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INDICATORS FOR PATENT CLASSIFICATION VIA DATA MINING FROM INVALIDATION REEXAMINATION DECISIONS OF CHINA UTILITY MODEL PATENTS

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Abstract

Based on 19,082 invalidation reexamination decisions of China utility model patents of decision dates from 2000 to 2021, the effect and value of ten indicators for classifying excellent/strong patents which fully/partly survived from invalidation reexaminations and weak patents that failed in invalidation reexaminations was analyzed via ANOVA. Three high-value indicators for classification, including claim terms, first claim words, and abstract words, were found, while five fair-value indicators for classification, including IPC codes, claim total words, figures, description words, and examination duration, were found. This research agreed on the importance of claim because claim terms and first claim words were both high value indicators while claim total words were a fair value indicator. Though patent attorneys usually underestimate the importance of the abstract, this research found abstract words were a high-value indicator; excellent patents showed the significantly highest mean, while weak patents showed the significantly lowest mean. Meanwhile, the strong patents were provided with the significantly longest examination duration. The finding would contribute to the state of the art in evaluating China utility model patents and help patent owners improve their patent asset management strategy.

Keywords: *Patent; ANOVA; Utility Model; Reexamination; Invalidation.*
JEL Codes: *C38, C46, G11, G12*

Introduction

Intellectual property plays a more important role in investing in new ventures worldwide. Works published in the last two decades show the evolution in the preference

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of factors with the focus shifting from the venture's team and product to factors such as patents, economic crisis, and social capital (Vazirani & Bhattacharjee, 2021). Patents are the most important outcome of innovation. China, showing outstanding technology capability, has been the world's largest domestic patent application country for many years. China Intellectual Property Administration (CNIPA) is now the world's largest patent office. By the end of 2022, CNIPA had more than 23 million accumulated grant patents.

With such a huge amount of China patents, Li (2012) found that Chinese patent subsidy programs induced an increase in patent propensity, and the patent grant ratio increased after the implementation of subsidy programs. Dang and Motohashi (2015) proposed that China's patent statistics are meaningful indicators because China's valid patent count is correlated with R&D input and financial output.

When quantity is achieved, quality becomes more important. Finding an indicator capable for identifying good patents, high quality patents, valuable patents, or strong patents has been a critical issue. Boeing and Mueller (2019) proposed a patent quality index based on internationally comparable citation data from international search reports (ISR) to consider foreign, domestic, and self-citations. They found that all three citation types may be used as economic indicators if policy distortion is not a concern.

Tsai et al. (2021a) defined the technology variety by the number of International Patent Classifications and found that the Chinese A-shares having patents of the higher technology variety showed higher stock return rates. Tsai et al. (2021b) found that Chinese A-shares with invention grant patents with longer examination duration showed higher stock return rates. Tsai et al. (2021c) found that Chinese A-shares of higher patent backward citations showed higher stock price means than the A-shares of lower patent backward citations. Chen et al. (2022) found that Chinese A-shares in the highest total drawing count groups of invention grant patents showed significantly higher stock return rates. Chen et al. (2022) further found that Chinese A-shares in the highest total drawing count groups of utility model patents also showed significantly higher stock return rates.

The patent invalidation reexamination database is an important, valuable patent source. Patent invalidation reexamination is a challenge to the legality of granted patents aimed at correcting possible erroneous patent issuing. Any entity or individual who believes a granted patent does not meet the issuing conditions may request the patent reexamination department to declare the patent invalid. This ensures the accuracy and fairness of the patent system and maintains fair market competition. The patents involved in invalidation reexamination could be regarded as high-value patents because patent invalidation reexamination events are usually accompanied by patent infringement

lawsuits that impact commercial merits. Galasso and Schankerman (2015), based on patent litigation at the U.S. Court of Appeals for the Federal Circuit, found that patent invalidation caused the patent holder to reduce subsequent patenting, and the impact was large for small and medium-sized firms. Han et al. (2021) outlined a framework for mining industry-level R&D trends from patents of patent applications and invalidated patents, then proposed a richer and more comprehensive analysis covering the entire lifespan.

