3, whereas the other 23 pairs of manufacturing industry sectors are free of significant patent count variances. Three industry sectors including C36 (automotive manufacturing), C38 (manufacturing of electrical machinery & equipment) and C39 (manufacturing of computer, communication & other electrical devices) show significantly higher patent count means than the other seven industry sectors; wherein, C39 (manufacturing of computer, communication & other electrical devices) also shows significantly higher patent count means than C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment). The other seven industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion), C34 (manufacturing of general equipment), C35 (manufacturing of dedicated equipment), show significantly lower patent count means; while there is no significant patent count variances between any two industry sectors. According to the significant mean differences, C39 (manufacturing of computer, communication & other electrical devices) shows the significantly highest patent count mean while C27 (medical industry & pharmacy) shows the significantly lowest patent count mean.

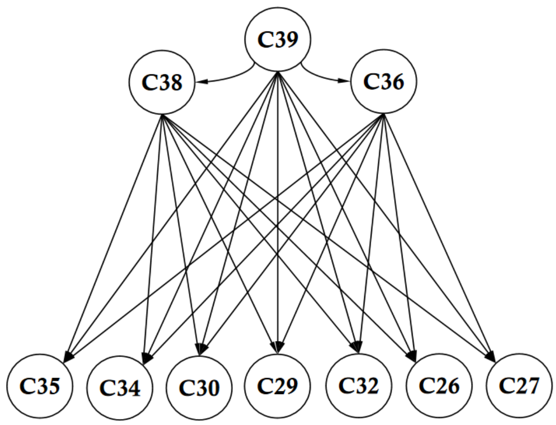


**Figure 3: Patent Count Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2021**

Source: Author's calculation

In summary, the industry difference in invention grant's patent count is significant. The industry sectors C36 (automotive manufacturing), C38 (manufacturing of electrical machinery & equipment) and C39 (manufacturing of computer, communication & other electrical devices) are verified to have significantly higher patent count means and might be regarded as the higher patent count industry sectors. The industry sectors C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion), C34 (manufacturing of general equipment), C35 (manufacturing of dedicated equipment) are verified to have significantly lower patent count means and might be regarded as the lower count industry sectors.

### 3.2 Differentiating Stock Return Rate by Invention Grant's Patent Count

Table 8 shows the stock return rate statistics of each manufacturing industry sector in each year from 2017 to 2021. Observing the highest stock return rate mean, C32 (nonferrous metal smelting, plating & extrusion) is the highest in 2017 and 2021, C27 (medical industry & pharmacy) is the highest in 2018 and 2020, C39 (manufacturing of computer, communication and other electrical devices) is the highest in 2019. Observing the lowest stock return rate mean, C29 (manufacturing of rubber & plastic products) is the lowest in 2017 and 2018, C36 is the in 2019, C32 (nonferrous metal smelting, plating & extrusion) is the lowest in 2020, and C27 is the lowest in 2021.

**Table 8: Stock Return Rate Statistics for Top Ten Manufacturing Industry Sectors**

| Industry sector | Stock return rate (%) | | | | |
|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2020 | 2021 |
| C26 (manufacturing of chemical materials & products) | -9.86 | -28.84 | -1.63 | 12.04 | 43.33 |
| C27 (medical industry & pharmacy) | -10.82 | -21.63 | 2.05 | 26.20 | 2.06 |
| C29 (manufacturing of rubber & plastic products) | -19.13 | -39.84 | -1.69 | 14.06 | 19.16 |
| C30 (manufacturing of non-metallic minerals & products) | 6.60 | -28.81 | 5.50 | 24.08 | 23.83 |
| C32 (nonferrous metal smelting, plating & extrusion) | 6.80 | -33.33 | 1.75 | 3.98 | 60.38 |
| C34 (manufacturing of general equipment) | -17.14 | -36.70 | 1.96 | 8.06 | 26.42 |
| C35 (manufacturing of dedicated equipment) | -13.95 | -31.36 | 3.30 | 20.84 | 18.66 |
| C36 (automotive manufacturing) | -5.51 | -35.93 | -6.89 | 14.12 | 27.98 |
| C38 (manufacturing of electrical machinery & equipment) | -12.76 | -35.61 | -2.87 | 17.22 | 36.95 |
| C39 (manufacturing of computer, communication & other electrical devices) | -13.26 | -28.69 | 18.29 | 16.65 | 7.60 |

Source: Author's calculation

Table 9 shows the results of ANOVA on stock return rate between top ten manufacturing industry sectors. The stock return rate variance between different industry sectors are of significance in each year from 2017 to 2021. The stock return rate means of some manufacturing industry sectors are significantly different from those of the other manufacturing industry sectors.

Ten different manufacturing industry sectors will generate 45 pairs of different manufacturing industry sectors. In order to discover which manufacturing industry sector having the significant higher or lower stock return rate, the multiple comparison of ANOVA on stock return rate between every two different manufacturing industry sectors is applied. Table 10 shows the pairs of different manufacturing industry sectors of significant stock return rate variances therebetween; meanwhile, the pairs are ranked from high to low according to the mean difference of the stock return rate for clearly observation.

**Table 9: ANOVA on Stock Return Rate between Top Ten Manufacturing Industry Sectors**

| Year | Industry sector | Stock return rate (%) | | | |
|---|---|---|---|---|---|
| | | Sum square | Mean square | F | p |
| 2017 | between sectors | 144,275.3 | 16,030.6 | 12.426 | 0.001*** |
| | within sectors | 5,153,988.2 | 1,290.1 | | |
| 2018 | between sectors | 110,969.2 | 12,329.9 | 15.828 | 0.001*** |
| | within sectors | 3,639,566.4 | 779.0 | | |
| 2019 | between sectors | 325,483.9 | 36,164.9 | 19.265 | 0.001*** |
| | within sectors | 9,236,204.1 | 1,877.3 | | |
| 2020 | between sectors | 151,072.6 | 16,785.8 | 6.108 | 0.001*** |
| | within sectors | 13,367,006.1 | 2,748.2 | | |
| 2021 | between sectors | 1,547,151.8 | 171,905.8 | 39.574 | 0.001*** |
| | within sectors | 26,706,006.0 | 4,343.9 | | |

p*<0.05, p**≤0.01, p***≤0.001; Source: Author's calculation

**Table 10: Multiple Comparisons of ANOVA on Stock Return Rate between Pairs of Manufacturing Industry Sectors in Each Year**

