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The logical evolution of internet governance policy in China from 1994-2017: A computational textual analysis approach

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The logical evolution of internet governance policy in China from 1994-2017: A computational textual analysis approach

Abstract: As China government gives full play to the role of digital technology in driving and leading the development of economy and society, policy issues on China internet governance have gained wide attractions from academics and practitioners. Grounded on a unique textual dataset collected from China official law and regulation database with over 300 central and local government laws and regulations on internet governance released during the period of 1994 and 2017, this study investigates the evolutionary characteristics of the policy central topics, policy subjective and policy orientation in the timeframe of 1994 to 2017. This paper contributes to the existing knowledge accumulation not only in its uncovering of the evolutionary logic hidden in the large swaths of policy text but also by introducing a computational text analysis approach to facilitate the text oriented policy evaluation.

Keywords: Internet governance; regulation policy; China, Topic modeling;

1 Introduction

Past two decades witnessed the gradually improved network infrastructure, the steady rising of internet penetration as well as the fast-booming internet companies in China. As China government gives full play to the role of digital technology in driving and leading the development of economy and society, policy issues on China internet governance have gained wide attractions from academics and practitioners. While prior literatures examined the internet governance in China from the technical, institutional and the official media discourse perspective, limited research explore the evolutionary logic of internet policies and regulations for the past 20 years using computational textual analysis approaches.

Grounded on a unique textual dataset collected from China official law and regulation database (public accessible at www.chinalaw.gov.cn) with 305 central and local government

policies and regulations on internet governance released during the period of 1994 and 2017, this paper aims at answering the following questions: (1) what are the key topics and trends which can be identified from the 20 years of corpus of policy texts within internet governance? (2) How to quantify the various regulation authorities' attitude toward the internet governance over a 20-year period?

this study investigates the evolutionary characteristics of the policy central topics, policy subjective and policy orientation in the timeframe of 1994 to 2017 from the government issued policy texts. Specifically, a novel covariate based probabilistic topic modelling method has been applied to discover how policy coverage of China's internet governance varies over the specified timeframe and by central and local government authorities. The results suggest that (1) in line with the technological change, there are three stages of internet governance in China characterized as network access regulation phase(1994-1999) , domain-specific application regulation phase(2000-2009) and industry regulation phase(2010-present),respectively.(2) although divided regulation policies released from various departments dominated over the past 20 years, a cooperative social governance structure has become a trend since the third sector, as an important policy stakeholder, can realize public policies transformation from "endogenous and passive" type to "external and proactive" one. (3) a shift from network security and website content regulation to cyber security and cyberspace regulation has always been the focus of Internet governance in China.

This paper contributes to the existing knowledge accumulation in several ways: First, it enhances our understanding of the evolutionary logic hidden in the large swaths of policy text and the variation in how the different department within China central and local authorities address the internet governance in the different period of time. Second, it introduces a computerized text analysis which incorporates the observable document level metadata, i.e., released time, data sources, document type etc. to measure how of these metadata impact the thematic meaning and content of the policy text. This type of analysis can be extended and validated to accommodate more research scenarios, especially in the textual policy evaluation field. A discussion of the capabilities computational text analysis methods offer ICT policy researchers are also concluded in the paper.。

The rest of paper is structured as follows: Section 2 first reviews related researches on

network governance and internet regulation in China. Furthermore, research gaps and focuses are addressed. Following that, in section 3, a computational text mining approach titled document covariate-based topic modeling is introduced together with detailed implementation procedures. Section 4 delineates the data analysis results and discussions. In addition, the theoretical contributions and practical implications are also presented. Finally, conclusions as well as limitations are drawn to guide the future research directions.

2 Internet governances: a policy review

Internet 。

2.1 Theories on internet governance

2.2 Researches on internet governance in China

As shown in prior works, there is a dearth of systematic review of the regulation policies. Moreover, most researches were conducted using manual content analysis and case approaches, which were time consuming and subject to personal bias. There is a growing awareness of using computational text analysis over hand coding to improve the speed and quality to process high volumes of policy texts. To achieve the research objectives proposed in section 1, a novel covariate topic modeling approach are introduced to uncover regulation variance from massive collection of policy texts on Internet Regulation (IG).

3 Research design and methodology

To structure and clarify our research design, the analysis procedure is illustrated in Figure 1 and further delineated in the ensuing subsections.