However, the characteristics of indicators of China patents involved in invalidation reexamination are not yet discussed, especially the indicator variance between excellent and strong patents that fully/partly survived the invalidation reexaminations and weak patents that failed. Therefore, this research aims to explore the characteristics.

The managerial implication of this research comprises:

(1) enriching the understanding of China patents involved in invalidation reexaminations, especially for China utility model patents, which occupying most of the China patents;

(2) developing criteria for classifying excellent patents, strong patents, and weak patents based on invalidation re-examined utility model patents; and

(3) helping patent owners improve their patent asset management strategy.

In the following paragraphs, section 2 presents the data and methodology, including the delimitation and limitation, population and sample, the patent indicators defined and analyzed, and the principal of analysis of variance (ANOVA); section 3 presents the result and finding; section 4 presents the conclusion.

Data and Methodology

Delimitation and Limitation

The objective of this research is to explore the valuable indicators from the invalidation reexamination decisions of China utility model patents in the database of the reexamination and invalidation department of the China Intellectual Property Administration (CNIPA). Therefore, only China patents that received the final invalidation reexamination decisions are discussed.

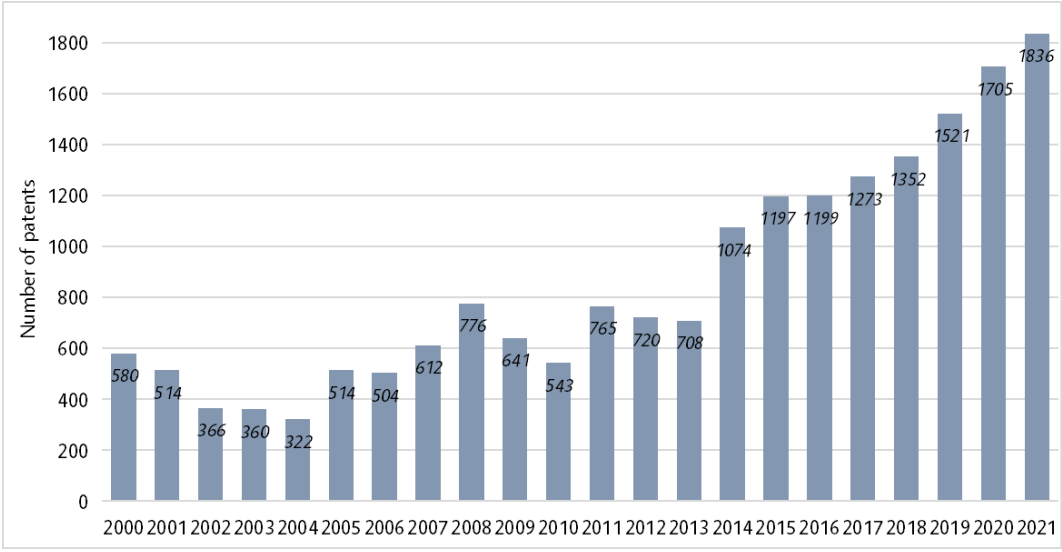
There are three patent species in China's patent system: the invention, the utility model, and the design. The design is a design application of a product that is issued by overcoming the preliminary examination by having a distinct configuration, distinct surface ornamentation, or both. The utility model is a utility model application of a product issued by overcoming the preliminary examination. The invention grant is an issued invention application that is overcoming not only the preliminary examination but

also the substantial examination by having novel and distinct technical features over the prior arts. Though the invention grant in China is always regarded as the most valuable patent species, the utility model occupies most of all China patents and is highly related to livelihood and traditional industries. It is, therefore, only the utility model patent is discussed in this research.

Population and Sample

The population is the China utility model patents, which received the final decisions of invalidation reexamination from the reexamination and invalidation department of CNIPA. Considering the patent database integrity, 19,082 samples of China utility model patents are finally collected, of which the final decisions of invalidation reexamination are made in the years from 2000 to 2021. Figure 1 shows the annual statistics of patent counts by the invalidation reexamination decision date from 2000 to 2021, in which the increasing trend apparently occurs from since 2014.

