Measurement on the policy diffusion: evidence from China's policy documents

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ABSTRACT

By utilising policy reference network analysis and keyword timing analysis, this paper proposes a framework for measuring policy diffusion, which can delineate research focus, measurement indicators, and methods of science and technology policy diffusion from four dimensions: intensity, breadth, speed, and direction. Based on the framework, this paper collects and categorises China's policies on technology transfer and commercialisation from 1985 to 2017, and conducts quantitative research on the diffusion process and characteristics of those polices from the previously mentioned four dimensions, which enables us to investigate the diffusion law of knowledge, information, and experience among those policies. The paper can provide data support on the choice of policy type for subsequent specific policy formulation by exploring the characteristics of different types of policy diffusion.

1. Introduction

Since the 1960s, policy diffusion theory has emerged and made significant progress. It has increasingly become the focus of public policy academic and industrial circles (Walker 1969; Berry and Baybeck 2005; Berry and Berry 2019; Zhang and Zhu 2019) and has promoted the development of policy process theory. Policy diffusion generally refers to the process by which a policy programme is transferred from one department or region to another, then adopted and implemented by new policy entities (Lucas 1983). Public policy scholars have begun to look more into the internal factors and driving forces for policy diffusion based on the case study, and have sought to describe the process, model, and path of policy diffusion from a practical perspective (Shipan and Volden 2008; Xiang and Ma 2019).

Upon reviewing literature on policy diffusion in recent years, most studies have focused on the following aspects: mechanisms, influence factors, and basic models of policy diffusion. Diffusion mechanism is a systematic set of statements that provides a plausible account on why the behaviour of A influences that of B (Braun and Gilardi 2006). Scholars have focused on many diverse mechanisms such as the spreading process of the policies (Shipan and Volden 2008), the role of similarities across governments (Simmons and Elkins 2004), the influence of policy success (Meseguer 2006), the extent to which the nature of policies themselves influences their diffusion (Makse and Volden 2011; Nicholson-Crotty and Carley 2016; Wu and Zhang 2018), etc. So far, most studies define four major mechanisms that specify how policy choices in one state are influenced by the choices of other

states, including learning, economic competition, imitation, and coercion (Butler et al. 2017). In regard to studies on the influence factors of policy diffusion, it can be divided into threel levels: (1) macro factors, such as the political, social, and economic characteristics of the adopted country of region (Karch 2007; Butler et al. 2017); (2) diffusion characteristics of innovative adopters and social network factors (Lanahan and Feldman 2015; Xiang and Ma 2019); and (3) factors from the nature of the policy itself (Volden 2006; Makse and Volden 2011). In regard to studies on basic models of policy diffusion, most studies discussed four basic models, such as the national interaction model, the regional diffusion model, the leader-laggard model, and the vertical influence model (Mooney 2001; Gu 2016).

Based on the aforesaid literature, we find that most research on policy diffusion was conducted in the area of political science, which mainly utilised the qualitative method. However, qualitative research is often accompanied by strong subjectivity and ambiguity. In addition, related articles mainly discussed the mechanism and impact of diffusion, and there was a literature gap on quantitative analysis and visual description of diffusion characteristics. Therefore, the research question of this paper is how to measure the policy diffusion by conduting a quantitative analysis. A policy document provides a good perspective for studying policy diffusion, especially Chinese policies. It includes information such as the issuance time, issuance department, policy tool, and policy reference. It provides data support for quantitative analysis of the characteristics and process of policy diffusion. The main theoretical method for policy document measurement is derived from bibliometrics, which is a research method for quantitative analysis on the structural attributes of policy documents. This paper attempts to establish a framework that can measure the process and characteristics of policy diffusion, and use policy document reference networks and keyword time analysis to carry out quantitative analysis. First, based on the theories and methods of knowledge diffusion, this paper proposes a multi-dimensional framework for measuring the 'strength, breadth, speed, and direction' of policy diffusion; second, this paper carries out empirical research on China's technology transfer and commercialisation policy. Through such research, this paper makes its contribution on providing a quantifiable framework and a visual way of characterisation for the study of policy diffusion, which is benefical to the scholars and policy makers for understanding the policy duffusion process from a direct and quantifiable perspective. It also provides a quantitative basis and source of indicators for carrying out the policy effect analysis and international comparative research; and a reference for the choice of policy type in the process of government policy formulation.

2. Measurement framework of policy diffusion

Based on the related concepts and research methods in the fields of knowledge diffusion and information diffusion, this paper analyses the processes and characteristics of policy diffusion from four aspects: diffusion intensity (Rowlands 2002; Liu and Rousseau 2010), diffusion breadth (Liu and Rousseau 2010), diffusion speed (Faber Frandsen 2004; Rousseau 2005), and diffusion direction (Allen, Pettus-Davis, and Haider-Markel 2004; Huang 2016). The description indicators are the intensity of policy diffusion, the breadth of policy diffusion, the speed of policy diffusion, and the direction of policy diffusion.

The intensity of policy diffusion (IPD) describes diffusion from the perspective of the frequency on a specified path. The higher the frequency of diffusion in the policy sample set in a certain period, the greater the intensity. IPD is divided into Absolute Intensity (AI) and Relative Intensity (RI). AI is the cumulative referenced frequency (expressed by R_i) of a single policy in the policy reference network. RI is the ratio of the Absolute Intensity R_i to the sum of the reference frequency (expressed by SR) of the policy sample set, that is R_i/SR.