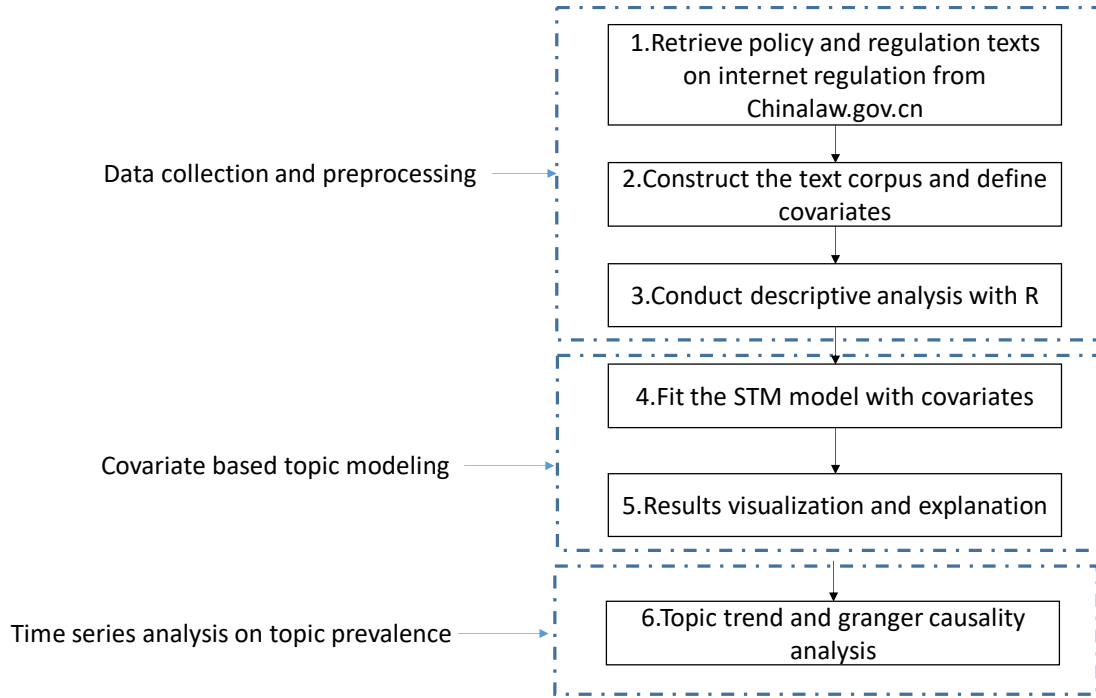


Figure 1 Research procedure of this study

3.1 Data collection and preprocessing (steps 1-3)

Since previous studies pointed out that the policies and regulations in China are issued by different level of authorities, to construct a dataset of IG policies as comprehensive and rigorous as possible, we conducted three rounds of data refining that we can approach. In the first round, we consulted with experienced subject experts from the China Academy of Information and Communications Technology (hereinafter referred to as “CAICT”) to find the candidate data sources. We used “internet regulation”, “network administration”, “ISP regulation” and “content regulation” as the keywords to search the 10 prestigious literature databases frequently used in China, including CNKI, WANFANG, and Chinalaw. After comparison, we decide to choose website **Chinalaw.gov.cn** as our data source for the following reason. The website is built by the Legislative Affairs Office of the State Council of China (LAOSCC) which is the central legal

authority and provides online access to the largest database which includes 63544 laws and regulations with full texts issued by central and local authorities for the past 50 years. In contrast with other databases, it is generally viewed as the most authoritative, comprehensive and reliable data source to retrieve the IG related laws and regulations.

In the second round, we retrieved 1100 records

The collected laws and regulations text was constructed into corpus which contains text and corresponding covariates (issue date, issue level: central government or local government). We use the whole texts of each policy as the unit of analysis since structural topic modeling allows for the mixture membership of topics in a policy and can identify dominant topics that the policy belong to. As elaborated in Section 3, this unique feature of the approach also enables the meaningful analysis on which policy best represents each aspect of IG.