Figure no. 1. Invalidation Reexamined Patent counts from 2000 to 2021



Source: Author's Calculation

Patent Indicator

There are ten quantitative patent indicators that are discussed in this research as below:

(1) Applicants: The indicator of “applicants” is defined as the number of entities who owned the patent application when the patent was issued, no matter whether the

entity is an individual or a company, small or big, domestic or foreign. For example, suppose a patent is filled by three entities, including a company, a university, and an individual. In that case the number of applicants is 3, though the company might have dozens of employees, and the university might have thousands of students and teachers. A patent of higher applicants usually implies a higher level of collaborative Innovation.

(2) Inventors: The inventor is the natural person who substantially contributes to a patent's inventive feature(s). The indicator of "inventors" is defined as the number of inventors whose names shown on the patent certificate. A patent of higher inventors usually implies a higher level of collective intelligence.

(3) IPC codes: The International Patent Classification (IPC), established by the Strasbourg Agreement 1971, provides a hierarchical system of language-independent symbols for classifying invention and utility model patents according to the specific areas of technology to which they pertain. A patent is provided with at least one and usually several IPC codes specified by the examiner. The first IPC of a patent, the principal IPC, indicates the principal technology area to which the patent pertains. The "IPC codes" indicator is defined as the number of IPC codes shown on the issued patent specification. A patent of higher IPC codes implies it pertains to more technology areas.

(4) Claim terms: The patent claim including independent claim terms (sentences) and dependent claim terms (sentences) defines the scope of patent right. The indicator of "claim terms" is defined as the number of claim terms comprised in a patent. A patent of higher claim terms usually implies a more rigorous scope of rights.

(5) First claim words: Claim 1 is the first claim term of a patent to represent the broadest scope of right. The "first claim words" indicator is defined as the number of total words in claim 1 of a patent, wherein, the unit for calculation is word. A patent of fewer first claim words usually implies having fewer specific features in claim 1, resulting in the broader scope of the right.

(6) Claim total words: The "claim total words" is defined as the number of total words comprised in all claim terms of a patent's claim part, wherein, the unit for calculation is thousand words. A patent of higher claim total words usually implies having more specific features in claim terms, resulting in a narrower scope of rights.

(7) Figures: The indicator of "figures" is defined as the number of figures comprised in a patent specification. According to the patent examination criteria, the figures and the description must support the embodiment and/or inventive features. A patent with higher figures usually implies having more embodiments or inventive features.

(8) Description words: The description provides a detailed illustration of inventive features and the resulting functions. The "description words" indicator is defined as the

number of words in a patent's description part. At the same time, the abstract and the claim are excluded, wherein the unit for calculation is a thousand words. A patent of higher description words usually implies having more embodiments and inventive features.

(9) Abstract words: The abstract is a clear and concise statement of a patent's technical disclosure. The "abstract words" indicator is the number of words comprised in a patent's abstract. However, the value of the abstract is barely discussed.

(10) Examination duration: A China utility patent is issued when it successfully passes the preliminary examination. The indicator of "examination duration" is defined as the time spent from the filing date to the issue date for simplification, wherein, the unit for calculation is month.

Patent Group

In invalidation reexamination decisions, there are three types of claim validation decisions: all claims maintaining valid, claims partly remaining valid, and all claims invalid. Therefore, three patent groups are defined in this research as below:

Group #E: The patents of which the invalidation reexamination decisions show that all claims remain valid. This group, consisting of excellent patents that fully survived from the invalidation reexamination procedure, is regarded as the excellent patent group.

Group #S: The patents of which the invalidation reexamination decisions show that claims remain partly valid and partly invalid. This group, consisting of strong patents, though they partly survived the invalidation reexamination procedure, is regarded as the strong patent group.

Group #W: The patents of which the invalidation reexamination decisions show that all claims are invalid. This group, consisting of weak patents which failed in the invalidation reexamination procedure, is regarded as the weak patent group.

Analysis of Variance

Analysis of Variance (ANOVA) is applied in this research to explore the following:

Is the variance of indicators between patent groups #E, #S, and #W significantly different? If yes, such an indicator is regarded as a valuable indicator for classifying excellent patents, strong patents, and weak patents.