The breadth of policy diffusion (BPD) describes diffusion from the perspective of coverage. The larger the coverage, the greater the breadth. As with IPDI, BPD is also divided into Absolute Breadth (AB) and Relative Breadth (RB). AB of a single policy diffusion is the number of departments
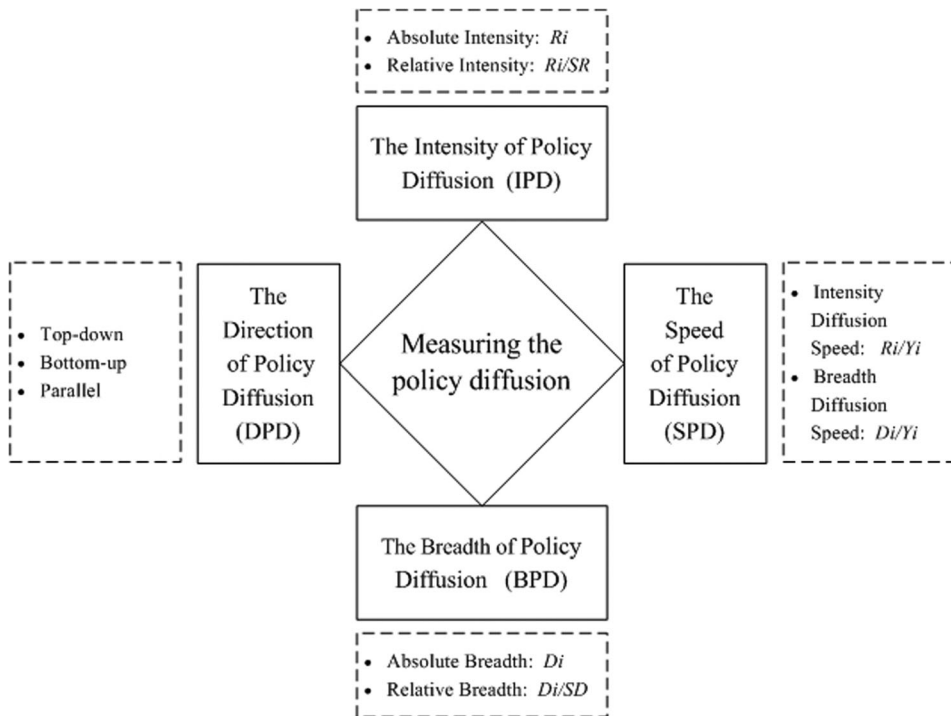
Figure 1. The framework for measuring the policy diffusion.

(expressed by D_i) that reference the policy. RB is the ratio of the Absolute Breadth D_i to the total number of departments (expressed by SD) involved in the policy sample set, that is D_i/SD.

The speed of policy diffusion (SPD) describes diffusion from the perspective of speed. The shorter the time spent on a given diffusion target, the faster the diffusion speed. SPD is divided into intensity diffusion speed (IDS) and breadth diffusion speed (BDS). IDS is the ratio of the absolute diffusion intensity R_i to the number of years of policy enactment Y_i, that is R_i/Y_i. BDS is the ratio of the absolute spread breadth D_i to the number of years of policy enactment Y_i, that is D_i/Y_i.

The direction of policy diffusion (DPD) describes the diffusion from the perspective of direction. The policy issue department consists of two levels: the central government and the local government. The policy documents have three types of relationship: upward, downward, and parallel. Therefore, unlike general knowledge diffusion, DPD includes three directions: top-down, bottom-up, and parallel. On the one hand, DPD can be expressed by the direction of the arrow in the policy reference network. On the other hand, the timing relationship of the same type of policy tool can be presented through the keyword timing map.

According to those analysis dimensions, the paper proposed a framework for measuring policy diffusion (as shown in Figure 1).

3. Measuring policy diffusion in China

In this section, the paper utilises China's policies on technology transfer and commercialisation (TTC) as the policy dataset to verify the aforesaid framework for measuring the policy diffusion. The paper delineates the diffusion of China's policies on TTC from four aspects: intensity, breadth, speed, and direction. On the basis of data analysis, the paper also shows how to explain the diffusion merits from these four aspects.

3.1. Data setting and methods

3.1.1. China's policy data collection

Technology is the engine for economic growth and the main driving force for improving comprehensive national strength (Luo, Olechowski, and Magee 2014; Wapner 2016). Promoting the technology transfer and commercialisation, as well as accelerating the industrialisation have always been important parts of the science and technology policies for developed countries and regions, such as the United States, the European Union, and Japan (Bozeman 2000; Prud'homme et al. 2018). Since the view of 'two skins of China's science and technology, and economic development' was proposed in 1985, the Chinese government has been focusing on TTC. The Chinese government has released a series of policies to promote the coordinated development of science and technology and the economy. The system for China's policies on TTC, which has been formed over the past 30 years, has the characteristics of long-term, multi-level, multi-type, and diversified tools. This provides a rich, effective, and applicable sample for a quantitative analysis of policy diffusion.