Descriptive analysis on the dataset were conducted using R programming. Unlike English texts, Chinese texts are not naturally split by the spaces between words, we need to conduct word segmentation during the text preprocessing stage. As suggested by previous studies, we executed word segmentation using R package JiebaR to split Chinese character into meaningful word token. Meanwhile, some meaningless words, like “of”(“的”), “and”(“和”) and “etc.”(“等”). In order to improve the success rate of domain keyword identification, we attached several dictionaries, which include professional terms on “internet service”, “network administration” and “policy and regulation” from Sogou.com¹ to JiebaR. Furthermore, we constructed the document-term matrix (DTM) where DTM_{ij} denotes the word frequency of term i in document (policy text) j . Using DTM, we can conduct keyword frequency analysis to explore the text copra structure.

3.2 Policy text mining using Structural topic model (steps 4)

¹ <https://pinyin.sogou.com/dict/detail/index/15128>

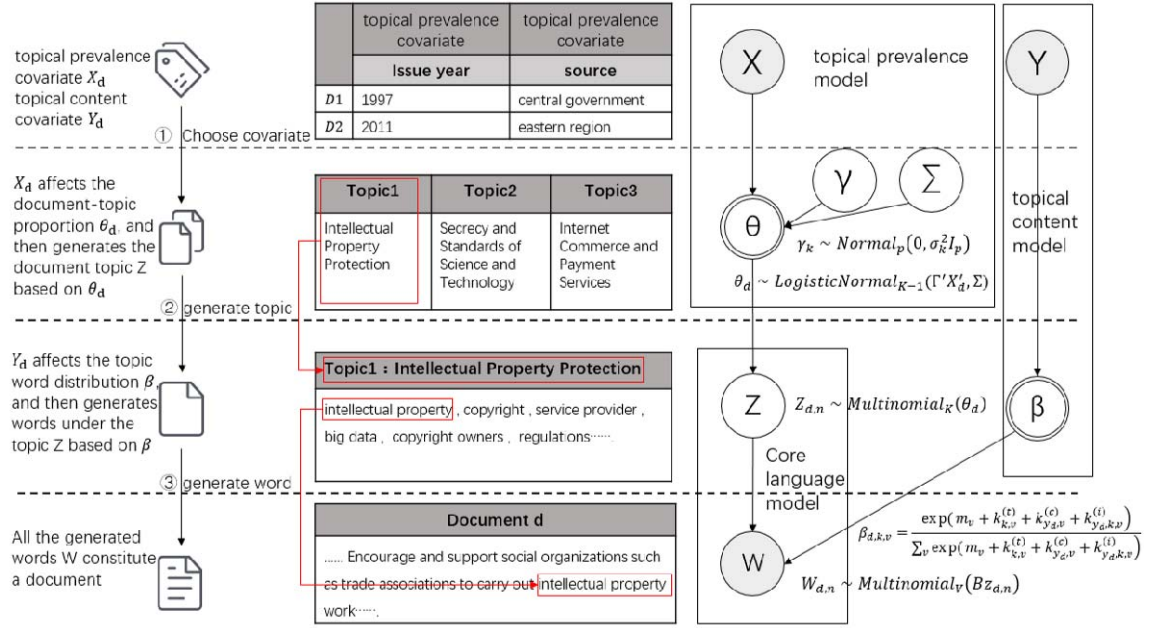


Figure 2 Heuristic description of generative process of the STM

3.3 Time-series analysis on policy topic prevalence (step5-6)

The prevalence of each topic in each year can be calculated as the proportion of words, corresponding to that topic, in the policies issued in that year (Steyvers and Smyth, 2004). Based on the STM fitting results, we can derive the topic prevalence data in each year and analyze the topic trend by time-series analysis. Since one of our research objective aims at analyzing the time series data of topic prevalence and the number of Internet users to explore how the regulatory concerns on specific aspects influence and are influenced by the growth of internet users, we need a method to assess such effect. In the following, we introduce the Granger causality test, a well-known econometric test useful when causality is the object of interest.

Granger causality entails the statistical notion of causality based on the relative forecast power of two time series. Time series j is said to “Granger-cause” time series i if past values of j contain information that helps in predicting i above and beyond the information contained in past values of i alone. The mathematical formulation of this test is based on linear regressions of X_{t+1} on X_t and Y_t . In our research scenario, we propose to calculate the Granger causality test on pairs of times series defined as follows:

1. If $\{X_{t-i}\}_{i=1}^k$ have significant effects on Y_t , while in turn $\{Y_{t-i}\}_{i=1}^k$ do not significantly influence X_t , then X is the Granger cause of Y and vice versa.