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

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

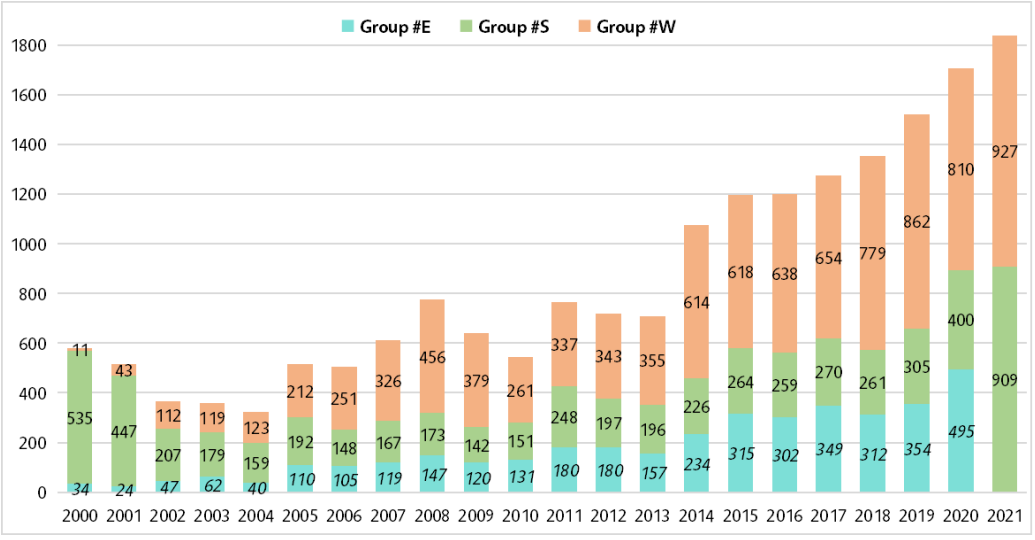
This F-ratio shows the difference between the within-group variance and the between-group variance, ultimately producing a result that allows a conclusion that the null hypothesis H_0: $\mu_1 = \mu_2 = ... = \mu_k$ is supported or rejected. If there is a significant difference between the groups, the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

Result and Finding

In 19,082 patent samples, the excellent patent group #E comprises 3,817 patents, the strong patent group #S comprises 6,035 patents while the weak patent group #W comprises 9,230 patents.

Figure 2 shows the annual statistics of patent counts in three patent groups by the invalidation reexamination decision date from 2000 to 2021. Though the patent counts do not steadily increase year by year, the increasing trend has apparently been shown since 2014.

Figure no. 2. Invalidation Reexamined Patent counts in Three groups from 2000 to 2021



Source: Author's Calculation

Table no. 1 shows the descriptive statistics of ten indicators of three patent groups. The strong patent group #S shows higher means of six indicators, including applicants, claim terms, claim total words, figures, description words, and examination duration. The excellent patent group #E shows higher means of three indicators, including inventors,

first claim words, and abstract words. The weak patent group #W shows higher means of only one indicator, i.e., IPC codes.

Table no. 1. Descriptive statistics of indicators of patent groups

Indicator	Group	Mean	Standard deviation	Standard error
Applicants	#W	1.072	0.324	0.003
	#S	1.082	0.344	0.004
	#E	1.076	0.340	0.006
	Total	1.076	0.334	0.002
Inventors	#W	1.854	1.692	0.018
	#S	1.835	1.597	0.021
	#E	1.889	1.636	0.026
	Total	1.855	1.651	0.012
IPC codes	#W	1.811	1.126	0.012
	#S	1.721	1.092	0.014
	#E	1.800	1.091	0.018
	Total	1.780	1.109	0.008
Claim terms	#W	5.662	4.569	0.048
	#S	6.082	4.877	0.063
	#E	5.848	3.679	0.060
	Total	5.832	4.512	0.033
First claim words	#W	189.548	177.729	1.850
	#S	209.457	172.805	2.224
	#E	227.232	173.317	2.805
	Total	203.383	175.917	1.273
Claim total words	#W	0.636	0.484	0.005
	#S	0.778	0.615	0.008
	#E	0.764	0.541	0.009
	Total	0.707	0.544	0.004
Figures	#W	3.969	4.304	0.045
	#S	4.643	4.607	0.059
	#E	4.501	4.273	0.069
	Total	4.288	4.407	0.032
Description words	#W	2.882	2.461	0.026
	#S	3.306	2.798	0.036
	#E	3.283	2.509	0.041
	Total	3.096	2.590	0.019
Abstract words	#W	225.738	59.764	0.622