China's policies on TTC are suitable for the analysis of policy diffusion due to three reasons. First, China's policy making is divided into two levels: the central government and the local government, which enable us to investigate the phenomena of policy diffusion between two levels of government. Second, China's policies on TTC involve the specific application of a large number of policy tools, which are used in different ways and at different times, which allows for the phenomenon of diffusion. Third, the Chinese government has continued to issue policies related to TTC over the years. The policy documents have a good continuity and are conducive to observing the phenomenon of policy diffusion from the time period.

The law database from Peking University is one of the core databases for the study of Chinese policy documents. The database system contains all the legal and regulatory documents from 1949 to the present, providing a rich source of data for policy research. Based on this database, this paper collects and clarifies the Chinese policies related to TTC from 1985 to 2017. There are three steps in the data cleaning process as shown in Figure 2. First, we searched the full text of the policies using the words 'transformation of scientific and technological achievements', 'technology transfer', 'technology popularization', 'commercialization', and 'industrialization'. A total of 9953 policies were identified, including 1768 issued by the central government's departments, and 8185 by the local government's departments (which included only the policies of the province and municipality level). Second, we selected the policies that were closely related to TTC by considering whether the objectives, methods and specific tools of TTC were explicitly mentioned in the policy documents. Third, policy makers and policy researchers were invited to re-verify the data selection criterion from the Ministry of Science and Technology, Tsinghua University, etc. Finally, 2324 of China's policies on TTC were selected, including 517 from the central government and 1807 from the local government.

3.1.2. Methods

Policy document measurement introduces bibliometrics, sociology, mathematics, statistics, and other subject methods into policy analysis. It focuses more on quantitative analysis for large sample sizes – structured or semi-structured policy documents. It originates from bibliometrics, and evolves through the migration of bibliometric methods in policy documents, such as timing analysis, word frequency analysis, co-word analysis, network analysis, citation analysis etc (Li et al. 2015; Huang et al. 2015). In order to measure Chinese policy diffution, we utilise the methods of policy document reference network and keyword time analysis.

(1) Policy document reference network

The reference between China's policy documents is similar to the citation of the literature, and the names of the referenced policies will be listed in the policy. The policy reference relationship
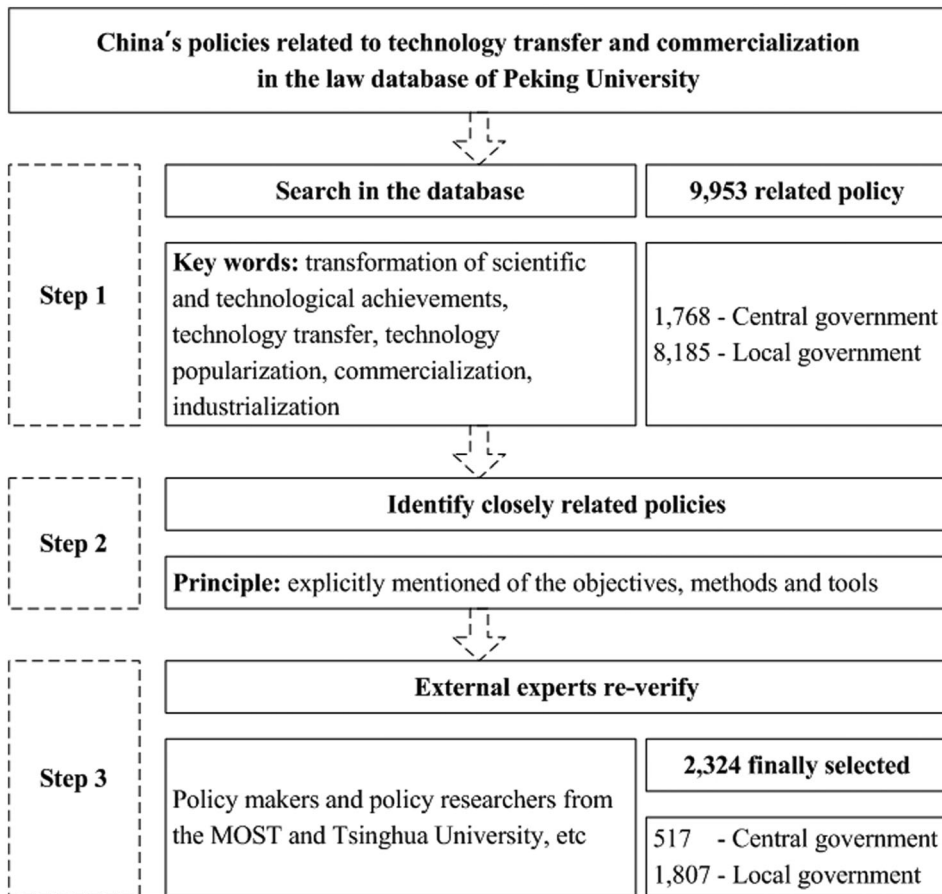
Figure 2. The data cleaning process.

includes one central government department referencing other central government departments, or one local government department referencing the central government departments. For China's policy document, if the words such as 'according to', 'based on', 'referenced', 'compliance', and 'implementation' can be found and is followed by a specific policy B, in the first paragraph of Policy A, we believed that Policy A referenced Policy B.