2. If $\{X_{t-i}\}_{i=1}^k$ have significant effects on Y_t , and $\{Y_{t-i}\}_{i=1}^k$ also significantly influence X_t , then X and Y are the Granger cause of each other.

3. If both the effects of $\{X_{t-i}\}_{i=1}^k$ on Y_t and the effects of $\{Y_{t-i}\}_{i=1}^k$ on X_t are insignificant, then there is no causal relationship between X and Y .

4 Results and discussions

4.1 Descriptive analysis on IG related policies in China

After preprocessing the text corpus and associated covariates (issue date and issue level), we first get a whole picture of the dataset. 88 out of 305 policies and regulations are released by central government while others are issued by local governments during the period of 1994 to 2017. Left panel of figure 1 visualizes the distribution of policies and regulations across the 31 provinces or municipalities in mainland China. It can be shown in the figure 1 that top 5 internet related policies and regulations are issued from Liaoning (23), Guangdong (21), Zhejiang (15), Shandong (12) and Anhui (10), suggesting more policies on IG are from east part of China. In addition, the Person correlation (0.56 with significant level $p < 0.01$) between the number of policies and the number of internet users in the correspondent province/municipalities further reveals that provinces with more internet users also tend to release more policies and regulations on IG.

Moreover, the right panel of figure 1 shows the total number of policies on IG as well as the internet users in mainland China over the past 20 years. In contrast with the sharp increase in the number of internet users especially in the recent 10 years, there has been a concurrent growth of policies since 2011, reflecting the growing awareness on the importance of internet regulation from different level of governments.

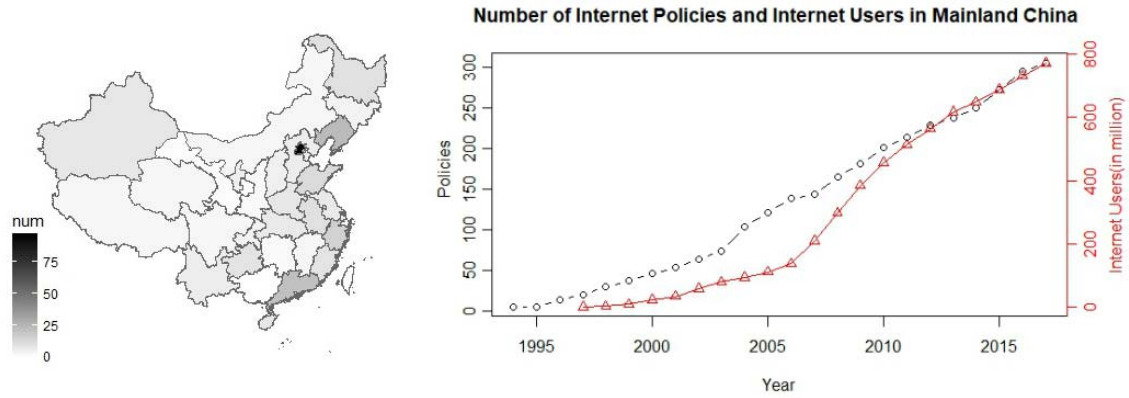


Figure 3. Distribution and growth of policies on IG in mainland China (1994-2017)

After transforming the policy texts corpora into document-term matrix, the keywords with the highest frequency can be extracted using tf-idf algorithm and visualized by a word cloud. Figure 3 illustrates the 100 most frequent keywords in the 14 years span of the text corpus. As shown in figure 3, keywords or phrases like “computer information”, “government”, “informatization”, “information opening”, “culture”, “operator”, “system security”, “information system engineering” and “public security” are the most frequently emerged terms in policies on IG.



Figure 4. Word cloud of top100 keywords in IG policies. Left panel shows original Chinese results while right panel displays correspondent English translations

4.2 Key aspect of governance issues

As mentioned earlier, two diagnostic methods are used to guide validation in selecting the optimal number of topics for the fitting of STM model. First, a quantitative measure known as perplexity scores with 5-30 topics were calculated to find the candidate topic number. As shown in figure 4, the standardized log likelihood value of the models with 9-12 topics are similar, indicating that models in this range need further evaluated by their interpretability.