	#S	216.163	61.368	0.790
	#E	237.986	57.208	0.926
	Total	225.160	60.264	0.436
Examination duration	#W	9.331	3.910	0.041
	#S	10.639	4.819	0.062
	#E	9.281	3.914	0.063
	Total	9.734	4.264	0.031

Source: Author's Calculation

By defining the valuable indicator for classification as the indicator of which the variance between patent groups is significant, Table no. 2 shows the valuable and valueless indicators based on the results of ANOVA on ten indicators between three groups. The variances between the three groups are free of significance for two valueless indicators, including applicants and inventors. The variances between the three groups are significant for the other eight indicators, i.e., valuable indicators, including IPC codes, claim terms, first claim words, claim total words, figures, description words, abstract words, and examination duration.

Table no. 2. ANOVA on indicators between patent groups

Indicator		**Sum Square**	**Mean Square**	**F**	**p**
Applicants	between groups	0.356	0.178	1.601	0.202
	within groups	2,122.548	0.111		
Inventors	between groups	6.775	3.388	1.242	0.289
	within groups	52,031.442	2.727		
IPC codes	between groups	31.260	15.630	12.720	0.001***
	within groups	23,444.144	1.229		
Claim terms	between groups	645.124	322.562	15.867	0.001***
	within groups	387,860.221	20.329		
First claim words	between groups	4,160,400.546	2,080,200.273	67.689	0.001***
	within groups	586,334,786.535	30,731.945		
Claim total words	between groups	89.175	44.587	152.786	0.001***
	within groups	5,567.798	0.292		
Figures	between groups	1,875.389	937.694	48.517	0.001***
	within groups	368,738.618	19.327		
Description words	between groups	819.247	409.623	61.447	0.001***
	within groups	127,186.698	6.666		
Abstract words	between groups	1,119,533.967	559,766.983	156.648	0.001***

	within groups	68,176,855.129	3,573.398		
Examination duration	between groups	7,221.384	3,610.692	202.773	0.001***
	within groups	339,732.383	17.807		

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

Regarding eight valuable indicators showing significance between three patent groups, Table no. 3 further shows the multiple comparisons of ANOVA on eight indicators between every two different patent groups. The variances between weak patent group #W and strong patent group #S are significant for all eight valuable indicators. The variances between strong patent group #S and excellent patent group #E are of significance for five valuable indicators including IPC codes, claim terms, first claim words, abstract words, and examination duration. The variance between excellent patent group #E and weak patent group #W is significant for six valuable indicators: claim terms, first claim words, claim total words, figures, description words, and abstract words. Therefore, eight valuable indicators are available for classifying patent groups #W and #S, five for classifying patent groups #S and #E, and six are available for classifying patent groups #E and #W.

In addition, there are three valuable indicators, including claim terms, first claim words, and abstract, of which the variances between patent groups #W and #S, the variances between patent groups #S and #E, and the variances between patent groups #E and #W, are respectively of significance. The three valuable indicators are regarded as high-value indicators. There are three valuable indicators, including claim total words, figures, and description words, of which the variances between patent groups #S and #E are respectively free of significance. There are two valuable indicators, including IPC codes and examination duration, of which the variances between groups #E and #W are free of significance. The five valuable indicators are regarded as fair value indicators.

According to the mean differences of significance shown in Table 3, the following are obtained:

(1) The strong patent group #S shows the significantly lowest mean of IPC codes.

(2) The strong patent group #S shows the significantly highest mean of claim terms, while the weak patent group #W shows the significantly lowest mean.

(3) The excellent patent group #E shows the significantly highest mean of first claim words, while the weak patent group #W shows the significantly lowest mean.

(4) The weak patent group #W shows the significantly lowest mean of claim total words.