For example, the policy 'Regulations of Zhejiang Province on Promoting the Transformation of Scientific and Technological Achievements' (Policy A), which was issued by Zhejiang Provincial People's Congress (including the Standing Committee) in 2004, mentioned that

> According to the 'Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements (Policy B)', the Provincial People's Congress set up the regulations to promoting the transformation of scientific and technological achievements, economic construction and social development …

This can be regarded as a reference relationship between the aforesaid two policies. The above-mentioned Zhejiang provincial policy (Policy A) is a referencing policy, and the policy issued by the central goverment is a referenced policy (Policy B).

We cleaned up 2324 policy documents and identified 1867 pairs of reference relationships by reading, comparing, screening, and eliminating duplicates and suspicious items one by one.

(2) Keyword timing analysis

The intensity, breadth, speed, and direction of policy diffusion can be analysed among central government departments or from central governments to local governments through the reference network analysis of the policy documents. However, it is difficult to reflect the process and characteristics of policy diffusion among local government departments or from the local government to the central government. Therefore, the paper introduces a keyword timing analysis method and uses two policy tools: (1) the equity incentive on service's scientific and technological achievements; and (2) the guidance fund of transformation of scientific and technological achievements, as the research objects. The closely related policy keywords were manually extracted from the database. In order to reduce the interference caused by low frequency words to the analysis results, only high frequency words were selected with a word frequency no less than two. In addition, the keywords were arranged according to the year in which they first appeared, forming a keyword timing map, which reflected the diffusion process for these two policy tools.

3.2. Results

3.2.1. The diffusion intensity of China's policies on TTC

The Absolute Intensity (AI) of policy diffusion indicates the frequency of a policy being referenced, that is R_i, which can be directly obtained through the policy document reference network. In the reference network for China's policy documents on TTC, there are 1867 lines (reference relationship), so the total frequency of policy reference is 1867; that is, SR is 1867. The Relative Intensity (RI) for a policy can be calculated by R_i/SR.

Table 1 shows the diffusion intensity for China's top 20 policies on TTC. The main issue departments were the Standing Committee of the National People's Congress (SCNPC), the Central Committee of the Communist Party of China (CCCPC), and the State Council (SC). China's general policies on TTC referenced the policies issued by those departments, which have a very high administrative level.

We found that the policies with high diffusion intensity fall into two categories: law and planning. The legal policies included policy 1, and 3 to 6; the planning policies included policy 2, 9, 10, 11, and 13 to 20. The legal policy with the highest diffusion intensity was 'Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements' (hereinafter referred to as the 'Law (1996)'). The revised version of the law was issued in 2015, which was 'Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements (2015 Revision)' (hereinafter referred to as 'Law (2015)'). By the end of 2017, the absolute diffusion intensity of 'Law (2015)' was 98, ranking third. The reason for this phenomenon is that, in order to manage and coordinate with the promotion of transformation of scientific and technological achievements within their respective administrative regions, the local governments will issue local supporting policies, such as 'Regulations on the Transformation of Scientific and Technological Achivements', in accordance with the 'Law (1996)' or 'Law (2015)'. Therefore, those local policy documents will reference the one of those two policies. The planning policy with the highest diffusion intensity was the 'Outline of the National Program for Medium- and Long-Term Science and Technology Development (2006–2020)' (hereinafter referred to as 'Outline (2005)'). The high diffusion intensity suggests that it is well implemented within the framework of China's science and technology management and operation. According to the overall requirements proposed by the Central Committee of the Communist Party of China (CCCPC) and the State Council (SC), the other central government departments and local government developments have implemented the tasks claimed by the 'Outline (2005)' through the introduction of corresponding policies and measures. They also formed an extensive response and comprehensive task implementation mechanism. It is also worth noting that in specific areas, agriculture (Policies 4 and 15) and manufacturing (Policy 11) policies were valued. China has attached great importance to agriculture, and the policies related to TTC had continuity. Meanwhile, with the continuous advancement of science and technology, TTC related to manufacturing gradually became the focus of new policies. In addition, the

Table 1. The diffusion intensity for China's policies on TTC (Top 20).

Rank	Policy title	Issue department	Policy category	Issue time	AI	RI
1	Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements	SCNPC	Law	1996	129	0.0691
2	Outline of the National Program for Medium- and Long-Term Science and Technology Development (2006–2020)	SC	Planning	2005	118	0.0632
3	Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements (2015 Revision)	SCNPC	Law	2015	98	0.0525
4	Law of the People's Republic of China on Popularizing Agricultural Technology	SCNPC	Law	1993	50	0.0268
5	Law of the People's Republic of China on Scientific and Technological Progress (2007 Revision)	SCNPC	Law	2007	48	0.0257
6	Law of the People's Republic of China on Scientific and Technological Progress	SCNPC	Law	1993	43	0.0230
7	Regulations on Impletminting the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements	SC	-	2016	41	0.0220
8	Action Plan on Promoting the Transformation of Scientific and Technological Achievements	GOSC	-	2016	40	0.0214
9	Opinions on Deepening Institutional Reform and Accelerating the Implementation of Innovation-driven Development Strategy	CCCPC & SC	Planning	2015	39	0.0209
10	Outline of the National Strategy for Innovation-Driven Development	CCCPC & SC	Planning	2016	39	0.0209
11	Made in China 2025	SC	Planning	2015	38	0.0204
12	Implementing Regulations of the Law of the People's Republic of China for Technology Contract	NSTC	-	1989	28	0.0150
13	Decision on Implementing the Outline of Science and Technology Program to Stengthen the Ability of Indigenous Innovation	CCCPC & SC	Planning	2006	27	0.0145
14	Decision on Strengthening Technology Innovation, Developing High Technology, and Realizing Industrialization	CCCPC & SC	Planning	1999	23	0.0123
15	Opinion on Deepening Reform and Strengthening the Construction of Grassroots Agricultural Technology Popularization System	SC	Planning	2006	23	0.0123
16	Opinion on Deepening the Reform of the Science and Technology System and Accelerating the Construction of the National Innovation System	CCCPC & SC	Planning	2012	23	0.0123
17	The 13th Five-Year Plan for National Science and Technology Innovation	SC	Planning	2016	21	0.0112
18	Supporting Policies on Implementing the Outline of the National Program for Medium- and Long-Term Science and Technology Development (2006-2020)	SC	Planning	2006	20	0.0107
19	Decision on Accelerating the Cultivation and Development of Strategic Emerging Industries	SC	Planning	2010	20	0.0107
20	Outline of the 13th Five-Year Plan for the National Economic and Social Development of the People's Republic of China	NPC	Planning	2016	19	0.0102