| Year | Industry sector (I) | Industry sector (J) | Stock return rate (%) | | |
|---|---|---|---|---|---|
| | | | Mean difference (I-J) | Std. error | p |
| 2017 | C32 | C29 | 25.929 | 3.979 | 0.001*** |
| | C30 | C29 | 25.725 | 4.080 | 0.001*** |
| | C32 | C34 | 23.947 | 3.411 | 0.001*** |
| | C30 | C34 | 23.743 | 3.528 | 0.001*** |
| | C32 | C35 | 20.757 | 3.177 | 0.001*** |
| | C30 | C35 | 20.553 | 3.302 | 0.001*** |
| | C32 | C39 | 20.059 | 3.004 | 0.001*** |
| | C30 | C39 | 19.855 | 3.136 | 0.001*** |
| | C32 | C38 | 19.567 | 3.098 | 0.001*** |
| | C30 | C38 | 19.363 | 3.227 | 0.001*** |
| | C32 | C27 | 17.619 | 3.164 | 0.001*** |
| | C30 | C27 | 17.414 | 3.290 | 0.001*** |
| | C32 | C26 | 16.667 | 3.156 | 0.001*** |
| | C30 | C26 | 16.463 | 3.283 | 0.001*** |
| | C36 | C29 | 13.618 | 3.613 | 0.001*** |
| | C32 | C36 | 12.311 | 3.483 | 0.001*** |
| | C30 | C36 | 12.107 | 3.598 | 0.001*** |
| | C36 | C34 | 11.636 | 2.975 | 0.001*** |
| | C26 | C29 | 9.262 | 3.299 | 0.005** |
| | C36 | C35 | 8.446 | 2.703 | 0.002** |
| | C27 | C29 | 8.311 | 3.306 | 0.012* |

| | | | | | |
|---|---|---|---|---|---|
| | C36 | C39 | 7.748 | 2.498 | 0.002** |
| | C26 | C34 | 7.280 | 2.585 | 0.005** |
| | C36 | C38 | 7.256 | 2.611 | 0.005** |
| | C38 | C29 | 6.362 | 3.244 | 0.049* |
| | C27 | C34 | 6.329 | 2.594 | 0.015* |
| | C36 | C27 | 5.307 | 2.689 | 0.048* |
| 2018 | C27 | C29 | 18.212 | 2.328 | 0.001*** |
| | C27 | C34 | 15.070 | 1.847 | 0.001*** |
| | C27 | C36 | 14.303 | 1.930 | 0.001*** |
| | C27 | C38 | 13.982 | 1.567 | 0.001*** |
| | C27 | C32 | 11.701 | 2.319 | 0.001*** |
| | C39 | C29 | 11.152 | 2.205 | 0.001*** |
| | C30 | C29 | 11.030 | 2.929 | 0.001*** |
| | C26 | C29 | 10.998 | 2.327 | 0.001*** |
| | C27 | C35 | 9.738 | 1.651 | 0.001*** |
| | C35 | C29 | 8.474 | 2.338 | 0.001*** |
| | C39 | C34 | 8.010 | 1.689 | 0.001*** |
| | C30 | C34 | 7.888 | 2.564 | 0.002** |
| | C26 | C34 | 7.856 | 1.846 | 0.001*** |
| | C39 | C36 | 7.243 | 1.779 | 0.001*** |
| | C27 | C26 | 7.214 | 1.636 | 0.001*** |
| | C27 | C30 | 7.182 | 2.417 | 0.003** |
| | C30 | C36 | 7.121 | 2.624 | 0.007** |
| | C26 | C36 | 7.089 | 1.928 | 0.001*** |
| | C27 | C39 | 7.060 | 1.457 | 0.001*** |
| | C39 | C38 | 6.923 | 1.377 | 0.001*** |
| | C30 | C38 | 6.801 | 2.370 | 0.004** |
| | C26 | C38 | 6.769 | 1.565 | 0.001*** |
| | C32 | C29 | 6.511 | 2.849 | 0.022* |
| | C35 | C34 | 5.331 | 1.860 | 0.004** |
| | C39 | C32 | 4.642 | 2.195 | 0.035* |
| | C35 | C36 | 4.564 | 1.941 | 0.019* |
| | C35 | C38 | 4.244 | 1.581 | 0.007** |
| 2019 | C39 | C36 | 25.187 | 2.631 | 0.001*** |
| | C39 | C38 | 21.162 | 2.108 | 0.001*** |
| | C39 | C29 | 19.981 | 3.326 | 0.001*** |
| | C39 | C26 | 19.921 | 2.177 | 0.001*** |
| | C39 | C32 | 16.547 | 3.333 | 0.001*** |
| | C39 | C34 | 16.338 | 2.659 | 0.001*** |
| | C39 | C27 | 16.245 | 2.180 | 0.001*** |
| | C39 | C35 | 14.997 | 2.244 | 0.001*** |
| | C39 | C30 | 12.799 | 3.265 | 0.001*** |
| | C30 | C36 | 12.388 | 3.749 | 0.001*** |
| | C35 | C36 | 10.190 | 2.903 | 0.001*** |
| | C27 | C36 | 8.942 | 2.853 | 0.002** |
| | C34 | C36 | 8.849 | 3.234 | 0.006** |