(5) The weak patent group #W shows the significantly lowest mean of figures.

(6) The weak patent group #W shows the significantly lowest mean of description words.

(7) The excellent patent group #E shows the significantly highest mean of abstract words, while the strong patent group #S shows the significantly lowest mean.

(8) The strong patent group #S shows the significantly highest mean of examination duration.

Table no. 3. Multiple Comparisons of ANOVA on Valuable Indicators

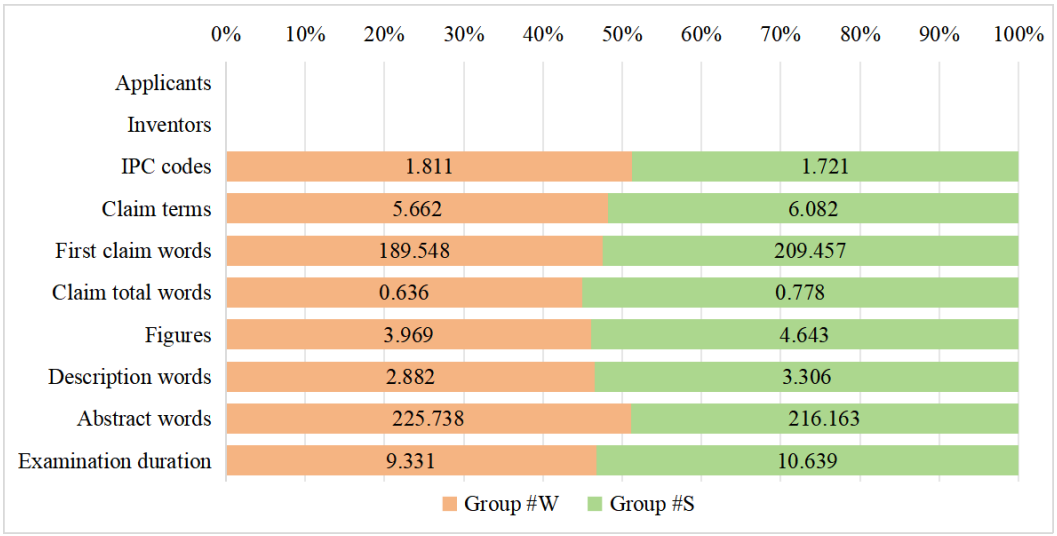
	(I) Group	(J) Group	Mean difference (I-J)	Standard deviation	p
IPC codes	#W	#S	0.090	0.018	0.001***
	#S	#E	-0.079	0.023	0.001***
	#E	#W	-0.011	0.021	0.596
Claim terms	#W	#S	-0.420	0.075	0.001***
	#S	#E	0.233	0.093	0.012*
	#E	#W	0.187	0.087	0.031*
First claim words	#W	#S	-19.900	2.902	0.001***
	#S	#E	-17.770	3.625	0.001***
	#E	#W	37.684	3.374	0.001***
Claim total words	#W	#S	-0.142	0.009	0.001***
	#S	#E	0.014	0.011	0.216
	#E	#W	0.128	0.010	0.001***
Figures	#W	#S	-0.674	0.073	0.001***
	#S	#E	0.142	0.091	0.119
	#E	#W	0.533	0.085	0.001***
Description words	#W	#S	-0.423	0.043	0.001***
	#S	#E	0.023	0.053	0.667
	#E	#W	0.400	0.050	0.001***
Abstract words	#W	#S	9.575	0.990	0.001***
	#S	#E	-21.820	1.236	0.001***
	#E	#W	12.248	1.150	0.001***
Examination duration	#W	#S	-1.307	0.070	0.001***
	#S	#E	1.357	0.087	0.001***
	#E	#W	-0.049	0.081	0.541

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

Figure no. 3 shows the graphic comparisons of the means of eight valuable indicators for strong patent group #S and weak patent group #W. The patents in strong patent group #S are supposed to have stronger patentability than those in weak patent group #W. However, the strong patent group #S is not provided with a significantly

higher mean of any valuable indicators than weak patent group #W. The strong patent group #S shows a significantly higher mean than the weak patent group #W of any of six valuable indicators, including claim terms, first claim words, claim total words, figures, description words, and examination duration. However, the strong patent group #S shows a significantly lower mean than the weak patent group #W of any of the two valuable indicators, including IPC codes and abstract words.