policies issued in the past two years (Policies 7, 8, 10, 17, and 20) had relatively high diffusion intensity. This indicated that the emphasis of China's policies on TTC had been continuously strengthened, and the response speed had been accelerated.

3.2.2. The diffusion breadth of China's policies on TTC

The Absolute Breadth (AB) of a policy diffusion is the number of departments that reference the policy; that is D_i, which can be obtained through the reference network of the policy issue department. The reference network of the policy issue departments consists of 65 central government departments, such as the Standing Committee of the National People's Congress (SCNPC), the Central Committee of the Communist Party of China (CCCPC), the State Council (SC), the Ministry

of Science and Technology (MOST), the Ministry of Finance (MOF), and the National Development and Reform Commission (NDRC) and 294 local government departments on the level of provinces, municipalities, and autonomous regions. Therefore, the total number of departments SD was 359 involved in the policy sample set. The Relative Breadth (RB) for each policy can be calculated by D_i/SD. Through calculations, it was found that among the policies issued by the central government, the average RB for legal policies (5 pieces) was 0.18106, and the average RB for planning policies (30 pieces) was 0.03435. This indicated that the legal policies had a wider diffusion breadth than the planning policies.

The 'Law (1996)' and the 'Outline (2005)' were the top 2 policies in diffusion intensity and had the greatest influence on China's policies for TTC. Therefore, we took these two policies as examples to measure the diffusion breadth and analyse its characteristics. The number of departments that referenced the 'Law (1996)' was 96, of which 21 were central government departments and 75 were local government departments. The absolute diffusion breadth was 96, and the relative diffusion breadth was 0.26741. The number of departments that referenced the 'Outline (2005)' was 64, of which 15 were central government departments and 49 were local government departments. The absolute diffusion breadth was 64 and the relative diffusion breadth was 0.17827.

The line graph in Figure 3 shows that the absolute diffusion breadth of the 'Law (1996)' was higher than the 'Outline (2005)', and thus had a larger coverage. The area chart shows that the increment of the diffusion breadth for the 'Law (1996)' was stable at the beginning. After four years of rapid diffusion, the growth speed slowed down in 2000, saturated in 2012, and then increased tardily in the next few years until the issue of the 'Law (2015)' in August 2015. The revised law showed a sustained and stable breadth diffusion model compared to planning policies. The diffusion breadth for the 'Outline (2005)' was 33 within one year after the promulgation in 2005, and has stabilised since the second year until the promulgation of the 'The 12th Five-Year Plan for National Science and Technology Development' in 2011. After that, the policy diffusion breadth of the 'Outline (2005)' became saturated. This indicated an instantaneous explosion pattern. The widely different breadth diffusion models for these two policies was caused by their different policy categories and characteristics. The 'Law (1996)' is a legally authoritative public policy (legal policy category), and its diffusion breadth was relatively long-lasting and stable. The 'Outline (2005)' is a politically mobilised public policy (planning policy category). After the
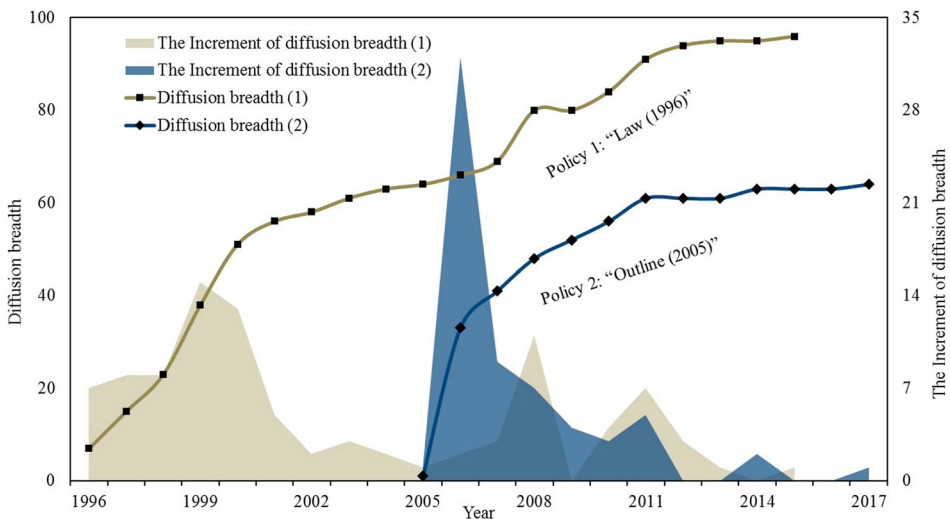

Figure 3. The diffusion breadth and its increment of the 'Law (1996)' and the 'Outline (2005)'.

promulgation, government departments at all levels responded quickly, resulting in explosive growth for its diffusion breadth.