| | | | | | |
|---|---|---|---|---|---|
| | C32 | C36 | 8.640 | 3.807 | 0.023* |
| | C30 | C38 | 8.363 | 3.402 | 0.014* |
| | C30 | C26 | 7.122 | 3.446 | 0.039* |
| | C35 | C38 | 6.164 | 2.439 | 0.012* |
| | C35 | C26 | 4.924 | 2.499 | 0.049* |
| | C27 | C38 | 4.916 | 2.380 | 0.039* |
| 2020 | C27 | C32 | 22.228 | 4.292 | 0.001*** |
| | C30 | C32 | 20.104 | 5.202 | 0.001*** |
| | C27 | C34 | 18.143 | 3.617 | 0.001*** |
| | C35 | C32 | 16.864 | 4.383 | 0.001*** |
| | C30 | C34 | 16.019 | 4.660 | 0.001*** |
| | C27 | C26 | 14.164 | 2.922 | 0.001*** |
| | C38 | C32 | 13.247 | 4.266 | 0.002** |
| | C35 | C34 | 12.779 | 3.724 | 0.001*** |
| | C39 | C32 | 12.678 | 4.068 | 0.002** |
| | C27 | C29 | 12.146 | 4.446 | 0.006** |
| | C27 | C36 | 12.087 | 3.459 | 0.001*** |
| | C30 | C26 | 12.039 | 4.144 | 0.004** |
| | C36 | C32 | 10.141 | 4.661 | 0.030* |
| | C30 | C36 | 9.963 | 4.538 | 0.028* |
| | C27 | C39 | 9.551 | 2.604 | 0.001*** |
| | C38 | C34 | 9.162 | 3.585 | 0.011* |
| | C27 | C38 | 8.981 | 2.903 | 0.002** |
| | C35 | C26 | 8.799 | 3.054 | 0.004** |
| | C39 | C34 | 8.592 | 3.348 | 0.010** |
| 2021 | C32 | C27 | 58.326 | 4.965 | 0.001*** |
| | C32 | C39 | 52.784 | 4.735 | 0.001*** |
| | C32 | C35 | 41.729 | 4.999 | 0.001*** |
| | C26 | C27 | 41.274 | 3.210 | 0.001*** |
| | C32 | C29 | 41.230 | 6.044 | 0.001*** |
| | C32 | C30 | 36.558 | 5.978 | 0.001*** |
| | C26 | C39 | 35.732 | 2.841 | 0.001*** |
| | C38 | C27 | 34.892 | 3.287 | 0.001*** |
| | C32 | C34 | 33.969 | 5.482 | 0.001*** |
| | C32 | C36 | 32.408 | 5.467 | 0.001*** |
| | C38 | C39 | 29.349 | 2.928 | 0.001*** |
| | C36 | C27 | 25.918 | 4.013 | 0.001*** |
| | C26 | C35 | 24.677 | 3.263 | 0.001*** |
| | C34 | C27 | 24.357 | 4.033 | 0.001*** |
| | C26 | C29 | 24.178 | 4.710 | 0.001*** |
| | C32 | C38 | 23.434 | 4.960 | 0.001*** |
| | C30 | C27 | 21.768 | 4.685 | 0.001*** |
| | C36 | C39 | 20.375 | 3.724 | 0.001*** |
| | C26 | C30 | 19.507 | 4.625 | 0.001*** |
| | C34 | C39 | 18.815 | 3.746 | 0.001*** |
| | C38 | C35 | 18.294 | 3.338 | 0.001*** |

| | | | | | |
|---|---|---|---|---|---|
| | C38 | C29 | 17.796 | 4.763 | 0.001*** |
| | C29 | C27 | 17.096 | 4.768 | 0.001*** |
| | C32 | C26 | 17.052 | 4.909 | 0.001*** |
| | C26 | C34 | 16.917 | 3.963 | 0.001*** |
| | C35 | C27 | 16.597 | 3.346 | 0.001*** |
| | C30 | C39 | 16.226 | 4.440 | 0.001*** |
| | C26 | C36 | 15.357 | 3.943 | 0.001*** |
| | C38 | C30 | 13.124 | 4.679 | 0.005** |
| | C29 | C39 | 11.554 | 4.528 | 0.011* |
| | C35 | C39 | 11.055 | 2.995 | 0.001*** |
| | C38 | C34 | 10.535 | 4.026 | 0.009** |
| | C36 | C35 | 9.320 | 4.055 | 0.022* |
| | C38 | C36 | 8.974 | 4.006 | 0.025* |
| | C26 | C38 | 6.383 | 3.202 | 0.046* |

p*<0.05, p**≤0.01, p***≤0.001; Source: Author's calculation

Figures 4 to 8 respectively show the stock return rate mean relationship diagrams of top ten manufacturing industry sectors from 2017 to 2021, wherein, any line which connecting two industry sectors denotes the stock return rate variance therebetween is of significance, and the arrow denotes the industry sector having significantly lower stock return rate mean.

As shown in Table 10 and Figure 4, there are 27 pairs of manufacturing industry sectors in 2017 having significant stock return rate variances therebetween, whereas the other 18 pairs of manufacturing industry sectors are free of significant stock return rate variances. Three industry sectors including C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion) and C36 (automotive manufacturing) show significantly higher stock return rate means. Four industry sectors including C29 (manufacturing of rubber & plastic products), C34 (manufacturing of general equipment), C35 (manufacturing of dedicated equipment) and C39 (manufacturing of computer, communication and other electrical devices) show significantly lower stock return rate means. According to the significant mean differences, C32 (nonferrous metal smelting, plating & extrusion) shows the significantly highest stock return rate mean while C29 (manufacturing of rubber & plastic products) shows the significantly lowest stock return rate mean.

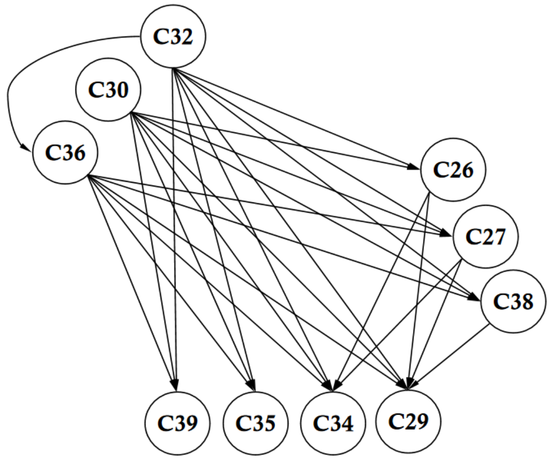


**Figure 4: Stock Return Rate Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2017**

Source: Author's calculation

In 2018, there are 27 pairs of manufacturing industry sectors having significant stock return rate variances therebetween as shown in Table 10 and Figure 5, whereas the other 18 pairs of manufacturing industry sectors are free of significant stock return rate variances. Five industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C30 (manufacturing of non-metallic minerals & products), C35 (manufacturing of dedicated equipment) and C39 (manufacturing of computer, communication & other electrical devices) show significantly higher stock return rate means. Four industry sectors including C29 (manufacturing of rubber & plastic products), C34 (manufacturing of general equipment), C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment) show significantly lower stock return rate means. According to the significant mean differences, C27 (medical industry & pharmacy) shows the significantly highest stock return rate mean while C29 (manufacturing of rubber & plastic products) shows the significantly lowest stock return rate mean.