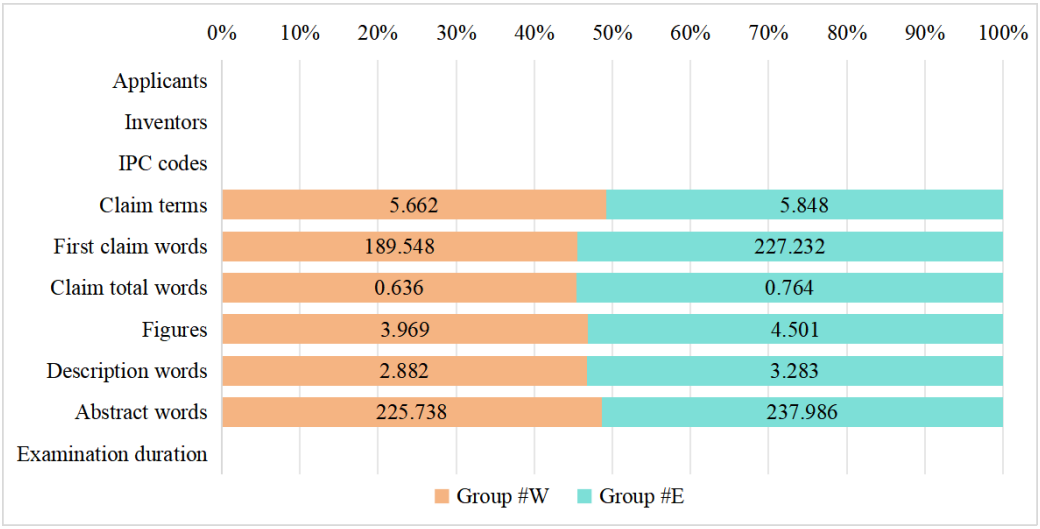
Figure no. 3 Means of significance of patent groups #W and #S



Source: Author's Calculation

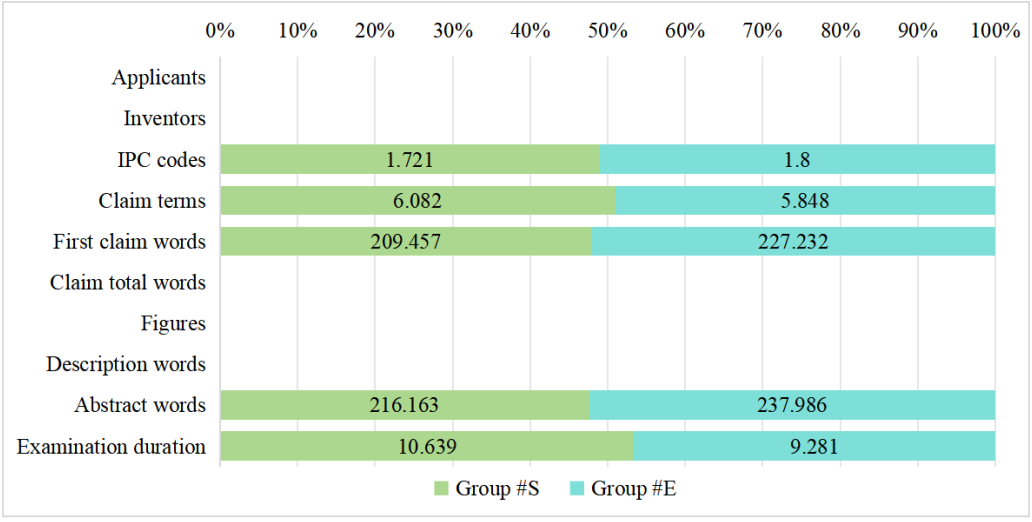
Figure no. 4 shows the graphic comparisons of the means of six valuable indicators for excellent patent group #E and weak patent group #W. The patents in excellent patent group #E are supposed to have stronger patentability than patents in weak patent group #W, as Figure 4 supports. The excellent patent group #E shows a significantly higher mean of any of six valuable indicators than the weak patent group #W.