3.2.3. The diffusion speed of China's policies on TTC

In this section, we still use the 'Law (1996)' and the 'Outline (2005)' as the analysis objects. We measured and analysed their diffusion speeds and characteristics. The policy's intensity diffusion speed (IDS) represents the longitudinal velocity of a specified diffusion path, and the policy's breadth diffusion speed (BDS) represents the lateral velocity of the policy diffusion between different departments. As of 2015, the number of years for implementing the 'Law (1996)' was 20 years. Its absolute intensity was 129 (as shown in Table 1) and its absolute breadth was 96. Thus, the IDS and BDS for the 'Law (1996)' were 6.45 and 4.8, respectively. As of 2017, the number of years for implementing the 'Outline (2005)' was 13 years. Its absolute intensity for policy diffusion was 118 (as shown in Table 1) and its absolute breadth was 64. Thus, the IDS and BDS for the 'Outline (2005)' were 9.08 and 4.92, respectively. It can be seen that the former was slower than the latter in both the IDS and BDS.

Taking the aforesaid two policies as a case, Figure 4 presents two differnet types of diffusion speed: the legal policy and the planning policy. Similar to the increment change in policy diffusion breadth shown in Figure 3, the IDS and BDS for the 'Law (1996)' remained stable. The IDS and BDS for the 'Outline (2005)', had a very fast speed in 2006, and then had a downward trend. This was caused by the differrent characteristics of different policy categories.

3.2.4. The diffusion direction of China's policies on TTC

The direction of policy diffusion indicates the flow direction for policy knowledge and information among government departments. The reference network of the policy document issue department reflects policy that can diffuse in two directions: within the central government departments, as well as the central government departments to local government departments. However, the reference network of the policy document issuing department cannot reflect the diffusion among the departments of the local government, or the diffusion from the local government to the central
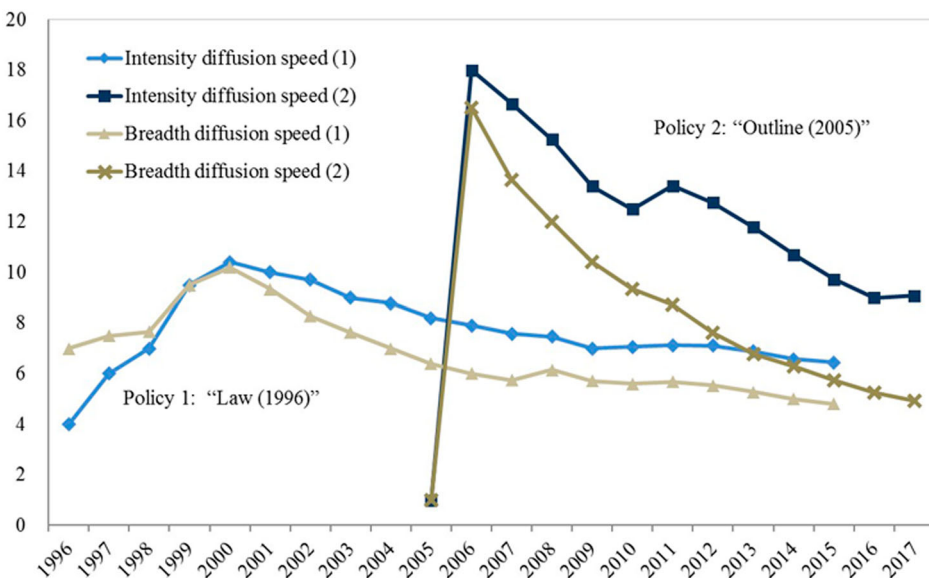

Figure 4. The intensity diffusion speed and breadth diffusion speed for the 'Law (1996)' and the 'Outline (2005)'.

government. Moreover, it's unable to present the diffusion for specific policy knowledge and information among different levels of government departments. In this situation, keyword timing analysis emerges as a helpful tool of supplementing and verifying the direction of policy diffusion.

The paper selects two types of policy tools to explore the diffusion direciton: (1) the equity incentive on the service's scientific and technological achievements (STA); and (2) the guidance fund of transformation of scientific and technological achievements (TSTA). The keywords are arranged according to the year in which they first appear. They form a keyword time series map to reflect the diffusion direction for policy tools among policy issuing departments.