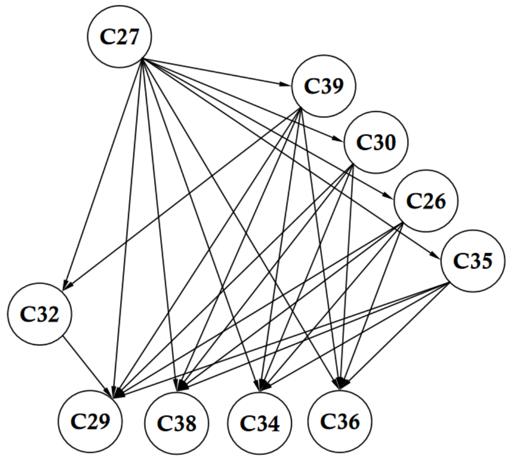


**Figure 5: Stock Return Rate Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2018**

Source: Author's calculation

In 2019, there are 19 pairs of manufacturing industry sectors having significant stock return rate variances therebetween as shown in Table 10 and Figure 6, whereas the other 26 pairs of manufacturing industry sectors are free of significant stock return rate variances. The industry sector C39 (manufacturing of computer, communication and other electrical devices) shows significantly higher stock return rate mean than the other nine manufacturing industry sectors. Four industry sectors including C26 (manufacturing of chemical materials & products), C29 (manufacturing of rubber & plastic products), C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment) show significantly lower stock return rate means. According to the significant mean differences, C39 (manufacturing of computer, communication and other electrical devices) shows the significantly highest stock return rate mean while C36 (automotive manufacturing) shows the significantly lowest stock return rate mean.

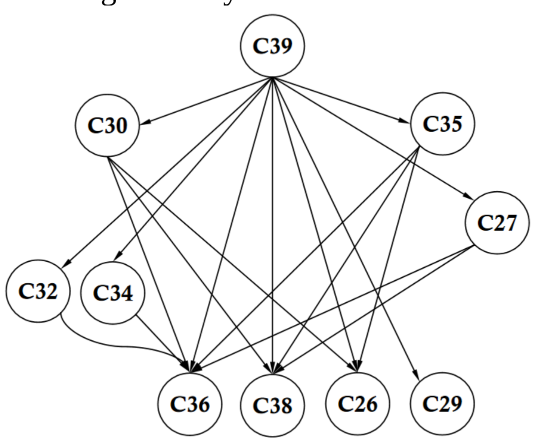


**Figure 6: Stock Return Rate Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2019**

Source: Author's calculation

In 2020, there are 19 pairs of manufacturing industry sectors having significant stock return rate variances therebetween as shown in Table 10 and Figure 7, whereas the other 26 pairs of manufacturing industry sectors are free of significant stock return rate variances. Three industry sectors including C27 (medical industry & pharmacy), C30 (manufacturing of non-metallic minerals & products) and C35 (manufacturing of dedicated equipment) show significantly higher stock return rate means. Two industry sectors including C32 (nonferrous metal smelting, plating & extrusion) and C34 (manufacturing of general equipment) show significantly lower stock return rate means. According to the significant mean differences, C27 (medical industry & pharmacy) shows the significantly highest stock return rate mean while C32 (nonferrous metal smelting, plating & extrusion) shows the significantly lowest stock return rate mean.

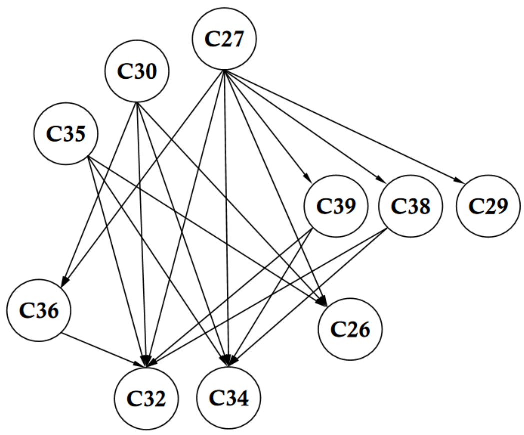


**Figure 7: Stock Return Rate Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2020**

Source: Author's calculation

In 2021, there are 35 pairs of manufacturing industry sectors having significant stock return rate variances therebetween as shown in Table 10 and Figure 8, whereas the other 10 pairs of manufacturing industry sectors are free of significant stock return rate variances. Three industry sectors including C26 (manufacturing of chemical materials & products), C32 (nonferrous metal smelting, plating & extrusion) and C38 (manufacturing of electrical machinery & equipment) show significantly higher stock return rate means. Two industry sectors including C27 (medical industry & pharmacy) and C39 (manufacturing of computer, communication and other electrical devices) show significantly lower stock return rate means. According to the significant mean differences, C32 (nonferrous metal smelting, plating & extrusion) shows the significantly highest stock return rate mean while C27 (medical industry & pharmacy) shows the significantly lowest stock return rate mean.

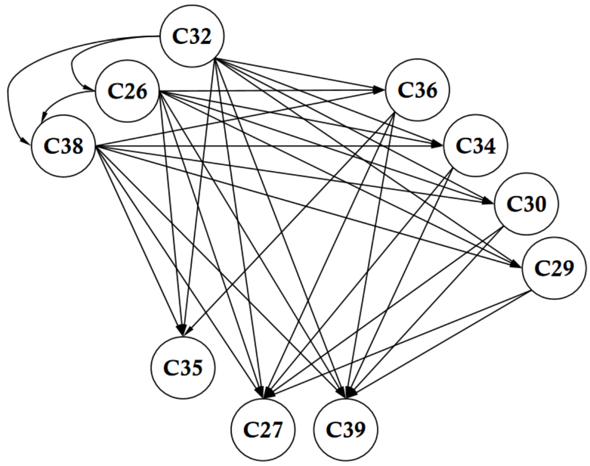


**Figure 8: Stock Return Rate Mean Relationship Diagram of Top Ten Manufacturing Industry Sectors in 2021**

Source: Author's calculation

According to Table 10 and Figures 4 to 8, it is unable to identify the specific industry sectors which usually show significantly higher stock return rate means. C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion) show the significantly highest stock return rate means in two years respectively; however, each of them also shows the significantly lowest stock return rate mean in one year respectively. However, C29 (manufacturing of rubber & plastic products) and C34 (manufacturing of general equipment) are identified to usually show significantly lower stock return rate means because each of them shows significantly lower stock return rate means in three years respectively.

Considering the invention grant's capability of differentiating the stock return rate, Table 11 shows the results of ANOVA on the stock return rate between invention grant's patent groups #A and #B of each manufacturing industry sector in each year from 2017 to 2021.