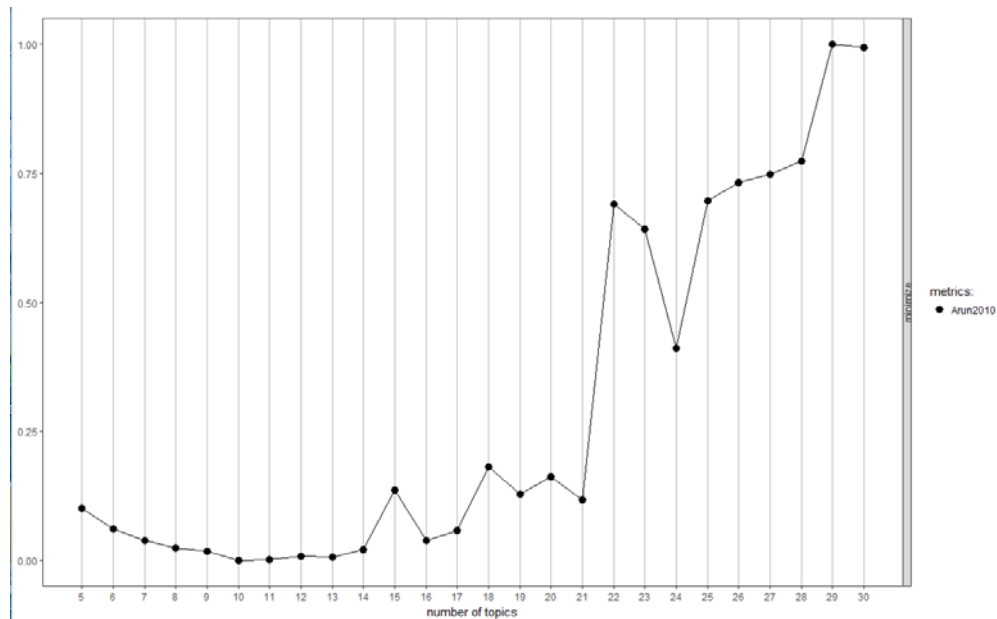


Figure 5. Plot of perplexity score results for 5-30 topic numbers. Dots represent topic specific scores

We further ran STM algorithm using stm package in R to calculate a combination of semantic coherence and exclusivity of words to topics to compare topic quality for different topic numbers. As shown in figure 5, the value of semantic coherence of choosing topic number 9 is greater than topic number 10 and 11, suggesting the 9-topic model has strong semantic consistency than the other two candidates.

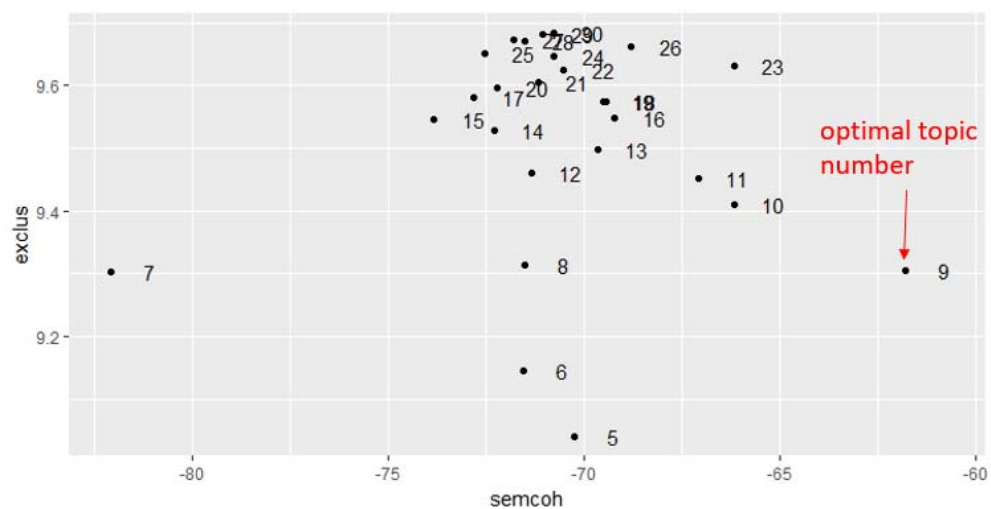


Figure 6. Plot of semantic and exclusivity score results for 5-30 topic numbers.