Equity incentive tools are regarded as 'reforms to solve the problem of transformation of the achievements of public institutions' in China. In order to promote the transformation and industrialisation of STA, especially to solve the problem of the 'long-term lock on the cabinet' of STA of public institutions and universities, the Beijing government first mentioned several measures on strengthening the equity incentive on service's STA in the 'Opinions on Building a National Indigenous Innovation Demonstration Zone in Zhongguancun' issued in April 2009. In June 2009, Ningxia Province also issued a similar policy. In February 2010, the MOST and the MOF jointly issued the 'Measures for the Implementation of Equity and Dividend Incentives of Zhongguancun National Indigenous Innovation Demonstration Zone', and announced the implementation of national independent innovation demonstration zones such as Wuhan East Lake and Shanghai Zhangjiang. Figure 5 shows the diffusion process for the equity incentive on service's STA among different levels of government department policies. It shows that the equity incentive on service's STA as a typical policy tool was first tried by local governments and then spread among local governments. After its adoption by the central government, it was promoted nationwide through administrative orders. In the early stage of policy diffusion, there was a parallel diffusion among local government departments and a bottom-up diffusion of 'the central government to local government'. This has led to top-down progressive diffusion and parallel diffusion among central government departments.
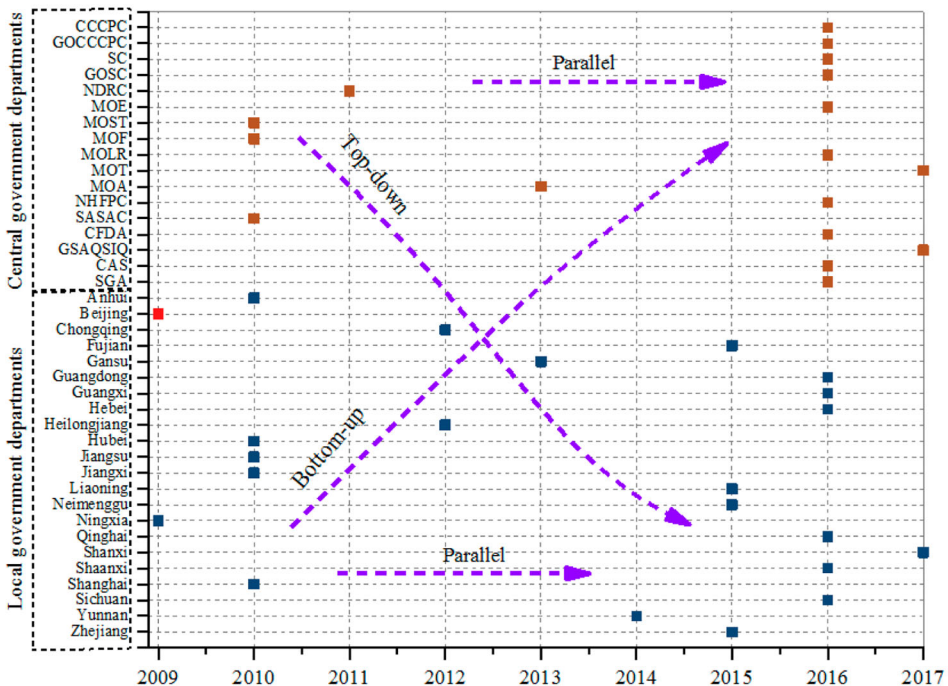

Figure 5. The diffusion direction of the policy tool: the equity incentive on service's STA.

Figure 6 shows the diffusion process for the guidance fund of TSTA among different levels of government department policies. In 2011, in order to promote the transformation and application of STA, social forces and local governments were guided to increase investment in TSTA. MOST and MOF jointly issued 'Interim Measures for the Administration of National Scientific and Technological Achievementss', which proposed to build a guidance fund for TSTA. The fund aimed to give full play to the leverage and guidance of fiscal funds, innovating financial and scientific investment methods, driving capital and private investment to transform STA, and further improving the diversified, multi-level, and multi-channel technology investment and financing system. After the aforesaid central government policy, several local governments also issued policies to build a guidance fund for TSTA, such as Fujian Province, Beijing, and Guangdong Province from 2011 to 2017. The guidance fund for TSTA as a policy tool presented a top-down diffusion from central government to local government and parallel diffusion among central government departments.