For the industry sectors C26 (manufacturing of chemical materials & products) and C27 (medical industry & pharmacy), the stock return rate variances between patent groups #A and #B in 2017, 2018 and 2020 are of significance whereas the stock return rate variances between two patent groups in the other two years are free of significance.

For the industry sector C29 (manufacturing of rubber & plastic products), the stock return rate variances between patent groups #A and #B in 2018 and 2019 are of significance whereas the stock return rate variances between two patent groups in the other three years are free of significance.

For the industry sector C30 (manufacturing of non-metallic minerals & products), the stock return rate variances between patent groups #A and #B in 2017 and 2020 are of significance whereas the stock return rate variances between two patent groups in the other three years are free of significance.

For the industry sector C32 (nonferrous metal smelting, plating & extrusion), the stock return rate variances between patent groups #A and #B in 2017, 2020 and 2021 are of significance whereas the stock return rate variances between two patent groups in the other two years are free of significance.

For the industry sector C34 (manufacturing of general equipment), the stock return rate variances between patent groups #A and #B in 2018 and 2020 are of significance whereas the stock return rate variances between two patent groups in the other three years are free of significance.

For the industry sector C35 (manufacturing of dedicated equipment), the stock return rate variances between patent groups #A and #B in 2017 and 2018 are of significance whereas the stock return rate variances between two patent groups in the other three years are free of significance.

For the industry sector C36 (automotive manufacturing), the stock return rate variances between patent groups #A and #B in 2017, 2018, 2020 and 2021 are of significance whereas the stock return rate variance between two patent groups in 2019 is free of significance.

For the industry sector C38 (manufacturing of electrical machinery & equipment), the stock return rate variances between patent groups #A and #B in 2017, 2018, 2019 and 2020 are of significance whereas the stock return rate variance between two patent groups in 2021 is free of significance.

For the industry sector C39 (manufacturing of computer, communication and other electrical devices), the stock return rate variances between patent groups #A and #B in all years from 2017 to 2021 are of significance.

**Table 11: ANOVA on Stock Return Rate between Invention Grant's Patent Groups**

| | | | Stock return rate (%) | | | |
|---|---|---|---|---|---|---|
| Industry sector | Year | patent group | Sum square | Mean square | F | p |
| C26 (manufacturing of chemical materials & products) | 2017 | between groups | 11,368.3 | 11,368.3 | 9.351 | 0.002** |
| | | within groups | 623,682.0 | 1,215.8 | | |
| | 2018 | between groups | 13,731.6 | 13,731.6 | 16.800 | 0.001*** |
| | | within groups | 474,887.8 | 817.4 | | |
| | 2019 | between groups | 207.1 | 207.1 | 0.172 | 0.678 |
| | | within groups | 757,027.2 | 1,203.5 | | |
| | 2020 | between groups | 45,395.3 | 45,395.3 | 19.207 | 0.001*** |
| | | within groups | 1,538,655.9 | 2,363.5 | | |
| | 2021 | between groups | 8,134.7 | 8,134.7 | 1.109 | 0.293 |
| | | within groups | 6,523,349.9 | 7,337.9 | | |
| C27 (medical industry & pharmacy) | 2017 | between groups | 11,208.4 | 11,208.4 | 13.903 | 0.001*** |
| | | within groups | 405,521.1 | 806.2 | | |
| | 2018 | between groups | 5,670.3 | 5,670.3 | 5.248 | 0.022* |
| | | within groups | 625,569.6 | 1,080.4 | | |
| | 2019 | between groups | 2,868.2 | 2,868.2 | 1.666 | 0.197 |
| | | within groups | 1,079,271.2 | 1,721.3 | | |
| | 2020 | between groups | 17,620.6 | 17,620.6 | 5.393 | 0.021* |
| | | within groups | 2,068,091.3 | 3,267.1 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2021 | between groups | 4,754.0 | 4,754.0 | 2.974 | 0.085 |
| | | within groups | 1,275,519.9 | 1,598.4 | | |
| C29 (manufacturing of rubber & plastic products) | 2017 | between groups | 1,453.9 | 1,453.9 | 1.579 | 0.211 |
| | | within groups | 139,959.7 | 920.8 | | |
| | 2018 | between groups | 5,172.8 | 5,172.8 | 12.587 | 0.001*** |
| | | within groups | 77,671.8 | 411.0 | | |
| | 2019 | between groups | 13,603.4 | 13,603.4 | 10.564 | 0.001*** |
| | | within groups | 257,541.4 | 1,287.7 | | |
| | 2020 | between groups | 5,826.0 | 5,826.0 | 3.587 | 0.060 |
| | | within groups | 285,855.2 | 1,624.2 | | |
| | 2021 | between groups | 9,619.9 | 9,619.9 | 3.272 | 0.072 |
| | | within groups | 732,046.3 | 2,939.9 | | |
| C30 (manufacturing of non-metallic minerals & products) | 2017 | between groups | 14,038.1 | 14,038.1 | 5.709 | 0.018* |
| | | within groups | 378,694.2 | 2,459.1 | | |
| | 2018 | between groups | 1,142.0 | 1,142.0 | 0.944 | 0.333 |
| | | within groups | 206,934.7 | 1,210.1 | | |
| | 2019 | between groups | 3,057.6 | 3,057.6 | 1.999 | 0.159 |
| | | within groups | 319,734.6 | 1,529.8 | | |
| | 2020 | between groups | 20,880.0 | 20,880.0 | 8.462 | 0.004** |
| | | within groups | 518,199.4 | 2,467.6 | | |
| | 2021 | between groups | 131.9 | 131.9 | 0.039 | 0.844 |
| | | within groups | 892,527.3 | 3,419.6 | | |
| C32 (nonferrous metal smelting, plating & extrusion) | 2017 | between groups | 21,061.2 | 21,061.2 | 11.670 | 0.001*** |
| | | within groups | 308,613.4 | 1,804.8 | | |
| | 2018 | between groups | 1,338.3 | 1,338.3 | 1.785 | 0.183 |
| | | within groups | 143,239.3 | 749.9 | | |
| | 2019 | between groups | 432.6 | 432.6 | 0.406 | 0.525 |
| | | within groups | 211,986.0 | 1,065.3 | | |
| | 2020 | between groups | 6,462.7 | 6,462.7 | 3.963 | 0.048* |
| | | within groups | 314,777.4 | 1,631.0 | | |
| | 2021 | between groups | 51,633.6 | 51,633.6 | 10.148 | 0.002** |
| | | within groups | 1,139,778.4 | 5,088.3 | | |
| C34 (manufacturing of general equipment) | 2017 | between groups | 359.7 | 359.7 | 0.399 | 0.528 |
| | | within groups | 276,850.6 | 901.8 | | |
| | 2018 | between groups | 2,224.7 | 2,224.7 | 5.260 | 0.022* |
| | | within groups | 158,173.0 | 422.9 | | |
| | 2019 | between groups | 1,674.7 | 1,674.7 | 0.880 | 0.349 |
| | | within groups | 669,696.6 | 1,902.5 | | |
| | 2020 | between groups | 13,736.1 | 13,736.1 | 7.372 | 0.007** |
| | | within groups | 581,319.6 | 1,863.2 | | |
| | 2021 | between groups | 91.1 | 91.1 | 0.024 | 0.878 |
| | | within groups | 1,531,418.3 | 3,838.1 | | |
| C35 (manufacturing of dedicated equipment) | 2017 | between groups | 21,074.0 | 21,074.0 | 20.804 | 0.001*** |
| | | within groups | 494,327.0 | 1,013.0 | | |
| | 2018 | between groups | 16,624.2 | 16,624.2 | 21.809 | 0.001*** |
| | | within groups | 426,860.8 | 762.3 | | |
| | 2019 | between groups | 713.9 | 713.9 | 0.464 | 0.496 |
| | | within groups | 879,254.0 | 1,537.2 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | between groups | 1,787.6 | 1,787.6 | 0.593 | 0.442 |
| | | within groups | 1,613,561.4 | 3,016.0 | | |
| | 2021 | between groups | 4,490.2 | 4,490.2 | 1.313 | 0.252 |
| | | within groups | 2,568,545.4 | 3,420.2 | | |
| C36 (automotive manufacturing) | 2017 | between groups | 10,388.2 | 10,388.2 | 6.437 | 0.012* |
| | | within groups | 442,159.5 | 1,613.7 | | |
| | 2018 | between groups | 4,069.7 | 4,069.7 | 7.434 | 0.007** |
| | | within groups | 177,926.9 | 547.5 | | |
| | 2019 | between groups | 1,828.0 | 1,828.0 | 2.079 | 0.150 |
| | | within groups | 318,312.0 | 879.3 | | |
| | 2020 | between groups | 11,670.2 | 11,670.2 | 4.989 | 0.026* |
| | | within groups | 837,464.0 | 2,339.3 | | |
| | 2021 | between groups | 49,974.0 | 49,974.0 | 8.912 | 0.003** |
| | | within groups | 2,270,926.4 | 5,607.2 | | |
| C38 (manufacturing of electrical machinery & equipment) | 2017 | between groups | 47,151.3 | 47,151.3 | 35.799 | 0.001*** |
| | | within groups | 790,267.6 | 1,317.1 | | |
| | 2018 | between groups | 15,078.1 | 15,078.1 | 25.727 | 0.001*** |
| | | within groups | 408,498.4 | 586.1 | | |
| | 2019 | between groups | 7,185.3 | 7,185.3 | 6.172 | 0.013* |
| | | within groups | 813,787.3 | 1,164.2 | | |
| | 2020 | between groups | 25,254.8 | 25,254.8 | 7.655 | 0.006** |
| | | within groups | 2,203,944.0 | 3,299.3 | | |
| | 2021 | between groups | 17,524.4 | 17,524.4 | 2.516 | 0.113 |
| | | within groups | 5,612,857.0 | 6,963.8 | | |
| C39 (manufacturing of computer, communication & other electrical devices) | 2017 | between groups | 15,048.8 | 15,048.8 | 10.857 | 0.001*** |
| | | within groups | 1,140,761.3 | 1,386.1 | | |
| | 2018 | between groups | 23,997.2 | 23,997.2 | 28.066 | 0.001*** |
| | | within groups | 850,754.9 | 855.0 | | |
| | 2019 | between groups | 20,483.7 | 20,483.7 | 5.605 | 0.018* |
| | | within groups | 3,877,539.3 | 3,654.6 | | |
| | 2020 | between groups | 18,226.7 | 18,226.7 | 6.293 | 0.012* |
| | | within groups | 3,238,277.9 | 2,896.5 | | |
| | 2021 | between groups | 14,894.2 | 14,894.2 | 5.052 | 0.025* |
| | | within groups | 3,997,789.2 | 2,948.2 | | |