To determine the semantic meaning of 9 identified topics, we conduct two rounds of semantic test to see the semantic coherence of each topics and the words unique to the specific topics. First, we checked whether the top keywords coincide with the representative policy texts which automatically generated by the fitting model. Second, we checked if the topic distribution in policy texts is consistent with the content of the texts. By reading it manually, we found that the original policy text is mainly about administration of computer system security which largely coincide with topic 9. The proportion of topics also coincide with the content, which mainly

focuses on the computer security (topic 9) and relates to Secrecy and Standards of Science and Technology (topic 2). Similar approach was also applied to the five most representative original texts of all the 9 topics. The results of the tests indicate strong consistency between the policy text contents and the topic names, albeit some minor inconsistency, based on which we modified the names of the topics. The semantic test suggests that the 9-topic model has sufficient explanatory power to model the intellectual structure of the corpus. After this test and the modification process, the topic names were finally determined as shown in Table 2.

Table 1 Fitting results of the 9-topic model. Note: only top 5 most relevant keywords (in bold) and 3 representative policies (in italic) are displayed

Topic 9 (19.5%) Information System Security		Topic 6 (19.2%) National Informatization Promotion		Topic 7 (18.9%) Open Government Data	
keywords	Prob.	keywords	Prob.	keywords	Prob.
Computer information	0.15	informatization	0.11	information disclosure	0.13
public safety agency	0.07	people's government	0.05	applicant	0.06
system security	0.05	competent authority	0.05	people's government	0.04
computer	0.04	information security	0.03	obligors	0.03
computer virus	0.03	information system	0.03	competent authority	0.02
Regulations	theta	Regulations	theta	Regulations	theta
Regulations of Heilongjiang Province on the Management of the Security of Computer Information Systems	0.9987	Regulations of Guangzhou City on Promotion of Informatization	0.9982	Decision of the Ningbo Municipal People's Government on Amending the Provisions of Ningbo Municipality on Government Information Disclosure	0.9989
Regulations of Shanxi Province on Computer Security	0.9985	Regulations of Guangzhou City on Promotion of Informatization (2015 Revision)	0.9977	Provisions of Haikou Municipality on Government Information Disclosure	0.9988
Regulations of Fuzhou City on the Management of the Security of Computer Information Systems	0.9984	Measures of Jilin City for the Promotion of Informatization	0.9964	Decision of the Liaoning Municipal People's Government on Amending the Provisions of Liaoning Municipality on Government Information Disclosure	0.9985

Topic 4 (10.9%) Internet Access and Audio-video Program Services		Topic 8 (10.6%) Internet Information Service		Topic5 (9.2%) Telecommunication Infrastructures	
keywords	Prob.	keywords	Prob.	keywords	Prob.
internet service bar	0.06	internet	0.12	operators	0.12
administration	0.06	information service	0.06	telecommunications business	0.08
license	0.04	network related vehicles	0.05	management agency	0.03
internet	0.02	taxi	0.03	telecommunication facilities	0.03
cultural market	0.02	drivers	0.03	competent authority	0.03
Regulations	theta	Regulations	theta	Regulations	theta
Regulations of Anhui Province on the Administration of the Culture Market (2006 Revision)	0.9973	Interim detailed Rules of Wuhan City for the Administration of Online Taxi Booking Business Operations and Services	0.9956	Telecommunication Regulations of the People's Republic of China (2014 Revision)	0.9985
Measures of Xining City on the Administration of Business Sites of Internet Access Services	0.9968	The Provisional Regulations Concerning Drug Information Service on Internet	0.9953	Telecommunication Regulations of the People's Republic of China	0.9982
Regulations of Tibet Autonomous Region on the Administration of the Culture Market (2009 Revision)	0.9967	Interim Measures of Qingdao City for the Administration of Online Taxi Booking Business Operations and Services	0.9944	Telecommunication Regulations of the People's Republic of China (2016 Revision)	0.9980
Topic 2 (5.5%) Secrecy and Standards of Science and Technology		Topic 1 (3.7%) Intellectual Property Protection		Topic3 (2.5%) Internet Commerce and Payment Services	
Keywords	Prob.	keywords	Prob.	keywords	Prob.
state secrets	0.12	intellectual property	0.13	e-commerce	0.10
science and technology	0.04	copyright	0.05	internet banking	0.08
standardization	0.03	service provider	0.03	financial institutions	0.06
confidentiality	0.03	big data	0.03	agency	0.03
competent authorities	0.02	copyright owners	0.03	people's Bank of China	0.03
Regulations	theta	Regulations	theta	Regulations	theta
Regulations on secrecy	0.9915	Regulations on	0.9987	Measures for the	0.9976