4. Conclusions and discussions

Based on the policy reference network and keyword timing analysis, the paper proposed a framework for measuring policy diffusion, which can delineate the research focus, measurement indicators, and methods of public policy diffusion from four dimensions: intensity, breadth, speed, and direction. The intensity of policy diffusion reflects the frequency of policy diffusion, and the breadth of diffusion reflects the coverage of policy diffusion. The intensity and breadth of diffusion together represent the influence of a policy. The diffusion speed is divided into intensity speed and breadth speed, which respectively reflect the longitudinal velocity of the policy diffusion path and the lateral velocity of the policy diffusion among different departments. The direction of diffusion reflects the flow of policy knowledge and information among government
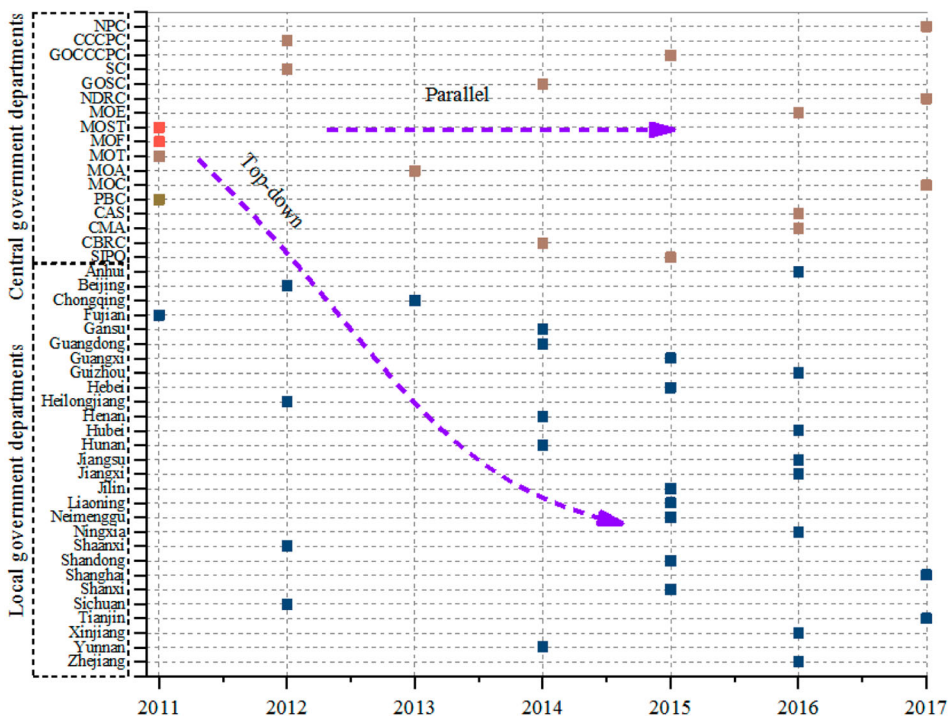

Figure 6. The diffusion direction of the policy tool: the guidance fund for TSTA.

departments, including the diffusion at the same government level, and the diffusion between the upper and lower departments.

The paper utilises this measurement framework to empirically analyse the diffusion of China's policies on technology transfer and commercialisation. From the perspective of diffusion intensity, the 'Law (1996)' issued by the Standing Committee of the National People's Congress (SCNPC) had the highest intensity, followed by the 'Outline (2005)' issued by the State Council (SC) in 2005. The top 20 policies with the highest intensity were mainly legal policies and planning policies. From the perspective of the breadth and speed of diffusion, the legal policies' coverage was larger but their diffusion speed was relatively low. The political mobilisation planning policies had a shorter response time. Their diffusion speed reached its peak very quickly, then sharply declined. From the perspective of diffusion direction, through the keyword timing analysis of two types of policy tools – equity incentive on service's STA and the guidance fund of TSTA – it is found that policy diffusion has three directions: top-down, bottom-up, and parallel. On the one hand, the direction of policy diffusion is shaped by the structure of the two levels of government: central government and local government. On the other hand, different types of policy tools exhibit different directions of diffusion, depending on the degree of 'innovativeness' or 'breakthrough' of policy tools. Top-down is the versatility and extensive testing represented by 'the guidance fund of TSTA'; bottom-up is the breakthrough of the existing institutional mechanism represented by 'equity incentive on service's STA'; no matter whether it is top-down or bottom-up, more policies must first go through parallel diffusion.

Through the reference network analysis of the external characteristics of policy documents and the keyword timing analysis of the internal tools used in policy documents, the paper provides a new perspective for the study of public policy diffusion. The paper describes the process of policy diffusion from four dimensions: intensity, breadth, speed, and direction; and presents the rules and characteristics of policy diffusion by using visual means. It will serve as an effective verification tool for the research on qualitative policy diffusion. First, four indicators can be used as the basis for carrying out research on evaluation of policy effects. Second, through the analysis of different types of policies, such as laws, outlines, and plans, this paper explores the characteristics of different types of policy diffusion and will provide data support for the choice of policy type for subsequent specific policy formulation. For example, when the government formulates policies, if it hopes that the policy will spread widely, rapidly and continuously, it should carefully choose the type of policy. Third, although this paper focuses on Chinese policy research, we hope that further follow-up on international comparative research will be conducted to see whether the diffusion characteristics under the Chinese scenario will remain the same or differentiate from the diffusion characteristics in the Western countries such as the United States, and what may be the difference. Such comparative studies may help us better understand the characteristics of different countries in the process of policy formulation and implementation, and make better decisions.

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Appendix Table A1. Abbreviations for China's Government Departments (arranged alphabetically)

	Department Name	Abbreviation
1	Central Committee of the Communist Party of China	CCCPC
2	China Food and Drug Administration	CFDA
3	China Banking Regulatory Commission	CBRC
4	China Meteorological Administration	CMA
5	Chinese Academy of Sciences	CAS
6	General Office of the Central Committee of the Communist Party of China	GOCCCPC
7	General Office of the State Council	GOSC
8	General State Administration for Quality Supervision and Inspection and Quarantine	GSAQSIQ
9	Ministry of Education	MOE
10	Ministry of Finace	MOF
11	Ministry of Science and Technology	MOST
12	Ministry of Transport	MOT
13	Ministry of Agriculture	MOA
14	Ministry of Commerce	MOC
15	Ministry of Land and Resources	MOLR
16	National Development and Reform Commission	NDRC
17	National Health and Family Planning Commission	NHFPC
18	National People's Congress	NPC
19	National Science and Technology Commission	NSTC
20	People's Bank of China	PBC
21	State Council	SC
22	State Grain Administration	SGA
23	State Intellectual Property Office	SIPO
24	State-owned Assets Supervision and Administration Commission	SASAC