p*<0.05, p**≤0.01, p***≤0.001; Source: Author's calculation

As shown in Table 11, there is one manufacturing industry sector, i.e. C39 (manufacturing of computer, communication & other electrical devices), in which the stock return rate variances between patent groups #A and #B are of significance in all five years.

There are two industry sectors including C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment), in which the stock return rate variances between patent groups #A and #B are of significance in four years; wherein, the stock return rate variances for C36 (automotive manufacturing) are significant in 2017, 2018, 2020 and 2021, the stock return rate variances for C38 (manufacturing of electrical machinery & equipment) are significant in 2017, 2018, 2019 and 2020.

There are three industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion), in which the stock return rate variances between patent groups #A and #B are of significance in three years; wherein, the stock return rate variances for C26 (manufacturing of chemical materials & products) and C27 (medical industry & pharmacy) are significant in 2017, 2018 and 2020, the stock return rate variances for C32 (nonferrous metal smelting, plating & extrusion) are significant in 2017, 2020 and 2021. There are four industry sectors including C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C34 (manufacturing of general equipment) and C35 (manufacturing of dedicated equipment), in which the stock return rate variances between patent groups #A and #B are of significance in two years; wherein, the stock return rate variances for C29 (manufacturing of rubber & plastic products) are significant in 2018 and 2019, the stock return rate variances for C30 (manufacturing of non-metallic minerals & products) are significant in 2017 and 2020, the stock return rate variances for C34 (manufacturing of general equipment) are significant in 2018 and 2020, the stock return rate variances for C35 (manufacturing of dedicated equipment) are significant in 2017 and 2018.

As shown in Table 11, there is one manufacturing industry sector, i.e. C39 (manufacturing of computer, communication & other electrical devices), in which the stock return rate variances between patent groups #A and #B are of significance in all five years.

Referring to the multiple comparisons on patent count in Table 7 and Figures 1 to 3, and the multiple comparisons on stock return rate in Table 10 and Figures 4 to 8, the significantly higher/lower patent count means and significantly higher/lower stock return rate means of top ten manufacturing industry sectors are summarized in Table 12, wherein, “H” denotes the value of the industry sector being significantly higher, “L” denotes the value of the industry sector being significantly lower, “N” denotes the value of the industry sector being insignificantly higher or lower.