Figure no. 4. Means of significance of patent groups #W and #E



Source: Author's Calculation

Figure no. 5. Means of significance of patent groups #S and #E



Source: Author's Calculation

Figure no. 5 shows the graphic comparisons of means of five valuable indicators for excellent patent group #E and strong patent group #S. Though patents in excellent patent group #E are supposed to have stronger patentability than patents in strong patent group #S, the excellent patent group #E is not provided with a significantly higher mean of any valuable indicators than strong patent group #S. The excellent patent group #E

shows a significantly higher mean than the strong patent group #S of any of the three valuable indicators, including IPC codes, first claim words, and abstract words. However, the excellent patent group #E shows a significantly lower mean than the strong patent group #S of any of two valuable indicators including claim terms and examination duration.

Conclusion

Based on 19,082 invalidation reexamination decisions of China utility model patents, the effect and value of ten indicators for classifying excellent patents (group #E) in which all claims remain valid, strong patents (group #S) in which claims partly remain valid, and weak patents (group #W) in which all claims invalid, was thoroughly analyzed via ANOVA. Valuable indicators showing variances of significance between patent groups for classification were successfully found.

19,082 invalidation re-examined China utility model patents of invalidation reexamination decision dates from 2000 to 2001 comprising 3,817 excellent patents, 6,035 strong patents, and 9,230 weak patents. Ten indicators comprised of applicants, inventors, IPC codes, claim terms, first claim words, claim total words, figures, description words, abstract words, and examination duration. The following conclusions had arrived:

(1) Eight valuable indicators for classification were found, including IPC codes, claim terms, first claim words, claim total words, figures, description words, abstract words, and examination duration.

(2) Three high-value indicators for classification, including claim terms, first claim words, and abstract words, were regarded as high-value indicators, of which the variances showing significance between patent groups #W and #S, between patent groups #S and #E, and between patent groups #E and #W, respectively.

(3) Five fair value indicators for classification including IPC codes, examination duration, claim total words, figures, and description words, were regarded as fair value indicators. The variances for the former two fair value indicators between patent groups #W and #S, and between patent groups #S and #E, were of significance, respectively; the variances for the latter three fair value indicators between patent groups #W and #S, and between patent groups #E and #W, were of significance respectively

(4) The number of valuable indicators for classifying strong and weak patents, classifying excellent and weak patents, and classifying excellent and strong patents, were 8, 6 and 5 respectively. It would be much easier to classify strong patents and weak

patents because the classification was provided with the largest number of valuable indicators.

(5) In practice, the claim is always regarded as the most important part of a patent to form the scope of the right. This research agreed because claim terms and first claim words were high-value indicators, while claim total words was a fair-value indicator.

(6) For classifying strong and weak patents, the strong patents were provided with significantly higher means for six valuable indicators, whereas the strong patents were provided with significantly lower means for the other two valuable indicators.

(7) For classifying excellent patents and weak patents, the excellent patents were provided with significantly higher means for all six valuable indicators.

(8) For classifying excellent and strong patents, the excellent patents were provided with significantly higher means for three valuable indicators, whereas the excellent patents were provided with significantly lower means for the other two valuable indicators.

(9) Though the abstract is usually regarded as a less important part of a patent-by-patent attorneys, this research found abstract words was a high value indicator for classification. The excellent patents showed the significantly highest mean, while the weak patents showed the significantly lowest mean.

(10) The required patentability test for China utility model patent is the preliminary examination, which involves the novelty test but regardless of the no obviousness test. The novelty test is objective, and the resulting time spent is short. However, it was interesting to find in this research that the strong utility model patents were provided with the significantly most extended examination duration.

Since the invalidation re-examined patents have already been recognized as the high-value patents, the finding of this research proposed an approach for systematically testing the indicators for classifying excellent, strong, and weak patents among high-value utility model patents. The approach is workable on China utility model patents and applies to other China patent species, foreign patents, and patents in different technologies. The finding will contribute to the state of the art in evaluating patents and help patent applicants and owners improve their patent asset management strategy.

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