of science and Technology (2015 Revision)		Computers Software Protection (2011 Revision)		Administration of Electronic Banking	
Regulations of Anhui Province on the Implementation of Guarding State Secrets	0.9910	Regulations on Computers Software Protection	0.9980	Measures of Shantou Special Economic Zone for Electronic Commerce Promotion (2016 Revision)	0.9731
Regulations of Liaoning Province on the supervision and management of information technology standardization	0.9874	Regulations of Kunming City on Intellectual Property Promotion and Protection	0.9969	Interim Measures for the Control of Online Banking Operations	0.9549

The 9 topics reflect 9 key aspects of IG concerns by different level of authorities in China during 1994 to 2017. According to Table 2, the proportion of topic # 9 Information System Security, # 6 National Informatization Promotion and #7 Open Government Data are the most predominant themes (57.6% in total), indicating that these key aspects gain most attention in IG related policies. Topic #2 Secrecy and Standards of Science and Technology, #1 Intellectual Property Protection and # 3 Internet Commerce and Payment Services are the least proportion of the policy that governments in different level concerns about. Some aspects aim to regulate telecom infrastructure and network access control and directly influence the behavior of the internet users. Some topics try to respond to the rapidly development of internet applications in online entertainments, e-commerce and content related services. A relative new finding is that national informatization promotion and government data opening are the two key hot topics revealed from the texts of laws and regulations, reflecting Chinese government paying much attention to the transformational role of information and communication technology in driving and leading the development of economy and society. To consider the temporal effect of each identified topics, because STM model allows for the inclusion of correlated topics, we can visualize the prevalence of 9 topics in the 1994-2017 period shown in Figure 7. A further time span analysis of the 9 topics and their correspondent distribution of the numbers of policy document over 24 years are discussed below.

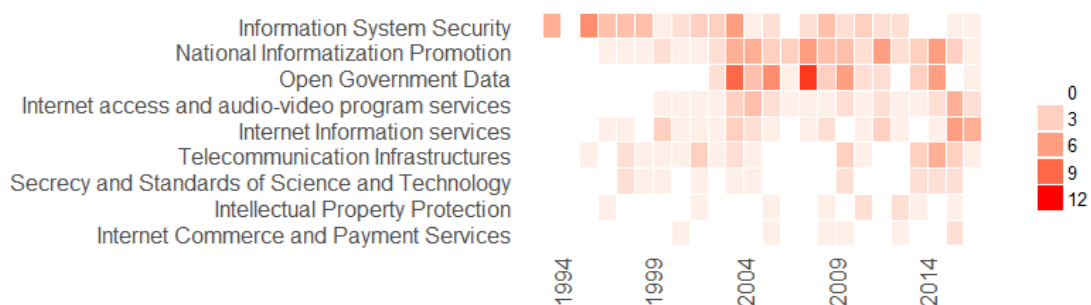


Figure 7. 9 topics and its correspond policy document distribution during 1994 to 2017.

According to the keywords and representative policies in table2 and the 9 key aspects of IG and their distribution over the timespan, some discussions in detail are as follows:

1. Topic 9 (19.5%) - Information System Security clarifies the security administration on the computer information systems and internet securities. As shown in Fig. 7, laws and regulations on this topic are prevalence during the period of 1994 to 2004, and the numbers are gradually decline after 2010. As Chinese government believes that the Internet is an important infrastructure facility for the nation. Within Chinese territory the Internet is under the jurisdiction of Chinese sovereignty. These important rules are included in laws and regulations in the early internet development, including the Decision of the National People's Congress Standing Committee on Guarding Internet Security, Law on Punishments in Public Order and Security Administration, Regulations on Telecommunications, Regulations on the Protection of Computer Information System Security Measures on the Administration of Internet Information Services and Measures on the Administration of Security Protection of the International Networking of Computer In-formation Networks.
2. Topic 6 (19.2%) - National Informatization Promotion specifies the endeavors to spur the development and application of the Internet and promoting its extensive use. As Internet in China has increasingly spread its influence into traditional industry, which leads to the emergence of new business models and service economy, generating new types of industries. Chinese government realize that the Internet is playing an increasingly important role in promoting economic restructuring and transforming the pattern of economic development. The representative policies of this topics are all detailed proactive plans aimed at promoting the effects of internet related application as soon as possible. Thus, this aspect reflects Chinese government has been vigorously promoting the development of websites featuring e-commerce and education, giving impetus to the building of e-government, advocating the development of emerging media such as online radio and online television.
3. Topic 7 (18.9%) - Open Government Data involves calling for the data resources owned or controlled by the different level of government should be open to the public. Laws and regulations belong to this category sustained increase during the period of 2001 to 2007 and surprisingly released all by local government until 2008 when central government initialize the regulations on information disclosure of the government of PRC. Thereafter, the central government requires governments at all levels to establish corresponding mechanisms and give prompt explanations to issues of public concern.
4. Topic 4 (10.9%) - Internet Access and Audio-video Program Services specifies network access and culture related service regulations. Online literature, music, radio and television in China have all witnessed rapid development. This aspect of regulation focuses on the prohibited audio or video information filtering and precautions.
5. Topic 8 (10.6%) - Internet Information Service emphasizes on carefully managing the distribution and generating of contents through internet channel. The increasingly expanding cyber culture consumption is encouraging the birth of many new industries and spurring the growth of the business income of information services. Chinese government calls for the provision of varied and rich Internet information services to satisfy the diversified, multi-leveled needs of information consumption.
6. Topic 5 (9.2%) - Telecommunication Infrastructures specifies the internet infrastructure especially network infrastructure regulation concerns. In 1993 the State Economic

Informationization Joint Meeting was initiated to lead the construction of a national network of public economic information. Laws and regulations on this aspect released often during the period of 1994 to 2001 and gradually decreased after 2003.

7. Topic 2 (5.5%) -Secrecy and Standards of Science and Technology involves the proactive regulations to protect the storing, communication and processing of national secrecy information.
8. Topic 1 (3.7%) -Intellectual Property Protection aims to protect the software and internet intellectual property. As shown in fig 7, this aspect of theme has been attracted very limited attention which need to be improve in the near future.
9. Topic3 (2.5%) -Internet Commerce and Payment Services includes regulations to adapt the rapid development of e-commerce services and their gradually formed supporting systems such as digital authentication, e-payment and logistics. Since such kind of service are in shape, the regulations are in development.

4.3 Topic prevalence trend analysis

We also explored the relationship between topic prevalence and the internet users by Granger causality analysis which based on the time series data from 1997-2017 shown in Table 1.

According to the information criteria, all the time lags (k in $\{X_{t-i}\}_{i=1}^k$ and $\{X_{t-i}\}_{i=1}^k$) of the 9 causality test models were determined (as shown in table 2). The F-statistics of 8 tests are listed in Table 2, where the arrows in the first column denote the direction of causality.

According to table 4, The emphases on 2 topics (#3 and # 7) are associated with significant increase in internet users reflecting the regulations on government opening of data is related to .

Table 2 Granger causality test results

Topic #	1	2	3	4	5	6	7	8	9
Log(IU)-> $\text{Log}(\text{Topic}_t)$	2.25	0.45	6.78* 4.53*		0.13	0.41	4.99*	0.59	1.33
$\text{Log}(\text{Topic}_t)$ -> Log(IU)	1.43	0.81	1.24 0.94		0.75	1.32	0.99	0.15	0.40
Time lag	2L	2L	1L,2L		2L	2L	2L	2L	2L

*denotes $p < 0.05$; IU denotes internet users

6. Conclusions and future directions

With the rapid changes in the environment related to technology and internet users demands,

internet governance has gained wide attention both from academics and practitioners. Drawing on the computational textual analysis of 305 internet governance related policies and regulations collected from Chinalaw.gov.cn, this study provides contributions to existing research on China's internet governance in several ways.

First, it systematically reviewed the IG related policies and regulations in mainland China from 1994 to 2017. The contribution of this paper

Second,

Third,

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