The industry C39 (manufacturing of computer, communication & other electrical devices) has significant stock return rate variances between patent groups #A and #B in all five years. Observing the patent count, C39 (manufacturing of computer, communication & other electrical devices) shows significantly higher patent count means in all five years. Observing the stock return rate, it has significantly higher stock return rate means in 2018 and 2019, significantly lower stock return rate means in 2017 and 2021, but insignificantly higher/lower stock return rates in 2020. Two industry sectors including C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment) have significant stock return rate variances between patent groups #A and #B in four years. Observing the patent count, C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment) always show significantly higher patent count means. Observing the stock return rate, C36 (automotive manufacturing) shows significantly higher stock return rate mean in 2017, significantly lower stock return rate mean in 2018, but insignificantly higher/lower stock return rate means in 2020 and 2021; C38 (manufacturing of electrical machinery & equipment) shows significantly lower stock return rates means in 2018 and 2019, but insignificantly higher/lower stock return rate means in 2017 and 2020.

Three industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion), have significant stock return rate variances between patent groups #A and #B in three years. Observing the patent count, C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion) always show significantly lower patent count means. Observing the stock return rate, C26 (manufacturing of chemical materials & products) shows insignificantly higher/lower stock return rate means in 2017, 2018 and 2020; C27 (medical industry & pharmacy) shows significantly higher stock return rate means in 2018 and 2020, but insignificantly higher/lower stock return rate means in 2017; C32 (nonferrous metal smelting, plating & extrusion) shows significantly higher stock return rate means in 2017 and 2021, but significantly lower stock return rate mean in 2020.

Four industry sectors including C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C34 (manufacturing of general equipment) and C35 (manufacturing of dedicated equipment), have significant stock return rate variances between patent groups #A and #B in two years. Observing the patent count, C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C34 (manufacturing of general equipment) and C35 (manufacturing of dedicated equipment) always show significantly lower patent count means. Observing the stock return rate, C29 (manufacturing of rubber & plastic products) shows significantly lower stock return rate mean in 2018 but insignificantly higher/lower stock return rate mean in 2019; C30 (manufacturing of non-metallic minerals & products) shows significantly higher stock return rate means in 2017 and 2020; C34 (manufacturing of general equipment) shows significantly lower stock return rate mean in 2020 but insignificantly higher/lower stock return rate mean in 2018; C35 (manufacturing of dedicated equipment) shows significantly lower stock return rate mean in 2017 but insignificantly higher/lower stock return rate mean in 2018.

To sum up, the industry difference in the stock return rate variance between patent groups #A and #B is therefore verified to be significant. Different industry sectors show different significance on differentiating the stock return rate. The industry sectors having higher invention grant's patent count means show preferable capability of differentiating the stock return rate by the invention grant's patent count. However, the higher or the lower stock return rate mean of the industry sector does not show relevance to the capability of differentiating the stock return rate by the invention grant's patent count.

Table 13 further shows the stock return rate means of invention grant's patent groups #A and #B of each manufacturing industry sector from 2017 to 2021, wherein, the values marked with '*' have the significant stock return rate variance therebetween.

**Table 12: Significant Features on Invention Grant's Patent Count and Stock Return Rate for Manufacturing Industry Sectors**

| Industry Sector | | Significant feature | | | | |
|---|---|---|---|---|---|---|
| | | 2017 | 2018 | 2019 | 2020 | 2021 |
| C26 | Patent count | L | L | | L | |
| | Stock Return Rate | N | N | | N | |
| C27 | Patent count | L | L | | L | |
| | Stock Return Rate | N | H | | H | |
| C29 | Patent count | | L | L | | |
| | Stock Return Rate | | L | N | | |
| C30 | Patent count | L | | | L | |
| | Stock Return Rate | H | | | H | |
| C32 | Patent count | L | | | L | L |
| | Stock Return Rate | H | | | N | H |
| C34 | Patent count | | L | | L | |
| | Stock Return Rate | | N | | L | |
| C35 | Patent count | L | L | | | |
| | Stock Return Rate | L | N | | | |
| C36 | Patent count | H | H | | H | H |
| | Stock Return Rate | H | L | | N | N |
| C38 | Patent count | H | H | H | H | H |
| | Stock Return Rate | N | L | L | N | |
| C39 | Patent count | H | H | H | H | H |
| | Stock Return Rate | L | H | H | N | L |

Source: Author's calculation

**Table 13: Stock Return Rate Means of Invention Grant's Patent Groups**

| Industry sector | Patent group | Stock return rate mean (%) | | | | |
|---|---|---|---|---|---|---|
| | | 2017 | 2018 | 2019 | 2020 | 2021 |
| C26 | #B | -14.22** | -33.36*** | -1.11 | 4.16*** | 46.11 |
| | #A | -4.80** | -23.63*** | -2.26 | 20.87*** | 40.05 |
| C27 | #B | -15.25*** | -24.51* | 0.08 | 21.31* | 4.31 |
| | #A | -5.81*** | -18.24* | 4.37 | 31.88* | -0.58 |
| C29 | #B | -21.89 | -44.75*** | -9.50*** | 9.18 | 13.77 |
| | #A | -15.72 | -34.32*** | 6.94*** | 20.76 | 26.28 |
| C30 | #B | -2.30* | -26.45 | 9.04 | 15.14** | 24.51 |
| | #A | 16.71* | -31.61 | 1.41 | 35.09** | 23.09 |
| C32 | #B | -3.43*** | -35.79 | 0.40 | -1.24* | 45.67** |
| | #A | 18.70*** | -30.51 | 3.34 | 10.32* | 75.91** |
| C34 | #B | -18.16 | -39.01* | 3.99 | 2.21** | 25.99 |
| | #A | -16.00 | -34.14* | -0.37 | 15.53** | 26.95 |
| C35 | #B | -20.15*** | -36.50*** | 2.28 | 19.14 | 16.37 |
| | #A | -7.01*** | -25.61*** | 4.52 | 22.80 | 21.26 |
| C36 | #B | -11.42* | -39.36** | -8.94 | 8.94* | 17.61** |
| | #A | 0.85* | -32.30** | -4.45 | 20.38* | 39.82** |
| C38 | #B | -21.13*** | -40.08*** | -5.97* | 11.25** | 32.45 |
| | #A | -3.40*** | -30.78*** | 0.43* | 23.53** | 41.77 |
| C39 | #B | -17.33*** | -33.26*** | 14.00* | 12.74* | 4.39* |
| | #A | -8.78*** | -23.43*** | 22.78* | 20.81* | 11.01* |

p*<0.05, p**≤0.01, p***≤0.001; Source: Author's calculation

As shown in Table 13, there are eight industry sectors in 2017, 2018 and 2020 respectively, which having significant stock return rate variances between patent groups #A and #B. Meanwhile, the A-shares in the patent group #A of any industry sector which having significant stock return rate variance, show higher stock return mean than the A-shares in the patent group #B.

In 2019 and 2021, there are three industry sectors respectively having significant stock return rate variances between patent groups #A and #B. Meanwhile, the A-shares in the patent group #A of any industry sector which having significant stock return rate variance, show higher stock return mean than the A-shares in the patent group #B.

To sum up, the invention grant's patent count is well capable of differentiating A-share's stock return rate for the industry sector C39 (manufacturing of computer, communication & other electrical devices). The A-shares in different patent groups show significantly different stock return rate means in all five years from 2017 to 2021.The A-shares in the patent groups #A show higher stock return rate means.

The invention grant's patent count is preferably capable of differentiating A-share's stock return rate for the industry sectors C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment). The A-shares in different patent groups show significantly different stock return rate means in four years from

2017 to 2021. The A-shares in the patent groups #A show higher stock return rate means in the significant years.

The invention grant's patent count is fairly capable of differentiating A-share's stock return rate for the industry sectors C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion). The A-shares in different patent groups show significantly different stock return rate means in three years from 2017 to 2021. The A-shares in the patent groups #A show higher stock return rate means in the significant years.

The invention grant's patent count is partially capable of differentiating A-share's stock return rate for the industry sectors C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C34 (manufacturing of general equipment) and C35 (manufacturing of dedicated equipment). The A-shares in different patent groups show significantly different stock return rate means in two years from 2017 to 2021. The A-shares in the patent groups #A show higher stock return rate means in the significant years.

## 4. Conclusion

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

The population was the China A-shares listed in either of Shanghai and Shenzhen stock exchanges whereas Chinese companies listed overseas were excluded. Any effective sample was the A-share being categorized by the securities supervision commission to one of top ten manufacturing industry sectors and having an annual stock return rate with at least one new China invention grant patent issued over previous one year by the end of any quarter from 2017Q1 to 2021Q4. The foreign patents other than China patent were excluded. The invention grant's patent count was defined as the quantity of all invention grants issued over previous one year of an A-share. According to the median of invention grant's patent counts, all effective sample A-shares in each quarter and in each manufacturing industry sector were divided into two patent groups of the higher and the lower patent counts: #A and #B. The following conclusions were arrived:

(1) Among top ten manufacturing industry sectors, there was only one industry sector C39 (manufacturing of computer, communication & other electrical devices) in which the invention grant's patent count invention grant's was well capable of differentiating A-share's stock return rate, because the stock return rate variances between patent groups #A and #B were of significance in all five years from 2017 to 2021. The A-shares in patent groups #A showed higher stock return rate means in all five years.

(2) There were two industry sectors including C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment) in which the invention

grant's patent count was preferably capable of differentiating A-share's stock return rate, because the stock return rate variances between patent groups #A and #B were of significance in four years from 2017 to 2021. The A-shares in patent groups #A showed higher stock return rate means in these significant years.

(3) There were three industry sectors including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion) in which the invention grant's patent count was fairly capable of differentiating A-share's stock return rate, because the stock return rate variances between patent groups #A and #B were of significance in three years from 2017 to 2021. The A-shares in patent groups #A showed higher stock return rate means in the significant years.

(4) There were four industry sectors including C29 (manufacturing of rubber & plastic products), C30 (manufacturing of non-metallic minerals & products), C34 (manufacturing of general equipment) and C35 (manufacturing of dedicated equipment), in which the invention grant's patent count was partially capable of differentiating A-share's stock return rate, because the stock return rate variances between patent groups #A and #B were of significance in two years from 2017 to 2021. The A-shares in patent groups #A showed higher stock return rate means in the significant years.

(5) There were five manufacturing industry sectors showing significant invention grant's patent count variances between five years and the invention grant's patent count significantly increased since 2017, including C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy), C30 (manufacturing of non-metallic minerals & products), C32 (nonferrous metal smelting, plating & extrusion) and C39 (manufacturing of computer, communication & other electrical devices). Since the industry sector C39 (manufacturing of computer, communication & other electrical devices) showed the well capability of differentiating the stock return rate by the invention grant's patent count, while C26 (manufacturing of chemical materials & products), C27 (medical industry & pharmacy) and C32 (nonferrous metal smelting, plating & extrusion) showed the fare capability of differentiating the stock return rate, the significantly increasing invention grant's patent counts showed higher relevance to the capability of differentiating the stock return rate.

(6) There were three industry sectors were verified to have significantly higher patent count means, wherein, C39 (manufacturing of computer, communication & other electrical devices) showed the well capability of differentiating the stock return rate of invention grants, while C36 (automotive manufacturing) and C38 (manufacturing of electrical machinery & equipment) showed the preferable capability of differentiating A-share's stock return rate. The manufacturing industry sectors of higher patent count means showed higher relevance to the capability of differentiating the stock return rate by invention grant's patent count.

(7) According to the cross comparisons of the manufacturing industry sector's stock return rate means and the the invention grant's capability of differentiating stock return rate, the higher/lower stock return rate means did not show relevance to the

invention grant's capability of differentiating the stock return rate. Every manufacturing industry sector had its particularity. The industry difference was distinct.

Via the data of China A-shares in top ten manufacturing industry sectors, this research showed that different manufacturing industry sectors showed different characteristics including the quantity of invention grant's patent counts, the varying trend of invention grant's patent counts, and the the invention grant's capability of differentiating A-share's stock return rate. The industry difference was strongly suggested to take into consideration when using any patent indicators. The finding of this research would help financial organizations improve their investment strategy by finding the proper manufacturing industry sectors in which the invention grant's patent count was well, preferably or fairly capable of differentiating the stock return rate and selecting the the proper stocks from the patent group which showing the significantly higher stock return rate mean. Since the stock return rate was a straight-forward indicator for evaluating listed companies, the finding of this research would also contribute the state of art in evaluating Chinese listed companies. The related researchers interested in this topic might apply the methodology to explore the industry differences on other patent indicators or other applications that patent indicators would contribute.

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